MOTOROLA

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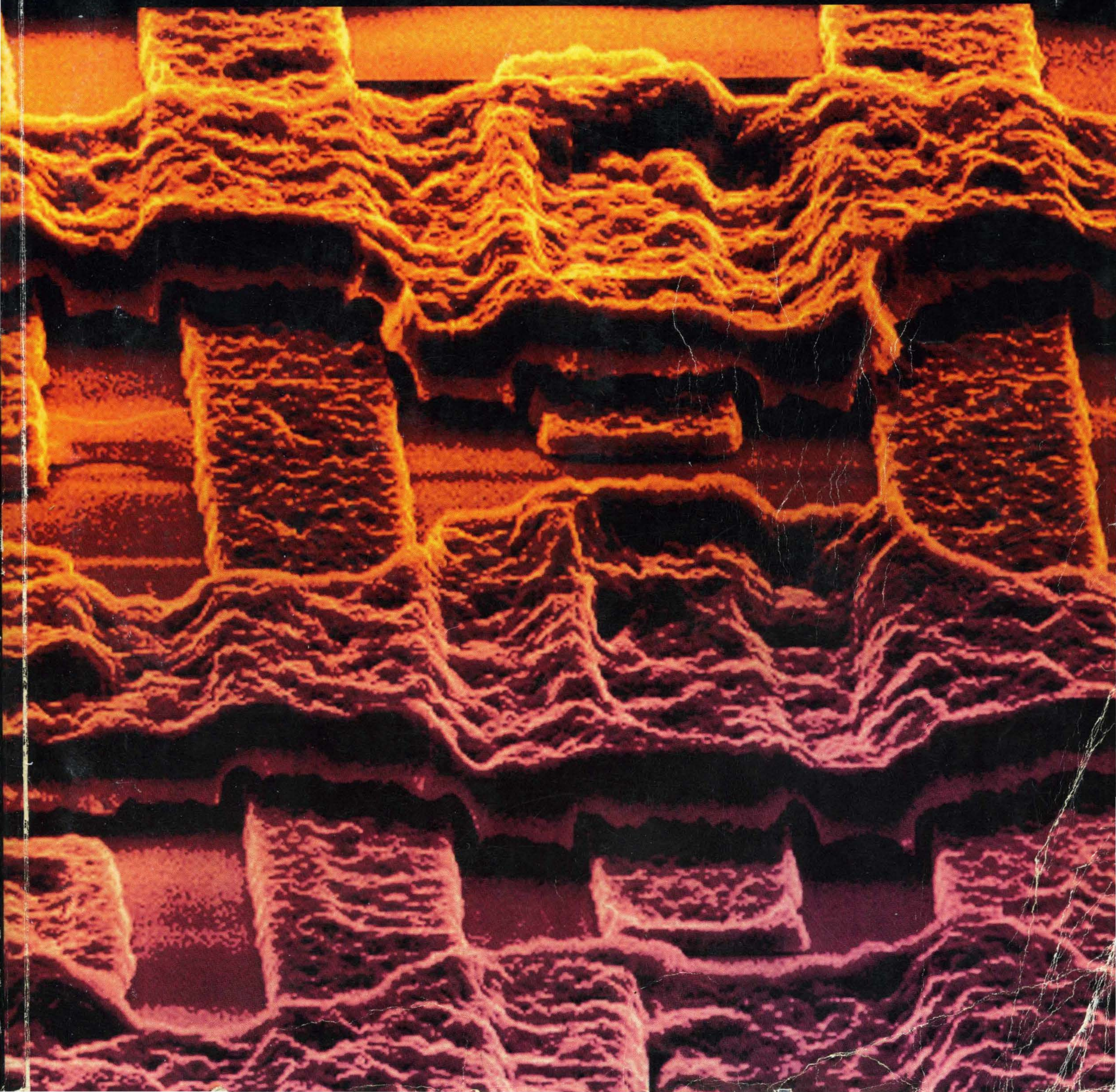
MOTOROLA SEMICONDUCTOR
MASTER SELECTION GUIDE



MOTOROLA

Master Selection Guide

Master Selection Guide

Where We Stand. . .

Total Customer Satisfaction

Service, speed and facility of response, product quality and reliability are the goals to which we are dedicated. Our commitment to progress such as Six Sigma performance and Cycle Time Reduction are symbolic of a culture in which Total Customer Satisfaction is, overwhelmingly, our primary objective.

In today's highly competitive market, selecting the most effective semiconductor components for a given application poses a significant challenge. The range of available functions and the sheer number of components within each unique product line is staggering. Add to this the number of vendors capable of satisfying a portion of the overall system demands and the selection of a cost-effective component complement can be as time consuming as the design of the system itself.

This is where Motorola occupies a unique position among semiconductor manufacturers – one that can significantly shorten the product selection cycle. Please consider these facts:

As a manufacturer of semiconductors since the very beginning of the technology, Motorola has emerged as a leading supplier of such components to the world market.

Motorola's product line is the *broadest* in the industry, capable of filling 75-80% of the many applications for semiconductor devices.

In each of its various product categories, Motorola is a recognized leader, with leading edge products as well as commodity products for mass applications.

Motorola's vast network of sales offices and distributors, augmented by manufacturing centers throughout the world, not only ensures easy communications, cost-effective pricing and rapid service, but guarantees a continuing stream of state-of-the-art products based on world-wide experience and demand.

How To Use This Guide. . .

This Selection guide is arranged to provide three-way assistance to engineers and technicians in making a first-order selection of components best suited for a specific circuit or system design.

If you have a device number that needs identification or if you want to know if Motorola manufactures a particular device type:

1. Turn to the Device Index for a complete listing of Motorola products, and the page numbers where more detailed information is given for these products.

If you have a device name or acronym and wish to know if Motorola makes such a device:

2. Look for it in the Subject Index.

If you want an overview of Motorola products for a specific product category:

3. Refer to the quick-reference product line guide located at the front of this publication or use the table of contents located at the front of each section.

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In Brief . . .

Motorola supports strategic programs and co-development partnerships to accelerate the availability of advanced processes (CMOS, BiCMOS, Bipolar), packaging and CAD technology. Extensive research, manufacturing and financial resources are focused to develop and maintain leading edge capabilities.

Page

ASIC Preview

Bipolar

ECL & ETL Series Arrays

Motorola's MOSAIC III™ technology features modified transistor structures to reduce series base resistance and collector-base junction capacitance. The result is enhanced switching speed. Mixed ECL/TTL interface compatibility and high frequency (over 2.5 GHz) operation highlights the versatile ETL Series.

CMOS

1.0 Micron HDC Series
Sub-Micron H4C & H4CPlus Series

High density CMOS arrays (HDC Series) are built on a 1.0 micron drawn, triple-layer-metal CMOS process. By utilizing three layers of metal for signal routing, designers can achieve greater utilization on a channelless architecture.

The sub-micron ($0.7\mu L_{eff}$) H4C Series enables densities over 300K gates with 365 picosecond typical gate delay performance. Available in Custom Defined Architecture (CDA).

Motorola's highest performance (0.6 micron) CMOS arrays, the H4CPlus Series, are targeted for mixed 3.3 V and 5 V applications in mid-1993. The H4CPlus arrays range in density from 13,056 to 295,596 available gates with packages ranging from 80 QFP to 447 PGA.

Application Specific MultiChip Modules

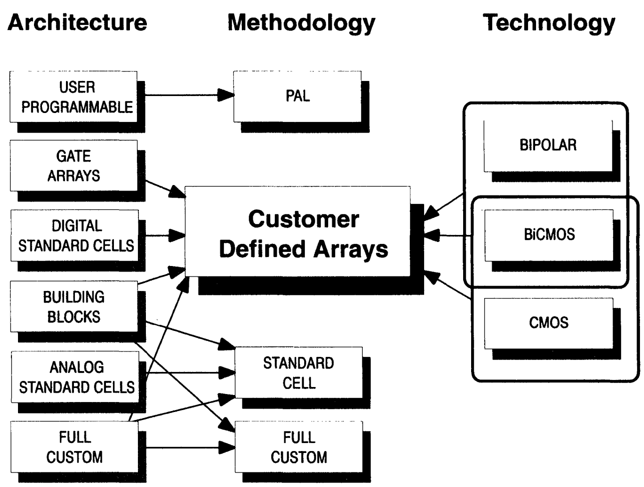
MultiChip Modules (MCM) can be defined as a packaging technology that places several semiconductor chips, interconnected with a high density substrate, into a single package. Modules often contain complex semiconductor components including microprocessor, ASIC and memory chips. These large, fast, high I/O count semiconductors place a premium on substrate interconnect, normally requiring some form of multi-layer thin film, cofired ceramic, or laminate technology.

Design Automation Software

Motorola's Open Architecture CAD System (OACS) provides a complete ASIC development environment using industry-standard workstations and leading third-party design and verification tools. The OACS system integrates sophisticated ASIC design software tools to handle high performance designs and has the required flexibility to support future technology advances.

Architecture for the 90's CDA (Customer Defined Arrays)

Performance, density and power dissipation are critical issues for next generation ASIC designs. The integration of large diffused blocks and embedded memory enhances intra-chip communication and saves board area. The Customer Defined Array (CDA) concept lets designers combine array based, cell based, and full custom logic with diffused memory blocks on a die. The concept equally supports Bipolar and CMOS, each with the capability to incorporate BiCMOS modules.



Benefits

- **Time-to-market through integration of functional building blocks and ASIC design methodology.**
- **Customers can create application specific arrays.**
- **Diffused RAM optimized for performance and density.**
- **Fixed die sizes for ease of manufacturing.**

Figure 1. CDA — Architecture of the 90s

Advanced Packaging

QFP-MCR: Quad Flat Package in lead counts from 64 to 304 in optional Molded Carrier Ring which provides coplanarity and lead protection during manufacturing, testing and shipping.

MicroCool QFP: A new QFP compatible plastic package with heat slug attached for improved heat dissipation capacity.

TAB: (Tape Automated Bonding) technology is used to bond die to an etched leadframe encased in polyimide tape. Assembled die and TAB tape supplied in 35 or 70mm carriers.

OMPAC: (Overmolded Pad Array Carrier), a surface mount plastic package with solder bumps instead of traditional pins for interfacing to printed circuit boards.

Bipolar ECL & ETL Series Arrays Third Generation

ETL Series Arrays Extend Design Flexibility

The ETL Series is flexible enough to simplify translation between high speed logic families.
Three base arrays:
MCA750ETL, MCA3200ETL, MCA6200ETL

- 848 to 6915 Equivalent Gates
- Channelled Architecture for up to 100% Utilization
- Input and Internal ECL Gate Delays - 0.15 ns (Typical)
- TTL Input/Translation Cell Delay - 0.55 ns (Typical)
- Up to 168 Universal I/O Signal Ports
- Bidirectional ECL and TTL I/O Macros
- ECL 100K, Pseudo ECL and TTL Logic Interfaces
- Programmable Speed/Power Levels
- Three-Level Series Gated Macros
- MCA2 and MCA3 ECL Series Library Compatible

Motorola's MOSAIC III™ bipolar process offers unexcelled mixed TTL/ECL interface capability in a high performance, mature technology.

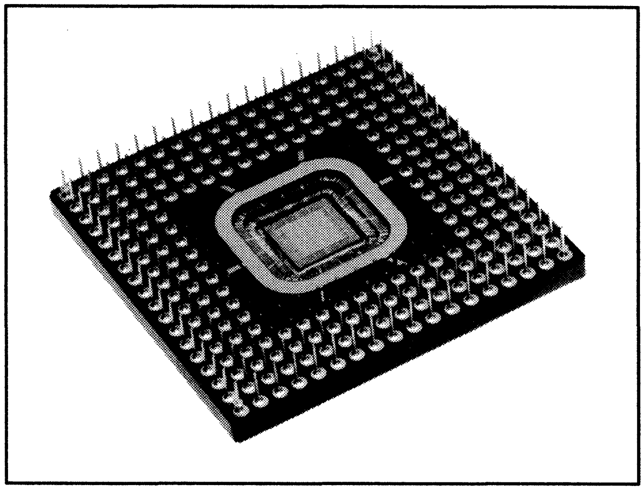


Figure 2. MCA6200ETL in Multi-Layer Ceramic 224 Pin-Grid-Array Designed for High Frequency, Mixed-Mode Applications

ETL Series Features Mixed ECL-TTL Interface

The ETL Series offers mixed ECL, PECL (pseudo ECL) and TTL compatible interfaces. The Series combines 150 ps typical gate delays with 2500 MHz operating frequencies. Any signal pin can be programmed for input, output, or bidirectional signals in ECL, TTL or PECL logic. MOSAIC III process technology, combined with innovative design, extensive macrocell library and versatile I/O structure adds up to superior performance and flexibility.

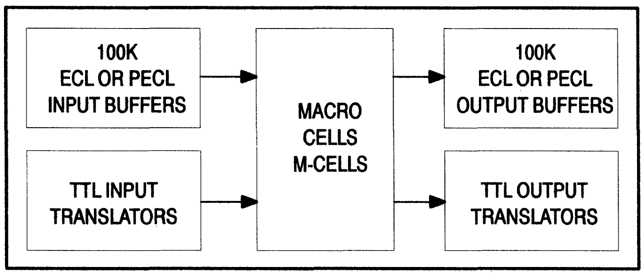


Figure 3. ETL Series Block Diagram

Table 1. ECL & ETL Series Features

Array / Features	MCA 2200ECL	MCA 10000ECL	MCA 750ETL	MCA 3200ETL	MCA 6200ETL
Technology	MOSAIC III				
Equivalent Gates	2412	12402	848	3570	6915
Internal (Major) Cells	68	414	24	110	225
I/O Signals	108	256	Universal I/O Ports		
Input/Interface Cells	96	224	42	120	168
Output (O) Cells	96	200			
Max Gate Delay (ns)	0.175	0.175	0.2	0.2	0.2
Max I/O Frequency (MHz)	1500	1200	2500	2500	2500
Typical Power Dissipation (W)	3-6	10-30	1-2	4-7	7-12

CMOS

1.0 Micron CMOS HDC Series Triple-Layer Metal

Built on a 1.0 micron, triple-layer metal CMOS process, the HDC Series represents a significant advancement in microchip technology. By utilizing three layers of metal for signal routing and power distribution, designers can achieve maximum utilization on a channelless architecture having minimum chip dimensions. The result is high performance combined with I/O flexibility and density.

The HDC Series is available in a wide variety of plastic and ceramic, through-board and surface mount packages. The diversity of package style and pin count lets the designer best match system size, cost and performance requirements.

Features

- 3,000 to 105,000 available gates
- Up to 70% utilization
- Channelless Sea-Of-Gates architecture
- 1.0 micron drawn gate length (0.8 μL_{eff})
- Triple layer metal routing and power distribution
- Eight transistor, fully utilizable, oxide isolated primary cell
- 475 picosecond typical gate delay (2-input NAND)
- Fixed RAM blocks (single, dual and quad)
- 5 V CMOS and TTL compatible I/O options
- Low power consumption of 6 μW/gate /MHz
- I/O cells can be paralleled on-chip for 48 mA drive
- Pin functions are 100% programmable as I/O or power on plastic packages
- 1000 V ESD protection, latchup immunity to 100 mA
- Comprehensive workstation based CAD support

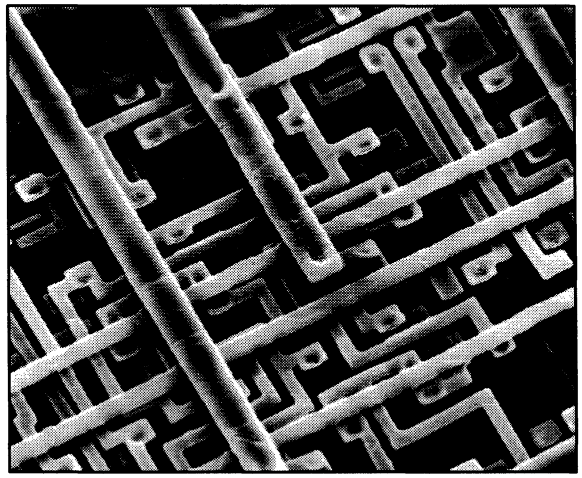


Figure 4. Triple-Layer Metal Signal Routing Enhances Utilization

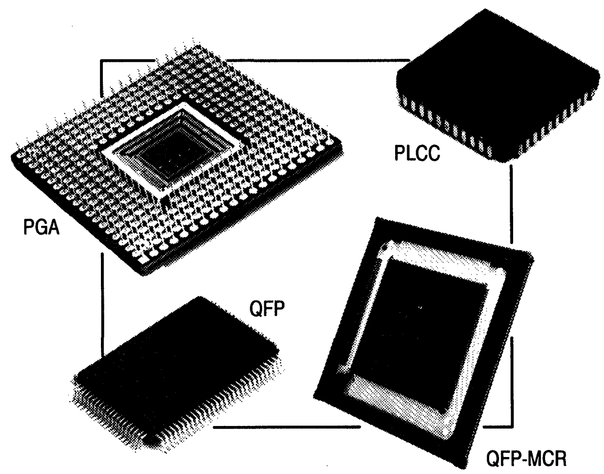


Figure 5. Typical HDC Series Packages

Table 2. HDC Series Features

Array	Available Gates	# of Die Pads (Wirebond)	Available I/O Cells	Die Size (mils square)
HDC003	3,036	76	88	136
HDC006	5,670	96	120	168
HDC008	8,208	108	144	182
HDC011	11,208	120	168	202
HDC016	16,416	136	204	232
HDC027	27,270	168	264	282
HDC031	31,290	180	280	295
HDC049	49,368	216	352	354
HDC064	63,900	240	400	402
HDC105	104,832	300	512	492

Sub-Micron CMOS H4C Series CDA Architecture

The H4C Series of CMOS Customer Defined Arrays (CDA) provides a new generation of ASICs to capture the functionality of the sub-micron process. The new fabrication process of the H4C Series supports speed requirements of 60 MHz processors with a power dissipation of only 3 μW/MHz/gate.

The CDA architecture offers the versatility and efficiency of system design on a single chip by providing large, fully-diffused architectural blocks such as user configurable SRAMs. Additionally, to ensure high quality ASIC system designs, several design-for-test implementations and clock skew management schemes are available.

Features

- 18,080 to 317,968 available gates
- Compatible channelless, Sea-Of-Gates and CDA architectures
- 0.7 micron effective gate length
- Triple-layer-metal signal routing and power distribution
- Up to 70% gate utilization (smaller arrays)
- 365 picosecond typical gate delay (2-input NAND)
- User configurable, fully diffused SRAM blocks up to 256K bits
- Low power consumption - 3 μw/MHz/gate
- 3.3 V and 5.0 V CMOS and TTL compatible I/O cells
- Up to 556 power/ground and signal pads
- BIST, JTAG (IEEE 1149.1) and LSSD/ESSD scan supported
- Digital PLL to manage clock skew
- High performance packaging
- Extended workstation-based CAD support for embedded functions
- Special macros available to manage clock distribution and provide skew control

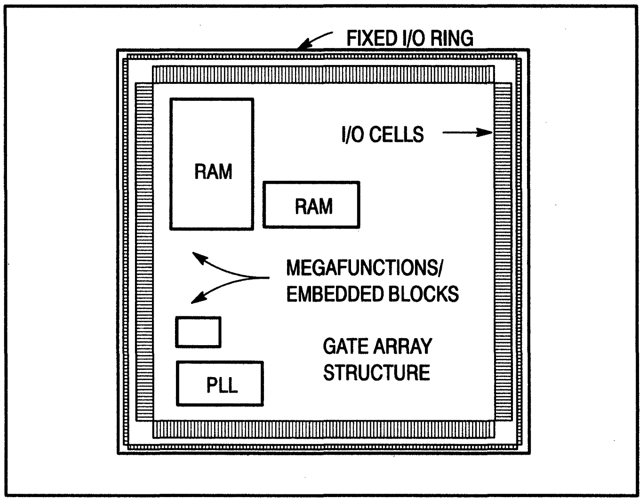


Figure 6. The CDA Concept: Megafunctions and Embedded Blocks Within a Gate Array

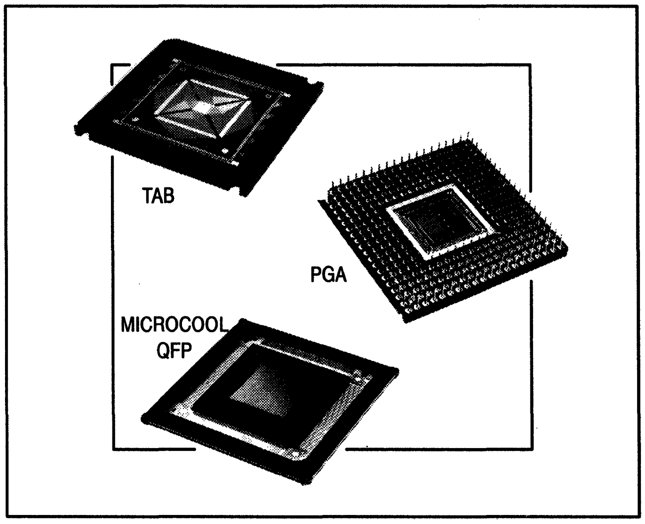


Figure 7. Typical H4C Series Packages

Table 3. H4C Series Features

Array	Available Gates	# of Die Pads Available: Wirebond	# of Die Pads Available: TAB	I/O Cells
H4C018	18,080	136	156	160
H4C027	27,048	160	188	196
H4C035	35,392	176	208	224
H4C057	57,368	216	256	284
H4C086	85,956	256	304	344
H4C123	123,136	304	360	416
H4C161	161,364	344	408	476
H4C195	195,452	376	444	524
H4C267	266,832	432	512	612
H4C318	317,968	468	556	668

Product Preview

Sub-Micron CMOS H4CPlus Series Mixed 3.3 V/5.0 V Levels

The new sub-micron CMOS H4CPlus Series is targeted for mixed 3.3V and 5V applications, as well as low-power 3.3 V systems. The H4CPlus arrays range in density from 13,056 to 295,596 available gates with packages ranging from 80 QFP to 447 PGA.

A key feature of this family is a powerful I/O buffer aimed at meeting the requirement for GTL I/O levels and capable of driving backplanes of 50Ω transmission lines in today's high-performance RISC/CISC microprocessor-based systems.

For the highest possible chip-to-chip operating frequencies, the H4CPlus family introduces Current Mode Transceiver Logic (CMTL™) buffers. This new self-terminating I/O method permits CMOS chip-to-chip interface speeds (using typical differential or single-ended inputs) to 250 MHz, at low power dissipation. It also provides a differential interface directly to industry standard ECLinPS™ logic when used with a +5V rail.

Features

- 0.6 micron effective gate length
- Typical gate delay of 280 ps for a NAN2, FO = 2 at 5 V
- Power dissipation of 1 µW/gate/MHz at 3.3 V
- Standard 5 V high performance or 2.7 V to 3.6 V low power configurations, with mixed 3.3 V and 5 V combinations
- Single I/O site, 2 mA to 24 mA drive, TTL and CMOS output macros
- PECL input buffer macros supporting inputs to 250 MHz (Typical)
- Current Mode Transceiver Logic I/O buffer for self-terminated, high-speed differential or single-ended interfacing to 250 MHz
- Separate 5 V and 3.3 V power bussing
- Fully-digital PLL macro functions for up to 75 MHz clocks
- Embedded Analog PLL macros for up to 125 MHz clocks
- Industry standard JTAG boundary scan built into I/O macros
- ESSD/LSSD scan internal macro library

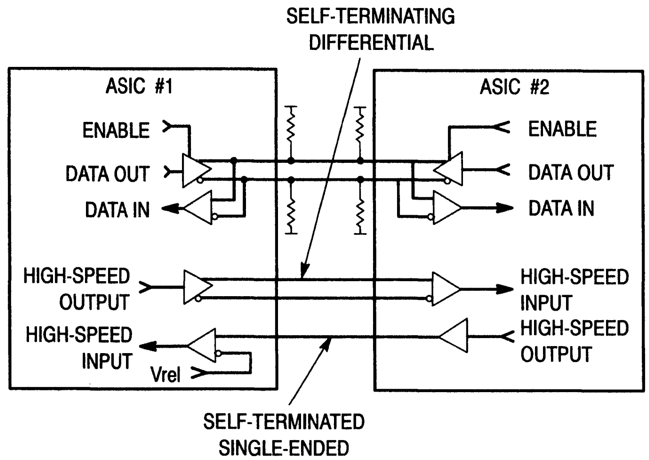


Figure 8. Interfacing H4CPlus Series with Current Mode Transceiver Logic

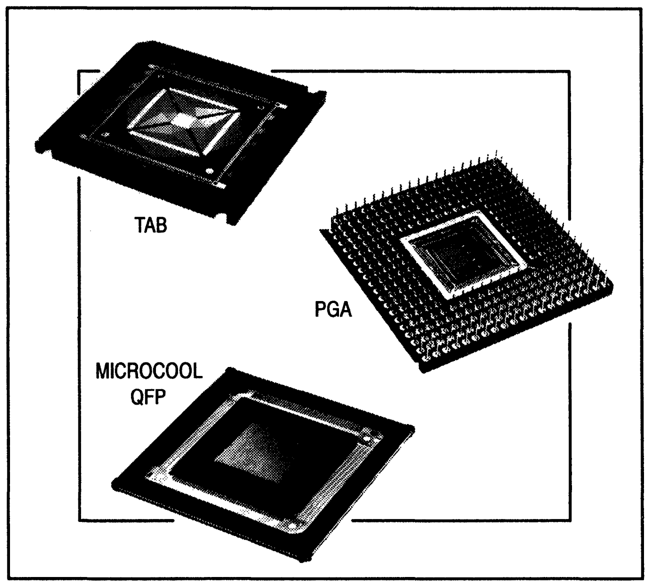


Figure 9. Typical H4C Series Packages

This document contains information on a product under development. Motorola reserves the right to change or discontinue this product without notice.

Sub-Micron CMOS H4CPlus Series CDA Mixed 3.3 V/5.0 V Levels (continued)

Table 4. H4CPlus Series Features

Array Name	Available Gates	Die Size (mils/side)	Die Pads Wirebond	I/O Sites	Package Pins
H4CP013	13,056	189	136	108	80-120
H4CP021	20,812	217	160	136	80-128
H4CP028	28,400	239	176	160	80-160
H4CP048*	48,100	287	216	208	80-208
H4CP075*	74,520	337	256	256	120-232
H4CP109*	109,368	391	304	312	160-304
H4CP146	145,544	438	344	360	160-304
H4CP178	178,000	476	376	400	160-375
H4CP246	246,372	545	432	468	447
H4CP296	295,596	589	464	512	447

*Initial Offering Mid '93

Application Specific MultiChip Modules (MCM) MCML Series

Aimed at cost sensitive, low-to-medium power applications, the MCML Series represents the next level of semiconductor integration by placing several semiconductor integrated circuit chips in a single package. Significant advantages are gained when compared with conventional single chip packages, through system miniaturization and improved system performance with shorter interconnect wiring lengths.

The MCML Series multichip module places multiple integrated circuits on a small printed circuit board (MCM-L) substrate. The combination of integrated circuits and substrate is then molded with a plastic compound. The final product is available in standard Quad Flat Pack (QFP) body sizes and lead counts. Customers using single chip QFP packages on circuit boards will be able to take advantage of multichip module packaging density while staying with existing manufacturing equipment. The MCML Series multichip modules reduce system piece parts and provide a path to lower circuit board assembly costs.

Features

- Application specific multichip modules with customer defined IC chip set
- Complete MCM product solution including design support, manufacturing, and test
- Uses Motorola's broad silicon portfolio and ASIC capability
- Cost-effective MCM-L laminate PCB-type substrate
- Standard EIAJ plastic quad flat pack (QFP) sizes
  128, 160, or 208 leads in a 28 mm body size
  232 or 304 leads in a 40 mm body size
- Compatible with surface-mount PC board manufacturing and test equipment
- Comprehensive workstation based CAD support

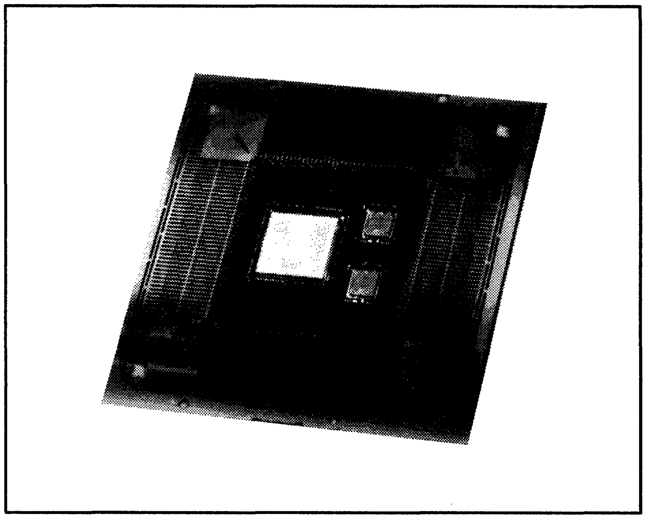


Figure 10. Typical MCML Series Module Containing One Gate Array and Two SRAMs On a 28 mm Substrate In a 160 Lead QFP Package

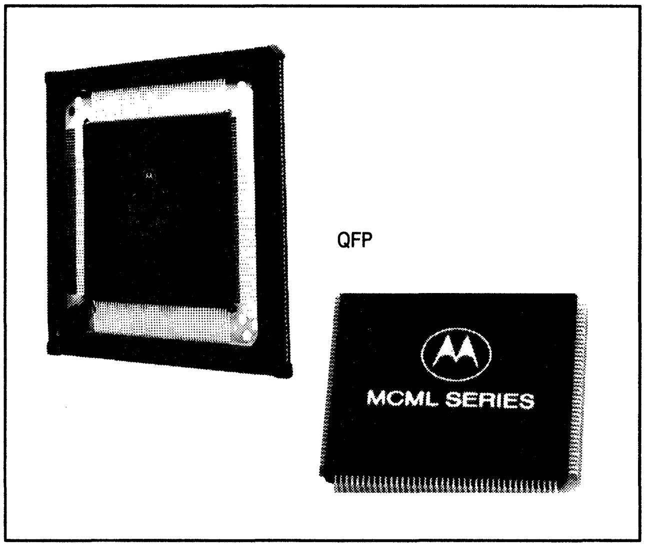


Figure 11. QFP in Optional Molded Carrier Ring or Excised QFP

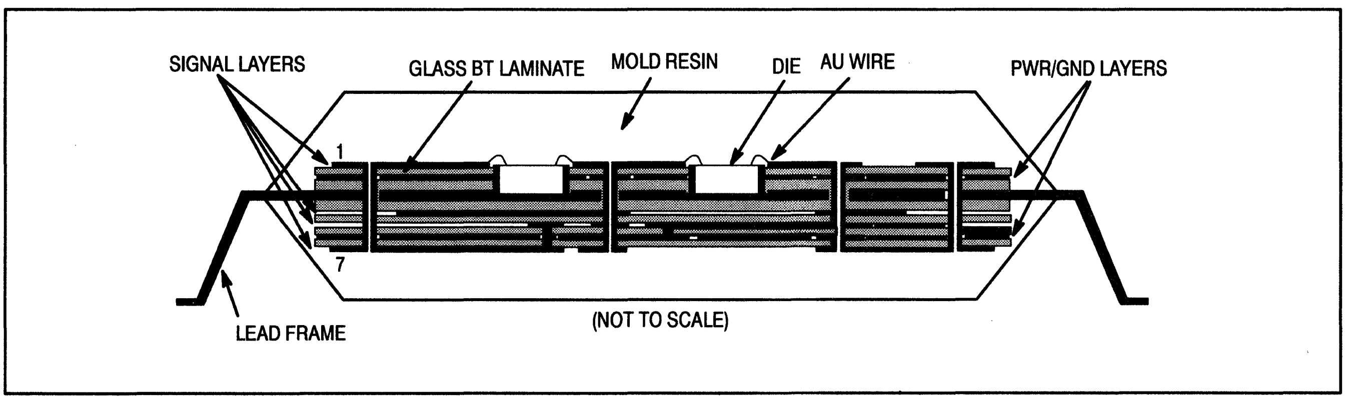


Figure 12. Basic Structure of Seven-layer MCML Series MultiChip Module

Design Automation Software

The Open Architecture CAD System (OACS) provides Motorola customers with a state-of-the-art and complete ASIC design solution. The OACS consists of sophisticated ASIC design software tools to handle today's advanced gate array designs. The system also incorporates the required flexibility to support ASIC technologies of tomorrow.

The OACS system's primary goal is to provide a user-friendly, efficient suite of ASIC design tools to facilitate error-free silicon design. The system allows the user to verify correctness of the ASIC at each stage of the design process with tools that closely mimic the workings of actual silicon. Traditional design tools addressing design capture, logic interconnection verification, and functional/delay simulation are fully supported by the base OACS system. Optional productivity enhancement packages such as static timing analysis, Automatic Test Pattern Generation (ATPG), and physical layout are fully supported.

Timing analysis is simplified with either Cadence Design System's Veritime timing package or Quad Design's MOTIVE timing package. These tools provide the capability to analyze the logic for all internal timing paths and input timing relationships.

OACS™

Open Architecture CAD System

OACS 2.1 features a new Motorola tool, PrediX which allows users to predict routability of a floorplan and eliminate a large portion of the difference between pre-layout and post-layout parasitics.

By using an open system approach, OACS offers a system that is universally applicable across multiple technologies. The result is a complete design system, fully supported by Motorola and guaranteed to produce silicon that performs as simulated.

OACS
2.0 and 2.1 System Highlights:

- EDIF 2.0.0 backplane approach to providing an open architecture
- Tools accessed through interactive menu system
- Extensive Electrical Rules Checking (ERC)
- Supports multiple technologies
- Design-For-Test support: ESSD/LSSD Scan, JTAG, and Muxed I/O Macros
- Clock-tree synthesis, clock skew management, timing driven layout
- Sophisticated delay calculations
  - Continuous temperature, voltage, and process variation
  - Delays computed based upon estimated and post-layout wiring
  - Based upon intrinsic delays, input edge-rates, output loading, and distributed RC delays
  - User specified output loading
- Supports the following design automation tools:
  - Synopsys' Design Compiler™ and HDL Compiler™ logic synthesis tools
  - Synopsys' Test Compiler for scan insertion*
  - Motorola's PrediX advanced physical Design System for routability and timing predictability*
  - Mentor Graphics' NetEd™ schematic capture (HP Apollo)**
  - Cadence's GED™ schematic capture (Sun)
  - Functional, pre- and post-layout simulation through:
    - — Mentor Graphics' QuickSim™**
    - — Cadence's Verilog-XL™
  - Quad Design's MOTIVE Static Timing Analysis*
  - Cadence Design's Veritime™ Static Timing Analysis*
  - Motorola's Mustang™ automatic test pattern generation
  - Motorola's Memorist™ SRAM Compiler (Single and Dual Port)
  - Motorola's TestPAS™ test vector validation and extraction
- Complete documentation covering the entire ASIC design process
- Support available on HP/Apollo™ DN4xxx, HP9000 Series 400, Sun™ 4 and SPARC workstations

*New Features in OACS 2.1.
**Features exclusive to OACS 2.0.

Advanced Packaging

Low cost, high performance systems require excellence in ASIC packaging technology. High density TAB (Tape Automated Bonding), MicroCool, QFP-MCR (Quad Flat Pack in an optional Molded Carrier Ring), OverMolded Pad Array Carrier (OMPAC) and MultiChip Module (MCM) packages illustrate cost effective manufacturing solutions for high lead count, high frequency applications.

Quad Flat Pack Molded Carrier Ring (QFP-MCR)

Motorola currently offers the popular EIAJ standard plastic Quad Flat Package (QFP) in lead counts from 64 to 208 pins. The Molded Carrier Ring (MCR) is a coplanarity and lead protection device for QFP packages. The ring provides lead protection during manufacturing/testing and shipping.

Standard ring sizes simplify manufacturing across the range of packages and improve component testability.

MicroCool Quad Flat Pack

The MicroCool QFP is a new QFP compatible plastic package with improved heat dissipation capacity. It has a heat slug attached to a printed circuit board which supports a copper lead frame. The package incorporates a molded carrier ring to maintain pin coplanarity. MicroCool packaging is cost-effective and capable of meeting high power dissipation (up to 3 W, depending on temperature and ambient conditions).

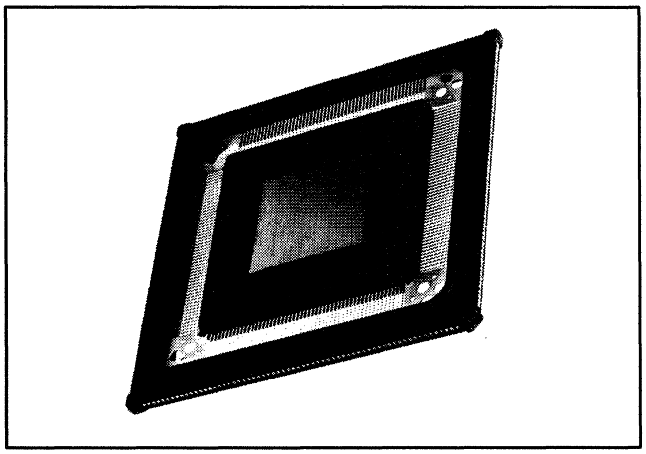


Figure 13. MicroCool Quad Flat-Pack in Molded Carrier Ring Lowers Board Cost and Improves Thermal Performance

Tape Automated Bonding

Tape Automated Bonding (TAB) represents the state-of-the-art in packaging technology. It provides high performance with ultra high pin density. In TAB technology the die pads are fabricated with gold bumps which are used to bond the die to an etched leadframe encased in polyimide tape. The assembled die and TAB tape are supplied in carriers (35 or 70 mm).

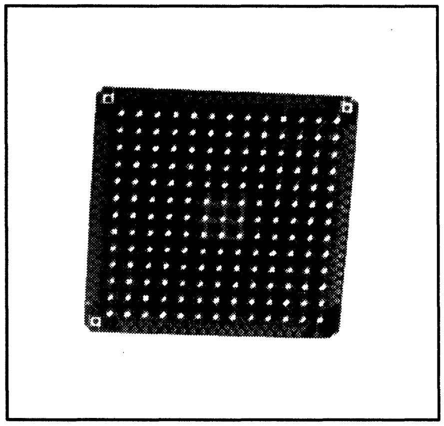


Figure 14. 169-lead OverMolded Pad Array Carrier (OMPAC) Saves Board Space and Improves Manufacturing Yields

OverMolded Pad Array Carrier (OMPAC)

. . . is a plastic surface mount package technology, with an array of solder balls on the bottom to interface with printed circuit boards.

Primary Advantages Over QFP

- Eliminates concerns with lead coplanarity and skew
- Improved electrical performance
- Comparable or better thermal performance
- Reduced board assembly defect level

Primary Advantages Over PGA

- Surface mount technology
- More cost effective

Advanced Packaging (continued)

Product Preview

High-Density MultiChip Module

High-density ceramic surface-mount or PGA formats which support applications requiring high performance, high density, high power, high pin count or large chipsets.

- Substrates are Cu/Polyimide thin-film interconnect on a ceramic base (MCM-C/D) or cofired ceramic (MCM-C).
- Supports high performance CMOS/BiCMOS arrays.
- Typical chipset: 6 to 25 chips.
- Power dissipation: Up to 40 Watts.
- QFP, PGA and Land Grid Array footprints are proposed.

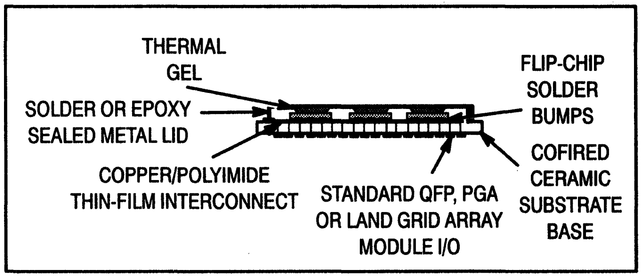


Figure 15. High Density Ceramic MultiChip Module Demo Combines Flip-Chip Die Attach Technology with Thin-Film Copper Polyimide Over Cofired Ceramic

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Literature

To order any literature item, call or write:

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Literature Distribution Center
P.O. Box 20912, Phoenix, Arizona 85036
(602) 994-6561

Order Number	Description
Design Manuals	
H4CDM/D	H4C Series CMOS Arrays
HDCDM/D	HDC Series CMOS Arrays
MCA3ETLDM/D	MCA3 ETL Series Arrays
MCA3ECL/D	MCA3 ECL Series Arrays
Data Sheets	
ETL/D	MCA750ETL, MCA3200ETL & MCA6200ETL Macrocell Arrays
H4C/D	Sub-micron H4C Series CMOS Arrays
H4CP/D	H4CPlus Series CMOS Arrays
HDC/D	HDC Series CMOS Arrays
MCA2200ECL/D	MCA2200ECL Macrocell Array
MCA10000ECL/D	MCA10000ECL Macrocell Array
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BR931/D	Symbols to Silicon (C_LAN)
BR1400/D	Open Architecture CAD System
BR1417/D	New Generation Open Architecture CAD System 3.0 M
SG367/D	ASIC Overview

Order Number	Description
Application Notes/Article Reprints	
AN1093/D	Delay & Timing Methods for CMOS ASICs
AN1095/D	Clock Distribution
AN1096/D	Guidelines for Using the Mustang™ ATPG System
AN1099/D	Test Methodology for HDC Series Arrays
AN1502/D	Embedded RAM BIST
AN1508/D	High Frequency Design Techs & Guidelines for Bipolar Gate Arrays
AN1509/D	ASIC Clock Distribution Using A PLL
AR330/D	High Density ECL Arrays Ease System Implementation
AR336/D	ASIC TAB Packaging Papers
AR337/D	Surface Mounting Tackles Fine Pitches
AR512/D	Gate Arrays Challenge Standard-Cell ASICs
AR520/D	Application Specific MultiChip Modules

ASIC Regional Design Centers

United States

California
San Jose .... (408) 749-0510

Illinois
Chicago .... (708) 490-9500

Massachusetts
Marlborough .... (508) 481-8100

International

England
Aylesbury, Bucks .... (0296) 395252

European Headquarters
Germany, Munich .... (089) 92103-0

Italy
Milan .... (02) 82201

France
Vanves .... (01) 40355877

Holland
Eindhoven .... (04998) 61211

Japan
Tokyo .... (03) 440-3311

Hong Kong, Silicon Harbour
Tai Po .... (852) 666-8333

Sweden
Stockholm .... (08) 734-8800

Microcomputer Components

2

In Brief . . .

Motorola continues to be a leading supplier of components for microcomputer systems. The product portfolio includes digital signal processors; CISC and RISC advanced microprocessors and complementary full-function peripherals; a comprehensive selection of high-performance microcontrollers; VLSI functions for Local Operating Network applications; and a broad range of fast static RAM and dynamic RAM chips and modules.

Our commitment is to provide state-of-the-art devices as well as continuing support of established products, with six-sigma quality and total customer satisfaction.

Page

Digital Signal Processors

In Brief . . .

Drawing on both design excellence and expertise in manufacturing, Motorola has created a range of architecturally compatible Digital Signal Processing chips. The philosophy behind the DSP families has been to create compatibility between products as well as conformance to international standards.

Currently, Motorola addresses three main areas of DSP hardware: general purpose, algorithm specific processors and peripherals. Our general purpose processors include 16- and 24-bit fixed point and 32-bit floating point families.

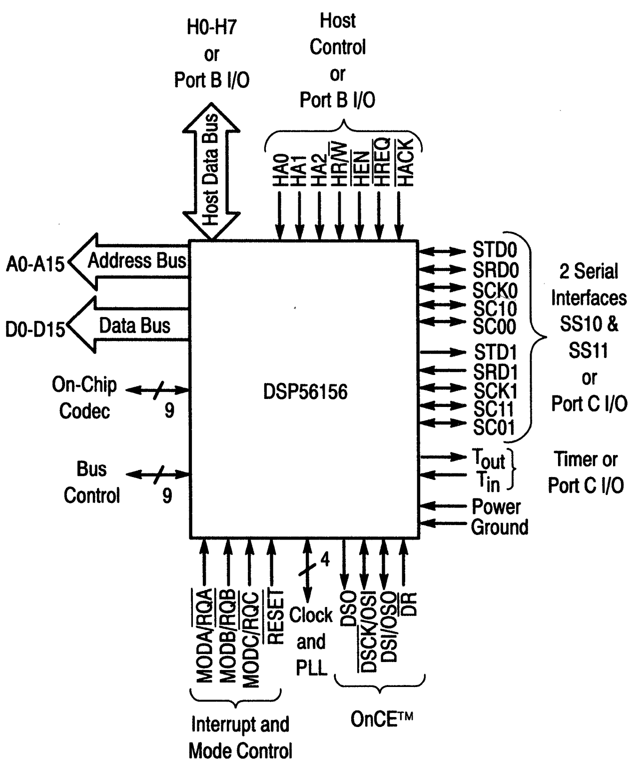
In addition, we offer a comprehensive array of development tools to give the designer access to the full power and versatility of the DSPs with minimum fuss. All the tools were designed for ease of use and functionality. They provide a low-cost means of evaluation and greatly simplify the design and development phase of a DSP project.

Page

16-/24-/32-Bit Families — Your Complete DSP Solution

DSP56100 — 16-Bit Digital Signal Processors

The DSP56100 family of HCMOS, low-power, 16-bit fixed-point general-purpose digital signal processors (DSP) is ideal for high end speech coding, telecommunications and control applications. The first DSP56100 family member, the DSP56156, combines the high-speed core with 8K bytes RAM, two serial ports, one parallel port, codec, phase-locked loop (PLL) and On-Chip Emulation (OnCE™). The DSP56166 is the second member of the DSP56100 family using the DSP5616 core and has identical package and pinout to the DSP56156 with different memory configuration and peripherals.



PART NUMBERS

Part	Description
XC56156FE40	40 MHz in CQFP
XC56156FE50	50 MHz in CQFP
XC56156FE60	60 MHz in CQFP
XC56166FE60	60 MHz in CQFP

DSP56156 BENCHMARKS

Benchmark	Instruction Cycles
Real FIR Filter with Data Shift	1 per Tap
LMS Adaptive Real FIR Filter	2 per Tap
Double Integration Sinewave Generation	2 per Sample
Complex FIR Filter with Data Shift	4 per Tap
General Lattice Filter	4 per Tap
Real Cascaded IIR Biquad Filter Sections (4 coeff.)	5 per Section
PID Loop	5
Double Precision Multiply	6
[1×3][3×3] Matrix Multiplication	21

DSP56156 Features

- DSP56100 family architecture
  - — 30 MIPS, 33 ns instruction cycle at 60 MHz
  - — Single cycle 16 x 16 → 40-bit multiply/accumulate
  - — Two 40-bit accumulators
  - — Double precision arithmetic support
  - — Zero-overhead nested DO loops
  - — Two instruction cycle fast interrupts
  - — 15-level stack
  - — Low power Wait and Stop Modes
  - — On-Chip Emulation for unobtrusive, full speed debugging
  - — Phase-locked loop frequency synthesizer
- DSP56156 on-chip memories
  - — 2K x 16 data RAM
  - — 2K x 16 program RAM (PRAM version)
  - — 12K x 16 program ROM (PROM version)
- DSP56156 on-chip peripherals
  - — 14-bit sigma delta, voice band codec (on-chip A/D and D/A)
  - — Full speed memory expansion port with 16-bit address and data buses
  - — Byte-wide Host Interface with DMA support
  - — Two Synchronous Serial Interface ports with µ-law/A-law compression
  - — 16-bit timer with external input/output
  - — 24 general-purpose I/O pins
- 112-pin ceramic quad flatpack (CQFP)

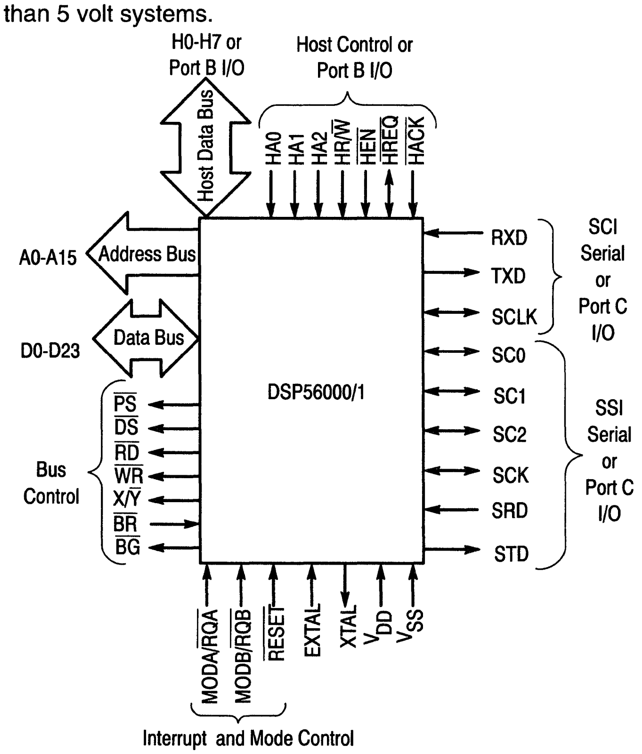
DSP56000 — 24-Bit Digital Signal Processors

The DSP56000 family of 24-bit fixed-point general purpose DSP is Motorola's original DSP family. This family with its triple Harvard architecture of seven internal buses and three parallel execution units — Data ALU, Address Generation Unit (AGU) and Program Controller — has set the standard for high end DSP devices. Motorola has retained architecture compatibility with the 24-bit DSP family into the newer 16-bit DSP56100 and 32-bit DSP96002 products helping to preserve our customer software investment.

The DSP56000 family of HCMOS, low-power, 24-bit DSP currently consists of six products: DSP56000, DSP56001, DSP56C001, DSP56002, DSP56L002 and DSP56004. These products are utilized extensively in telecommunications, control and audio. The DSP56000 family's unique 24-bit architecture has made these products the industry standard for CD-quality digital audio processing.

All DSP56000 Family members are source code compatible products. The DSP56000 and DSP56001 are the original two members and are identical except that the DSP56001 is program RAM based (512 x 24) while the DSP56000 contains a customer specific program ROM (3.75K x 24). The DSP56L002 is a low-voltage implementation of the DSP56002. Its 3.3 volt operation effectively extends the battery life of portable applications up to three times longer than 5 volt systems. The DSP56002 is a next generation DSP56001 with similar on-chip peripherals and memories. The DSP56002 provides faster clock speed (40 MHz) and adds phase-locked loop (PLL) and On-Chip Emulation.

The DSP56L002 is a low-voltage implementation of the DSP56002. Its 3.3 volt operation effectively extends the battery life of portable applications up to three times longer than 5 volt systems.



DSP56001 BENCHMARKS

Benchmark	Instruction Cycles
Real FIR Filter with Data Shift	1 per Tap
Two Dimensional Convolution (3×3 coeff. mask)	1 per Output
LMS Adaptive Real FIR Filter	3 per Tap
Real Cascaded IIR Biquad Filter Sections (4 coeff.)	4 per Section
Complex FIR Filter with Data Shift	4 per Tap
[1×3][3×3] Matrix Multiplication	17
Division	28
Leroux-Gueguen LPC Analysis:	
8th Order	473
10th Order	622
16th Order	1203

DSP56001/2 Features

- DSP56000 family architecture
  - — 17.5 MIPS, 60 ns instruction cycle at 33 MHz (DSP56001)
  - — 20 MIPS, 50 ns instruction cycle at 40 MHz (DSP56002)
  - — Single cycle 24 x 24 → 56-bit multiply/accumulate
  - — Two 56-bit accumulators
  - — Zero-overhead nested DO loops
  - — Two instruction cycle fast interrupts
  - — 15-level stack
  - — Low-power Wait and Stop Modes
  - — On-Chip Emulation for unobtrusive, full speed debugging (DSP56002)
  - — Phase-locked loop frequency synthesizer (DSP56002)
- DSP56001 on-chip memories
  - — 512 x 24 program RAM
  - — 2 x 256 x 24 data RAM
  - — 2 x 256 x 24 data ROM (sine and cosine tables)
- DSP56001/2 on-chip peripherals
  - — Full-speed memory expansion port with 16-bit address and 24-bit data buses
  - — Byte-wide Host Interface with DMA support
  - — Synchronous Serial Interface port
  - — Serial Communication Interface (asynchronous) port
  - — 24 general-purpose I/O pins
- 132-pin plastic quad flatpack (PQFP) or 88-pin PGA (DSP56001)/132-pin PGA (DSP56001)

DSP56000 — 24-Bit Digital Signal Processors (continued)

The DSP56004 contains audio peripherals specially designed for consumer and automotive audio applications. The DSP56004 uses the same processing and memory modules as the DSP56002. The Serial Audio Interface (SAI) provides two stereo inputs and three stereo outputs with I2S, Sony or Matsushita formats. The External Memory Interface (EMI) supports a byte-wide data port to DRAM or SRAM. The Serial Host Interface (SHI) provides a low-cost microcontroller interface using SPI or I2C.

DSP56004 Features
- DSP56000 family architecture
- DSP56004 on-chip memories
- DSP56004 on-chip peripherals
  - — Serial Audio Interface (SAI)
  - — External Memory Interface (EMI)
  - — Serial Host Interface (SHI)
  - — Four general-purpose I/O pins
- 80-pin plastic quad flatpack (PQFP)

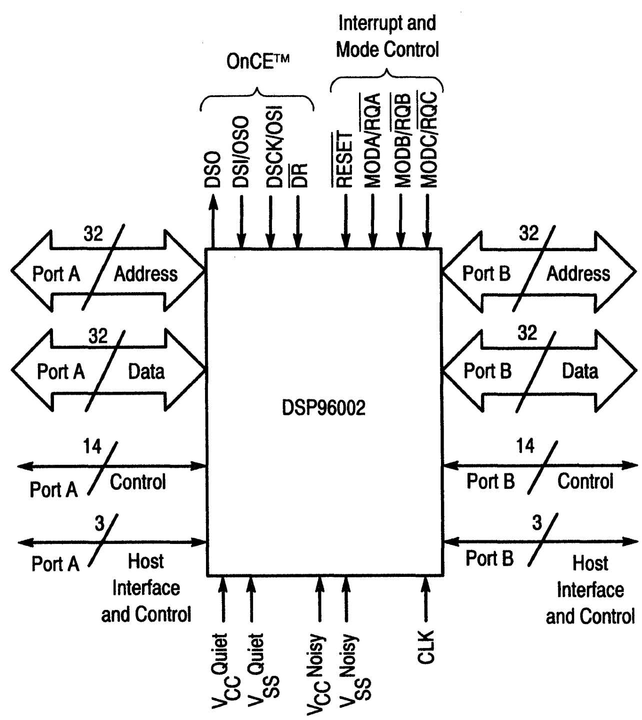
PART NUMBERS

Part	Description
DSP56000RC20	20 MHz ROM-based in PGA
DSP56000FE20	20 MHz ROM-based in CQFP
DSP56001RC20	20 MHz RAM-based in PGA
DSP56001FE20	20 MHz RAM-based in CQFP
DSP56001FC20	20 MHz RAM-based in PQFP
DSP56001RC27	27 MHz RAM-based in PGA
DSP56001FE27	27 MHz RAM-based in CQFP
DSP56001FC27	27 MHz RAM-based in PQFP
DSP56001RC33	33 MHz RAM-based in PGA
DSP56001FE33	33 MHz RAM-based in CQFP
DSP56001FC33	33 MHz RAM-based in PQFP
XC56002RC40	40 MHz RAM-based in PGA
XC56002FC40	40 MHz RAM-based in PQFP
XC56L002FC40	40 MHz RAM-based in PQFP
XC56004FJ40	40 MHz 80-pin PQFP

DSP96000 — 32-Bit Digital Signal Processors

The DSP96000 has full architecture compatibility with the 16-bit DSP56100 and 24-bit DSP56000 Families. The DSP96002 is the first in a family of 32-bit IEEE floating-point DSP devices. The DSP96002 has two identical memory expansion ports simplifying network configurations for multiprocessor and DSP96002 communications. These ports interface to SRAM, DRAM (operating in their fast access modes), video RAM or directly to other processors with host interface logic.

The superior performance of the DSP96002 has allowed Motorola to designate it as the Media Engine™ processor. Although designed primarily for image processing, other proven applications include communications, spectrum analysis, instrumentation, speech processing and pattern recognition.



DSP96000 — 32-bit IEEE Floating Point Dual-Port Processors (continued)

PART NUMBERS

Part	Description
XC96002RC33	33 MHz in PGA
XC96002RC40	40 MHz in PGA

DSP96002 BENCHMARKS

Benchmark	Instruction Cycles
Real	
FIR Filter with Data Shift	1 per Tap
V = V*S + V	2
Lattice Filter with Data Shift	3 per Tap
Cascaded IIR Biquad Filter Sections (4 coeff.)	4 per Section
1024-point FFT and bit reversal	12880
Complex	
V = V*V + V	4
FIR Filter with Data Shift	4 per Tap
1024-point FFT and bit reversal	20931
Graphics/Image Processing	
Divide (32-bit accuracy)	7
Square Root (32-bit accuracy)	12
Bezier Cubic Evaluation for Font Compilation	13
[4×4][4×4] = [4×4]	67

DSP96002 Features

- DSP96000 family architecture
  - — Full IEEE Standard 754 compatible for 32-bit (SP) and 44-bit (SEP) arithmetic
  - — 20 MIPS, 50 ns instruction cycle at 40 MHz
  - — 60 million floating-point operations per second (MFLOPS) at 40 MHz
  - — Single cycle 32 x 32 → 96-bit multiply/accumulate
  - — Ten 96-bit general-purpose data registers
  - — Zero-overhead nested DO loops
  - — Two instruction-cycle fast interrupts
  - — Low-power Wait and Stop Modes
  - — On-Chip Emulation for unobtrusive, full-speed debugging
- DSP96002 peripherals
  - — Two 32-bit address and data host ports
  - — Dual channel DMA controller
- DSP96002 memories
  - — 1024 x 32 program RAM
  - — 2 x 512 x 32 data RAM
  - — 2 x 512 x 32 data ROM (sine and cosine tables)

DSP Peripherals

DSP56200 — The Cascadable Adaptive Finite Impulse Response Digital Filter

The DSP56200 is an algorithm-specific DSP peripheral designed to perform computationally-intensive tasks. Two principal algorithms are implemented on the DSP56200 making the primary functions finite impulse response (FIR) and adaptive FIR filtering. Its performance, features and simple interface with host microprocessors make the DSP56200 a natural solution for echo cancelling, noise cancelling, convolution, correlation and orthogonal transform applications.

PART NUMBERS

Part	Description
XC56200LC10	10.5 MHz in Ceramic DIP

Key Features

- Low Power HCMOS
- 100 ns per tap throughput
- 256×16-bit data RAM
- 256×24-bit coefficient RAM
- 16×24-bit multiplier, 40-bit accumulation
- Three modes of operation
  - — Single FIR filter
  - — Dual FIR filter
  - — Single adaptive FIR filter with dc tap and leakage control
- Programmable tap lengths
  - — 256 taps in single channel mode
  - — 128 taps per channel in dual mode
- Cascadable in single channel mode
- Programmable leakage and gain
- 8-bit I/O port with 7 control lines
- Scratch pad memory
- Power down mode

DSP Peripherals (continued)

DSP56ADC16 — The Analog-To-Digital Converter

The DSP56ADC16 is a single-chip, linear analog-to-digital (A/D) converter. It is an ideal choice for high-performance digital audio systems, voice-bandwidth communication and control applications. It does not require antialiasing filters and sample-and-hold circuitry because they are an inherent part of the sigma-delta technology. The DSP56ADC16 can be easily interfaced to the DSP56001 and other host processors using its flexible serial interface.

Key Features

- 16-bit output resolution at 100 kHz from FIR filter
- 12-bit output resolution at 400 kHz from Comb filter
- 96-dB dynamic range
- 90-dB signal-to-THD ratio
- 90-dB signal-to-noise ratio
- In-band ripple: <0.001 dB
- Maximum output sample rates:
  — FIR filter — 100 kHz
  — Comb filter — 400 kHz
- Maximum input sample rate is 6.4 MHz
- Maximum internal clock rate is 12.8 MHz
- DC stability is 10-bits
- Supply voltage is single +5V (±10%)
- Supply current is <100 mA
- Linear-phase analog front end and internal digital filters
- Simple serial interface to host microprocessors
- Fully differential inputs

PART NUMBERS

Part	Description
DSP56ADC16S	16-bit in Ceramic DIP

DSP56401 — The Digital Audio Transceiver

The DSP56401 is a low-cost, digital audio transceiver system which is compatible with the AES/EBU and EIAJ CP340 digital audio transmission standards. These standards are supported by CD players, RDAT recorders, professional recording and broadcasting equipment, audio workstations, and other applications including using RDAT recorders as mass storage for general data. The serial interfaces provide a no-glue interface to Motorola DSP SSI and SCI ports, 6805 and 68HC11 SPI ports, and Motorola Sigma-Delta A/D and D/A converters. Eight serial modes provide flexible interfacing for the audio sample data and the non-audio information in various systems.

Key Features

- Single-chip digital audio system — transmitter, receiver and clock generation
- Compatible with the AES/EBU and EIAJ CP340 digital audio transmission standards
- Allows simple audio-only data interfaces or full-featured AES/EBU systems
- Independently clocked on-chip transmitter, receiver and serial interfaces
- Four on-chip oscillators with on-chip programmable dividers
- On-chip phase locked loop frequency and phase detectors
- Three software selected digital audio inputs
- Two programmable clock outputs
- Four programmable I/O pins
- No-glue interface to Motorola DSP SSI, I²S and Japanese digital audio interfaces
- No-glue interface to Motorola DSP SCI and MCU SPI ports for non-audio data
- Serial daisy-chain supports digital audio buses having multiple DSP56401 and data converter time slots
- Simultaneous stereo sampling with two Motorola DSP56ADC16 A/D converters
- Low jitter clock recovery compatible with Sigma-Delta converter requirements
- Multi-Port Serial Interface™ provides eight serial data formats
- Programmable number of 16, 24 or 32 bit serial time slots
- All non-audio information is available at fast or slow transfer rates
- Non-audio data interface supports SSI, SCI, SPI and EPROM ports
- User features and DSP software loading controlled by software drivers
- 24-bit program word and 16-bit status word control and monitor on-chip operation
- Hardware parity generation and error detection
- Hardware CRC generation and error detection
- Multiple chip transmit modulator synchronization
- TTL compatible inputs, CMOS compatible outputs

PART NUMBERS

Part	Description
DSP56401FN	68-pin PLCC (Plastic Leaded Chip Carrier) Surface Mount Package

DSP Development Tools

Application Development Systems

Every member of the Motorola Family of 16-, 24- and 32-bit DSPs is supported by a multi-component Application Development System (ADS) which acts as a tool for designing, debugging and evaluating real-time DSP target system equipment. The ADS simplifies evaluation of the user's prototype hardware/software product by making all of the essential timing and I/O circuitry easily accessible. Using an IBM PC™, Macintosh™ II or a Sun-4™ as a medium between the user and the DSP hardware significantly reduces the overall complexity and cost of development while increasing the capabilities of the system. With the ADS, DSP programs can be executed in real-time, single instruction traced or multiple instruction stepped with registers and/or memory block contents displayed. The ADS is fully compatible with the CLAS design-in software package for each product and may act as an accelerator for testing DSP algorithms.

Emulation capability is available for the DSP56000ADS with the addition of an emulator cable which plugs into the euro-card connector on the ADS board. The DSP56156ADS and DSP96002ADS offer an On-Chip Emulation (OnCE™) circuit for unobtrusive, processor speed independent debugging. The ADS takes full advantage of this circuit to allow the user non-intrusive control of the target.

The DSP56KT2, a direct replacement of the DSP56000ADS and emulator cable, is a four-component system which acts as a real-time signal processing emulator pod for DSP56000/1 target applications. The DSP56KT2 takes advantage of the OnCE port of the DSP56002 to provide non-intrusive, real-time support by allowing users to debug target systems at zero wait state, 33 MHz operation.

General ADS Features

Software —
- Single/multiple stepping through DSP object programs
- Conditional/unconditional software and hardware breakpoints
- Program patching using a single-line assembler/disassembler
- Session and/or command logging for later reference
- Loading and saving of files to/from ADM memory
- Macro command definition and execution
- Display enable/disable of registers and memory
- Debug commands which support multiple DSP development
- Hexadecimal/decimal/binary calculator
- Multiple input/output file access from DSP object programs
- On-line help screens for each command and register

Hardware —
- Full speed operation
- Multiple ADM support with programmable ADM addressing
- Stand-alone operation of ADM after initial development

PART NUMBERS

Development Systems	Host Machine
DSP56100ADSA	IBM PC
DSP56100ADSB	Macintosh II
DSP56100ADSF	Sun-4
DSP56000ADSA	IBM PC
DSP56000ADSB	Macintosh II
DSP56000ADSF	Sun-4
DSP96000ADSA	IBM PC
DSP960000ADSB	Macintosh II
DSP96000ADSF	Sun-4
DSP56002ADSA	IBM PC
DSP56002ADSB	Macintosh II
DSP56002ADSF	Sun-4
DSP56002ADSA	IBM PC
DSP56004ADSB	Macintosh II
DSP56004ADSF	Sun-4
DSP56KT2A	IBM PC
DSP56KT2B	Macintosh II
DSP56KT2F	Sun-4
DSP56000ADM	ADM Board for 56000/1
DSP56002ADM	ADM Board for 56002
DSP56004ADM	ADM Board for 56004
DSP56156ADM	ADM Board for 56156
DSP96000ADM	ADM Board for 96000
DSPPCHOST	PC compatible host board and interface software
DSPMACHOST	Macintosh II host board and interface software
DSPSUN4HOST	Sun-4 host board and interface software
DSPCOMMAND	16-, 24-, 32-bit Command Converter board
DSP56004AIB	Audio Interface Board for DSP56004ADS/ADM

DSP Development Tools (continued)

DSP56156ADS Features
- System commands from within ADS user interface program
- 16K words of configurable static RAM expandable to 64K words

DSP56000ADS Features
- Host operating system commands from within ADS user interface program
- 8K/32K words of configurable RAM for DSP56000/1 code development
- 96-pin euro-card connector for accessing all DSP56000/1 pins
- 1K words of monitor ROM expandable to 4K words
- Separate connectors for accessing serial or host/DMA ports

DSP96000ADS Features
- System commands from within ADS user interface program
- 128K words of configurable static RAM expandable to 512K words
- 2K words of EPROM with sockets expandable to 64K words
- Full support of multiple data memory maps
- Two sets of 96-pin connectors provide access to all DSP96002 pins
- 2K words of EPROM with sockets expandable to 16K words
- Full support of multiple data memory maps
- 96-pin connector provides access to all DSP56156 pins

DSP56KT2 Features
- Full-speed 33 MHz DSP56000/1 emulator in target application with zero wait state external bus accesses
- Direct replacement of the DSP56000ADS and DSP56000EMULTRCABL
- OnCE port on DSP56002 provides dedicated debug port
- Local oscillator for easy evaluation of different target speeds

DSP Development Software

Design-In Software Packages

PART NUMBERS

Simulator/Assembler/ Linker/Library	Host Machine
DSP56100CLASA	IBM PC
DSP56100CLASB	Macintosh II
DSP56100CLASF	Sun-4
DSP56000CLASA	IBM PC
DSP56000CLASB	Macintosh II
DSP56000CLASF	Sun-4
DSP96000CLASA	IBM PC
DSP96000CLASB	Macintosh II
DSP96000CLASF	Sun-4

The Simulator/Macro-Assembler/Linker/Librarian software package is a development system support tool. The Simulator program imitates the operation of the DSP on a clock-cycle by clock-cycle basis and gives an accurate measurement of code execution time. All on-chip peripheral operations, memory and register updates and exception processing activities may be functionally simulated.

The full-featured Macro Cross Assembler translates one or more source files containing instruction mnemonics, operands and assembler directives into a Common Object File Format (COFF) file which is directly loadable by the Simulator. It supports the full instruction set, memory spaces and parallel transfer fields of the DSP.

The Linker relocates and links relocatable COFF object modules from the Assembler to create an absolute load file which can be loaded directly into the Simulator. The Librarian utility will merge separate, relocatable object modules into a single file allowing frequently used modules to be grouped for convenient linking and storing.

The assembler and linker now provide support for assembly language source-level debugging via the simulator. Global symbols, symbols local to sections and even underscore labels may be referenced with all scoping constructs intact. In addition, the assembler generates information about included files and macros. The assembler and linker also support numbered counters ranging from 0 to 65535.

DSP Development Software (continued)

New C-Compiler Packages

A full ANSI C compliant compiler, based on GNU technology, provides higher efficiency and implements more than 20 major optimization techniques. It has improved in-line assembly capability and an ANSI C preprocessor. The package includes the C Compiler, a new COFF Assembler, Linker, complete ANSI C Libraries and a new C source level debugger as well as expanded user's reference manual. The software package is available for various host computers listed below.

PART NUMBERS

GNU C Compiler	Host Machine
DSP56000/1	
DSP56KCCA	IBM PC 386
DSP56KCCF	Sun-4
DSP96002	
DSP96KCCA	IBM PC 386
DSP96KCCF	Sun-4

C-Compiler Upgrades

Registered users of the earlier versions of the Motorola DSP C compiler can upgrade to the new GNU C compiler for $120. To order, contact a Motorola sales representative or distributor. Have your registration number ready.

PART NUMBERS

GNU C Compiler	Host Machine
DSP56000/1	
DSP56KCCAJ	IBM PC
DSP56KCCFJ	Sun-4

The M68000 Family

. . . the Upward Compatible 8-/16-/32- Bit Microprocessor Family

In Brief . . .

An MPU For All Functions

To designers of the most advanced microcomputer systems, the Motorola M68000 Family of microprocessors needs no introduction. Products based on its members have become the standard for systems utilizing the UNIX operating system and for CAD/CAM engineering workstations. They are invading the next generation designs of personal computers and color graphics systems, and they find widespread implementation in multi-user/multi-tasking applications and in small business systems. M68000 MPUs are found in the leading products in fault-tolerant systems requiring high performance and parallel processing, and they are the preferred components for artificial intelligence engines requiring large linear addressing capabilities. Control applications include graphics, numerical controllers, robotics, telecommunications switching and PBX voice/data transmission.

Upward Compatibility

The M68000 MPU Family consists of a line of processors based on a 32-bit flexible register set, a large linear address space, a simple yet powerful instruction set and flexible addressing modes. The internal architecture of the 8-, 16-, and 32-bit MPU versions, and the common instruction set, provide software compatibility and offer an easy upward migration path for products requiring increasing levels of processing power.

A Host of Peripherals

A large selection of full-function peripheral chips complements the processor family. Compatible LSI and VLSI chips for memory management, data communications, DMA control, network control, system interfacing, general I/O and graphics, all simplify system design and reduce design and manufacturing cost while improving system performance.

Microprocessors

The 68K Family of Microprocessors has revolutionized virtually every segment of the electronic industry. They have set the standard for performance while still maintaining binary software compatibility from generation to generation. The combination of low cost and high performance (measured in $/system MIPS) makes every member of the Family a price performance leader. The M68000 Family provides the widest range of price and performance with choices from 1.6 MIPS to over 100 MIPS.

Table 1.

	68000	68020	68030	68040	68060
MIPS	1.6	5.5	12	35	100
MFLOPS	–	0.25	0.5	3.5	15
Address Range	16M Byte	4G Byte	4G Byte	4G Byte	4G Byte
Data Bus	16 bit	32 bit	32 bit	32 bit	32 bit
Clock Speed (MHz)	8-16	16-33	16-50	25-40	50-66
Instruction Cache	–	256 Byte	256 Byte	4K Byte	8K
Data Cache	–	–	256 Byte	4K Byte	8K
Burst Mode	–	–	16 Byte R	16 Byte R/W	16 Byte R/W
General Purpose Registers	16	16	16	16	16
Address Modes	14	18	18	18	18
On-Chip MMU	No	No	Yes	Yes*	Yes*
Floating-Point Solution	68881	68882	68882	On-Chip	On-Chip

*Separate Instruction/Data

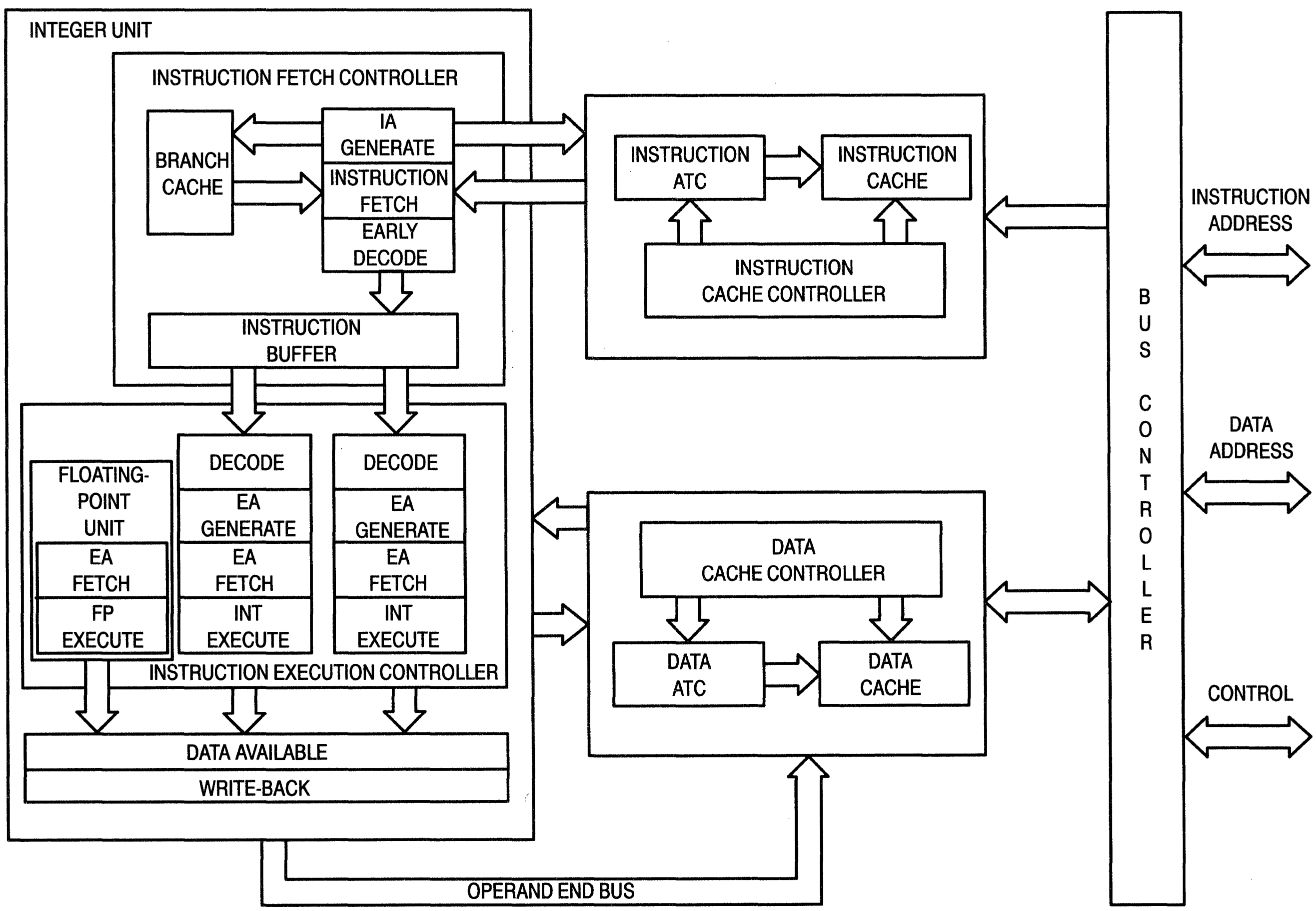


Figure 1. MC68060 Block Diagram

MC68060
Superscalar 32-Bit Microprocessor

The MC68060 is fully compatible with all previous members of the M68000 family. The MC68060 features dual on-chip caches, fully independent demand-paged memory management units (MMUs) for both instructions and data, dual integer execution pipelines, on-chip floating-point unit (FPU) and a branch target cache. A high degree of instruction execution parallelism is achieved through the use of a full internal Harvard architecture, multiple internal buses, independent execution units, and dual instruction issue within the instruction controller. Power management is also a key part of the MC68060 architecture. The MC68060 offers a low-power mode of operation that is accessed through the LPSTOP instruction, allowing for full power-down capability. The MC68060 design is fully static so that when circuits are not in use, they do not draw power. Each unit can be disabled so that power is used only when the unit is enabled and executing an instruction.

Complete code compatibility with the M68000 family allows the designer to draw on existing code and past experience to bring products to market quickly. There is also a broad base of established development tools, including real-time kernels, operating systems, languages and applications, to assist in product design. The functionality provided by the MC68060 makes it the ideal choice for a range of high-performance computing applications as well as many portable applications that require low power and high performance.

MC68040
Third-Generation 32-Bit Microprocessor

The MC68040 is Motorola's third generation of M68000-compatible, high-performance, 32-bit microprocessors. The MC68040 is a virtual memory microprocessor employing multiple, concurrent execution units and a highly integrated architecture to provide very high performance in a monolithic HCMOS device. On a single chip, the MC68040 integrates an MC68030-compatible integer unit, an IEEE 754-compatible floating-point unit (FPU), and fully independent instruction and data demand-paged memory management units (MMUs), including independent 4K-byte instruction and data caches. A high degree of instruction execution parallelism is achieved through the use of multiple independent execution pipelines, multiple internal buses, and a full internal Harvard architecture, including separate physical caches for both instruction and data accesses. The MC68040 also directly supports cache coherency in multimaster applications with dedicated on-chip bus snooping logic.

The MC68040 is an enhanced, 32-bit, HCMOS microprocessor that combines the integer unit processing capabilities of the MC68030 microprocessor with independent 4K-byte data and instruction caches and an on-chip FPU. The MC68040 maintains the 32-bit registers available with the entire M68000 Family as well as the 32-bit address and data paths, rich instruction set, and versatile addressing modes. Instruction execution proceeds in parallel with accesses to the internal caches, MMU operations, and bus controller activity. Additionally, the integer unit is optimized for high-level language environments. The MC68040 is user-object-code compatible with previous members of the M68000 Family and is specifically optimized to reduce the execution time of compiler-generated code. The MC68040 is implemented in Motorola's latest HCMOS technology, providing an ideal balance between speed, power, and physical device size.

Instruction execution is pipelined in both the integer unit and FPU. Independent data and instruction MMUs control the main caches and the address translation caches (ATCs). The ATCs speed up logical-to-physical address translations by storing recently used translations. The bus snooper circuit ensures cache coherency in multimaster and multiprocessing applications. The MC68040 FPU is user-object-code compatible with the MC68882 floating-point coprocessor. The FPU has been optimized to execute the most commonly used subset of the MC68882 instruction set, and includes additional instruction formats for single- and double-precision rounding of results.

The MMUs support multiprocessing, virtual memory systems by translating logical addresses to physical addresses using translation tables stored in memory. Each MMU has two transparent translation registers available that define a one-to-one mapping for address space segments ranging in size from 16 Mbytes to 4 Gbytes each. The instruction and data caches operate independently from the rest of the machine, storing information for fast access by the execution units. Each cache resides on its own internal address bus and internal data bus, allowing simultaneous access to both. The data cache provides writethrough or copyback write modes that can be configured on a page-by-page basis.

The MC68040 bus controller supports a high-speed, nonmultiplexed, synchronous external bus interface, which allows the following transfer sizes: byte, word (2 bytes), long word (4 bytes), and line (16 bytes). Line accesses are performed using burst transfers for both reads and writes to provide high data transfer rates.

MC68030
The Second Generation 32-Bit MPU

The 030 started with a high performance 020 core and added many performance improvement features including increased internal parallelism, dual on-chip caches with a burst fillable mode, dual internal data and address buses, improved bus interface, and on-chip paged memory management unit.

Two independent 32-bit address buses and two 32-bit data buses allow the CPU, caches, MMU, and the bus controller to operate in parallel, so the 030 can, for example, simultaneously access an instruction from the instruction cache, data from the data cache and instruction/data from external memory.

Performance is further enhanced by on-chip instruction and data caches. Separate 256-byte data and instruction caches reduce the access time and increase CPU throughput by providing data and instructions on-chip.

Overall bus requirements are reduced and multiple processors can run more efficiently thanks to increased bandwidth of the 030 bus, achieved by the enhanced bus controller allowing high speed fills of both data and instruction caches.

The on-chip paged memory management unit translates logical address to the corresponding physical address in 1/2 the time required by the 020 and MC68851 Paged Memory Management Unit. Pipelining permits this translation to be performed in parallel with other functions so that no translation time is added to any bus cycle.

MC68020

The Original 32-Bit Performance Standard

The MC68020, oh twenty, is the industry's leading 32-bit microprocessor because of high performance, architecture, ease of design-in, and long-range compatible growth path.

The 020 has a full 32-bit internal and 32-bit external, regular, symmetrical architecture designed with the customer in mind. It offers all the functionality of the other M68000 Family MPUs, and maintains software user-code compatibility which controls the expense of your product migration.

Programmers appreciate the large general purpose register set, simple yet powerful instruction set and the many flexible M68000 addressing modes. The unique on-chip instruction cache helps provide burst-mode operation to 12.5 MIPS.

The 020 is the proven leader in high performance systems in office automation, engineering workstations, fault tolerant computers, parallel processors, telephone switching systems, and intelligent controllers.

MC68010

A Virtual Memory Enhancement

The MC68010 offers the advantage of Virtual Memory. A high-speed loop mode operation executes tight software loops faster to enhance performance. Its instruction continuation feature has made it the choice for fault-tolerant and parallel processing systems. The MC68010 can support a governing operating system which handles the supervisory chores of any number of subordinate operating systems.

MC68HC000

A Micropower Alternative

HCMOS design gives the MC68HC000 all the functions and performance of its MC68000 predecessors . . . at one-tenth of the operating power requirements. With a maximum power dissipation of only 0.175 watts, the MC68HC000 is ideal for high-performance computer peripherals, industrial controllers, instrumentation and communications equipment.

MC68HC001

Low Power HCMOS 8-/16-/32-Bit Microprocessor

The MC68HC001 provides a functional extension of the MC68HC000 HCMOS 16-/32-bit microprocessor with the addition of statically selectable 8- or 16-bit data bus operation. The MC68HC001 is object-code compatible with the MC68HC000, and code written for the MC68HC001 can be migrated without modification to any member of the M68000 Family. This is possible because the user programming model is identical for all members of the M68000 Family and the instruction sets are proper subsets for the complete architecture.

MC68000

The 16-Bit Foundations

As the first member of the M68000 family, the state-of-the-art technology and advance circuit design concepts of the MC68000 16-bit MPU started a new trend in microprocessor architecture. Its seventeen 32-bit data and address registers permit rapid internal execution of its powerful yet simple instruction set. It is designed for large multiprocessing systems and realtime applications with vectored interrupts, seven priority levels and a 16 megabyte linear addressing space. It offers mainframe-like performance, supporting high-level languages and sophisticated operating systems.

The MC68000 MPU has been joined by more advanced products with even greater capabilities, yet it satisfies a large segment of the existing applications. It is extremely cost competitive and it remains one of the major growth products in the entire MPU line.

MC68008

An 8-Bit Compatible Competitor

With an 8-bit data bus and 32-bit internal architecture, the MC68008 offers performance that competes with a number of 16-bit MPUs. It has the same register set, same instructions, and the same functionality as the MC68000 with extensive exception processing. Large modular programs can be developed and executed efficiently because of the large, 1-megabit non-segmented, linear address space. It is the choice for high performance, cost effective, 8-bit designs, particularly those requiring a migration path to 16-bit or full 32-bit operation.

Embedded Controllers

The principle elements of this popular microprocessor family have now been redesigned specifically for embedded applications. The new 68EC0x0 family including the 68EC000, EC020, EC030 and EC040 MPUs are all optimized for cost-sensitive embedded control designs. The 68EC0x0 family offers the high performance of the 680x0 family, yet streamlines the feature sets for embedded applications. The 68EC0x0 family completes the triad forming the M68000 family of compatible products: the 680x0 family of computer-class central processing units; the 68300 family of integrated processors; and now, the 68EC0x0 family of embedded microprocessors.

Table 2.

	68EC000	68EC020	68EC030	68EC040
MIPS	2.5	6.5	10.7	29
Address Range	16M Byte	16M Byte	4G Byte	4G Byte
Data Bus	16 bit	32 bit	32 bit	32 bit
Clock Speeds	8, 10, 12, 16 MHz	16, 25 MHz	25, 40 MHz	20, 25, 33* MHz
Instruction Cache	–	256 Byte	256 Byte	4K Byte
Data Cache	–	–	256 Byte	4K Byte
Burst Fill Caches	–	–	16 Bytes	16 Bytes
General Purpose Registers	16	16	16	16
Address Modes	14	18	18	18
Floating Point Hardware	68881/68882	68881/68882	68881/68882	68040
Packages	PLCC	PPGA, PQFP	PPGA, CQFP	PGA, CQFP*

* Available in the future

MC68EC040

32-Bit High-Performance Embedded Controller

The 68EC040 is the newest addition to Motorola's embedded microprocessor family. It is the performance leader for top-of-the-line embedded applications. The EC040 is capable of delivering 29 MIPS of sustained performance at 1.2 cycles per instruction with a system cost that is unattainable by competing architectures.

This impressive performance is a result of a six-level pipelined integer unit, independent four-way set-associative instruction and data caches, and a very high level of on-chip parallelism. The EC040 also supports multimaster and multiprocessor systems with bus snooping.

By integrating all these features into the EC040, the microprocessor is able to perform the vast majority of work on-chip, limiting external memory accesses to allow for higher system performance with less expensive DRAMs. The result is virtual immunity to the effects of memory wait states.

Embedded Controllers (continued)

MC68EC030
32-Bit Enhanced Embedded Controller

The MC68EC030 is a 32-bit embedded controller that streamlines the functionality of an MC68030 for the requirements of embedded control applications. The MC68EC030 is optimized to maintain performance while using cost-effective memory subsystems. The rich instruction set and addressing mode capabilities of the MC68020, MC68030, and MC68040 have been maintained, allowing a clear migration path for M68000 systems. The MC68EC030 is object-code compatible with the MC68020, MC68030, and earlier M68000 microprocessors. Burst-mode bus interface is provided for efficient DRAM access.

The MC68EC030 has an on-chip data cache and on-chip instruction cache with 256 bytes each. Dynamic bus sizing is available for direct interfacing to 8-, 16-, and 32-Bit Devices. The MC68EC030 includes 32-bit nonmultiplexed address and data buses, sixteen 32-bit general-purpose data and address registers, and two 32-bit supervisor stack pointers and eight special-purpose control registers. The EC030 provides complete support for coprocessors with the M68000 coprocessor interface. There are two access control registers that allow blocks to be defined for cacheability protection. The pipelined architecture, along with increased parallelism, allows internal caches accesses in parallel with bus transfers and overlapped instruction execution. The enhanced bus controller supports asynchronous bus cycles (three clocks minimum), synchronous bus cycles (two clocks minimum), and burst data transfers (one clock).

MC68EC020
32-Bit Embedded Controller

The 68EC020, with a complete 32-bit internal implementation, has a 32-bit data bus and an on-chip instruction cache to provide dramatically increased performance over 8- and 16-bit microprocessors. In addition, upward migration to the EC020 is made simple with dynamic bus sizing, allowing 8, 16 and 32-bit peripherals to communicate with the microprocessor.

Other performance features include advanced bit manipulation capabilities that provide multiple bit shift operations in a single instruction cycle. This capability greatly simplifies and accelerates the bit operations required in graphics processing and optical recognition applications.

MC68EC000
Low-Powered HCMOS Embedded Controller

The 68EC000 is a low-power HCMOS derivative of the 68000 optimized for cost-effective embedded processing. The EC000 has a flexible data bus that can operate in either 8- or 16-bit modes and a 24-bit address bus that provides 16 Mbytes of memory addressing capability. Electrical characteristics of the 68EC000 have been optimized to ensure easy access to low-cost memories.

The 68EC000 represents the lowest cost entry point to any 32-bit architecture. Coupled with efficient support for high-level languages and real-time operating systems, the 68EC000 provides unparalleled compatible migration paths to higher performance.

Integrated Processors

Powerful solutions to cost-, space-, and power-sensitive embedded applications are provided by the 68300 family of integrated microprocessors and microcontrollers. The 68300 family combines two of Motorola's greatest strengths — the 32-bit microprocessor architecture of the 68000 family and a proliferation of peripheral circuits offering a growing family of integrated solutions.

The 68000 family is based on a proven, expandable architecture that spans the performance range from 1 to over 29 MIPS. This architecture offers the industry's highest level of compatibility for both hardware and software. Motorola's single-chip microcomputers and microcontrollers provide the industry's broadest selection of peripheral combinations, insurance that one will fit the need of practically any application. The 683000 family embraces both of these concepts.

Each member of the 68300 family contains a core processor based on the 68000 family, a System Integration Module (SIM), an on-chip bus and various peripheral modules. The SIMs include support circuitry such a clock generation, external chip selects, system protection, timers and JTAG. The on-chip intermodule bus (IMB) on the CPU-based 68300s creates a standard interface over which the CPU and each of the modules communicate. The peripheral modules include specialized processors, system controllers, traditional peripherals and memory. Because the peripheral modules are independent from each other, they can appear in multiple 68300 devices. With so many major features incorporated into a single 68300 device, a system designer can realize improved reliability along with significant savings in design time, power consumption, cost, board space, pin count and program development. In a 68300 device, the major functions and glue logic are all properly connected, internally timed with the same fast clock, fully tested and consistently documented.

Table 3.

	68302	68306	68330	68331	68332	68333	68334	68340
Core Processor	68000	680EC00	CPU32	CPU32	CPU32	CPU32	CPU32	CPU32
Speeds (MHz)	16, 20	16	16, 25	16	16	16	16	16, 25
DMA	Yes	–	–	–	–	–	–	Yes
Serial Processor	Yes	–	–	–	–	–	–	–
Time Processor Unit	–	–	–	–	Yes	Yes	Yes	–
Flash EEPROM	–	–	–	–	–	64K	–	–
Serial I/O	Yes	Yes	–	Yes	Yes	Yes	–	Yes
Timers	1	–	–	1	–	–	–	2
A/D Converter	–	–	–	–	–	Yes	Yes	–
SRAM	1K	–	–	–	2K	4K	1K	–
DRAM Controller	–	Yes	–	–	–	–	–	–
Glue Logic (SIM)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3.3 Volts Available	–	–	–	–	–	–	–	Yes

MC68302

Integrated Multiprotocol Processor

The MC68302 integrated multiprotocol processor (IMP) is a very large-scale integration (VLSI) device incorporating the main building blocks needed for the design of a wide variety of controllers used in the communications industry. The IMP is the first device to offer the benefits of a closely coupled, industry-standard M68000/MC68008 microprocessor core and a flexible communications architecture. The three-channel communications device may be configured to support a number of popular industry interfaces, including those for the Integrated Services Digital Network (ISDN) basic rate and terminal adaptor applications. Through a combination of architectural and programmable features concurrent operation of different protocols (HDLC/SDLC™, UART, BISYNC, DDCMP™, or transparent modes) can easily be achieved. Data concentrators, modems, line cards, bridges, and gateways are examples of suitable applications for this device

The IMP is a Complementary Metal-Oxide Semiconductor (CMOS) device consisting of an M68000/MC68008 microprocessor core, a system integration block (SIB), and a Communications Processor (CP). By integrating the microprocessor core with the serial ports (in the CP) and the system peripherals (in the SIB), the IMP is capable of handling complex tasks such as all ISDN basic rate (2B+D) access tasks.

Integrated Processors (continued)

MC68306

Integrated 68EC00 Processor

The 68306 integrated EC000 processor includes many of the features commonly found in 68000-based designs. The 68306 includes a 68EC000 core processor, a 68681 Dual Universal Asynchronous Receiver Transmitter (DUART), system integration functions, and a DRAM controller. The on-chip DRAM controller gives the 68306 the family's simplest interface to DRAM-based designs. The DRAM controller easily accommodates 64 Mbytes of memory. The 68306 saves time in the design cycle by providing valuable 68000 system components pre-packaged in one chip.

MC68330

Integrated CPU32 Processor

The 68330 is ideal for applications requiring 32-bit microprocessor performance without the additional expense inherent in 32-bit memory systems. The 68330 is the simplest and lowest priced member of the CPU32-based 68300 family. The 68330 allows the designer access to the high performance of the CPU32 along with minimized external glue logic, while allowing the greatest freedom in selecting needed peripherals, ASICs or gate arrays.

MC68331

32-Bit Microcontroller

The 68331 is well suited to applications requiring simple serial communications and general timing needs. The 68331 contains the CPU32, a SIM, a General Purpose Timer (GPT) and a Queued Serial Module (QSM). The general purpose timer is a simple yet flexible timer that provides four modes of operation with multiple channels for some operations. The QSM provides two modes of communication: an asynchronous channel that provides up to 524-Kbits per second transfer rate and a serial peripheral interface with separate 16-word receive/transmit queues.

MC68332

32-Bit Microcontroller

The 68332 is especially suited for high-performance timing applications such as automotive engine control, precision motor control and industrial robotics. The powerful Time Processor Unit (TPU) distinguishes the 68332 providing optimum performance in controlling time-related activity. It drastically reduces the need for CPU intervention with its dedicated execution unit, tri-level prioritized scheduler, data storage RAM and dual time bases. In addition to the TPU and CPU32, the 68332 features the QSM, a SIM and 2-Kbytes of standby static RAM.

MC68F333

32-Bit Microcontroller

The 68F333 provides the highest level of integration available to high-performance timing applications such as avionics and automotive engine control. The 68F333 contains the CPU32, the TPU and the QSM. It also adds two banks of flash EEPROM totaling 64-Kbytes, a total of 4-Kbytes of SRAM (512 bytes separately powered) and an 8-channel, 10-bit analog-to-digital converter. The Single-Chip Integration Module (SCIM) allows 18 of the external address and data pins to be converted to I/O pins, resulting in a single-chip solution suitable for many applications.

MC68334

32-Bit Microcontroller

The 68334 is a streamlined version of the 68332, taking advantage of the powerful TPU. The 68334 includes the CPU32 core processor, the TPU, a SIM, 1-Kbyte of SRAM, a 10-bit analog-to-digital converter and up to 47 discrete I/O lines.

MC68340

Integrated Multiprotocol Processor with DMA

The 68340 is excellent for applications requiring high-speed or block data transfers, such as disk drives and navigation systems. The combination of general peripherals and the extremely low power consumption possibilities of the 68340 make it ideal for many battery powered, portable applications such as hand held computers and data acquisition systems.

The most distinguishing 68340 feature is the high speed two channel, 32-bit Direct Memory Access (DMA) controller. Incorporating the CPU32 and DMA on the same chip eliminates the usual bus arbitration and synchronization delays, maximizing data throughout (25-Mbytes per second on a 16-bit bus).

In addition to the CPU32, a SIM and the DMA, the 68340 contains a 68681/2681-compatible DUART. The 68340 also has two identical, versatile counter/timers, each with a 16-bit counter and an 8-bit prescaler with 80 ns resolution.

Coprocessors

MC68851

Paged Memory Management Unit, PMMU

The PMMU is a 32-bit memory manager which provides full support for a demand paged virtual environment with the 68010 or MC68020. It supports a 4-gigabyte addressing space when used as a coprocessor with the MC68020. An on-chip address translation cache minimizes translation delays and maximizes system performance.

MC68881

A Floating Point Coprocessor

Designed specifically for arithmetic expansion of the MC68020 MPUI, this powerful coprocessor can also be used as a peripheral to all other M68000 family members, and with non-M68000 processors as well. It performs floating point math calculations in strict conformance to a full implementation of the IEEE Standard for Binary Floating Point Arithmetic (754) and, in addition to the basic add, subtract, multiply, and divide functions, it handles full selection of transcendental and non-transcendental operations. These operations include root values, trigonometric functions, exponentials, hyperbolics, and logs. All functions are calculated to 80 bits of extended precision in hardware.

MC68882

Enhanced Floating Point Coprocessor

The MC68882 is pin-to-pin hardware and software compatible with the MC68881 Floating Point Coprocessor and implements a variety of performance enhancements including dual-ported registers and an advanced pipeline. Additional circuitry allows execution of multiple instructions in parallel for more than twice the Floating Point performance of the trail-blazing MC68881. Where higher performance requirements indicate, the MC68882 is a drop-in replacement for the MC68881.

DMA Controllers

MC68450

DMA Controller DMAC

The DMAC maintains high-performance data movement for complex M68000 MPU-based systems. While pin compatible with the MC68440 DDMA, the DMAC offers four completely independent DMA channels. In addition to all the features of the DDMA, the DMAC also provides very sophisticated manipulation of data through sequential and linked array-chained addressing capabilities.

MC68440

Dual Direct Memory Access Controller, DDMA

The DDMA complements the performance capabilities of M68000 microprocessors by moving blocks of data in a quick, efficient manner with a minimum of intervention from the MPU. The DDMA performs memory-to-memory, peripheral-to-memory, and memory-to-peripheral transfers through each of two completely independent DMA channels. The DDMA also offers two interrupt vectors per channel and supports both 8-bit and 16-bit data transfers.

Network Devices

MC68824

Token Bus Controller, TBC

The TBC is the industry's first single-chip VLSI device to implement the IEEE 802.4 Media Access Control Sublayer of the ISO Data Link Layer, as specified by General Motors Manufacturing Automation Protocol, MAP. The TBC supports serial data rates of 1, 5, and 10 Mbps and relieves the host processor of the frame formatting and token management functions. For efficient transfer of data frames, to and from memory, the TBC features an on-chip four-channel DMA with bus master capability, a 32-bit address range, an 8- or 16-bit data bus, and a 40-byte FIFO. The MC68824 also offers support options for network bridges, real-time support and network monitoring services.

MC68184

Broadband Interface Controller

The MC68184 Broadband Interface Controller (BIC) is a high-performance interface device for use with the MC68824 Token Bus Controller (TBC) to implement the digital portion of the physical layer of a broadband IEEE 802.4 token bus node. The BIC manipulates both data and control for RF transmitter circuitry and RF receiver circuitry. The CMOS BIC supports data rates up to 10 Mbps using a duo-binary modulation technique and provides 20 lines for receiver/transmitter control with 13 user-defined outputs.

The BIC performs the digital functions of the physical layer when implementing a broadband token bus node. The modem side of the BIC provides data and control for the RF transmitter/receiver circuitry. A standard serial interface is used to connect the BIC to the MC68824 TBC. The TBC performs the media access control (MAC) function. The MC68184 has the ability to scramble and descramble data.

MC68185

Twisted-Pair Modem

The MC68185 Twisted-Pair Modem (TPM) is used in conjunction with a MC68824 Token Bus Controller (TBC), an RS485 transceiver, and a twisted-pair media to implement a low-cost area network (LAN). The MC68824 TBC implements the layer 2 media access control (MAC) portion of the IEEE 802.4 LAN station and receiver portion for the IEEE 802.2 logical link control (LLC) type 3 as well as providing support for LLC type 1 and type 2. The TPM interfaces directly to the TBC, providing physical layer management, including MAC symbol encoding/decoding at data rates up to 2 Mbps.

The TPM contains an 32 kHz to 20 MHz on-chip crystal oscillator that generates a transmit clock without external circuitry. The physical layer management includes local loopback mode, transmitter enable, and reset. An on-chip digital filter provides for noise reduction of received data.

MC68194

Carrierband Modem

The bipolar LSI MC68194 Carrierband Modem (CBM), when combined with the MC68824 Token Bus Controller (TBC), provides an IEEE 802.4 single-channel, phase-coherent carrierband, Local Area Network (LAN) connection. The CBM performs the physical layer function, including symbol encoding/decoding, signal transmission and reception, and physical management.

The CBM provides the three basic functions of the physical layer: data transmission to the coaxial cable, data reception from the cable, and management of the physical layer. For standard data mode (also called MAC mode), the CBM receives a serial transmit data stream from the TBC (called symbols or atomic symbols), encodes, modulates the carrier, and transmits the signal to the coaxial cable. Also in the data mode, the CBM receives a signal from the cable, demodulates the signal, recovers the data, and sends the received data symbols to the TBC. End-of-transmission receiver blanking as required by IEEE 802.4 is supported. Communication between the TBC and CBM is through a standardized serial interface consistent with the IEEE 802.4 DTE-DCE interface.

MC68195

LocalTalk Adaptor

The MC68195 LocalTalk adaptor (LA) is used in conjunction with the MC68302 Integrated Multiprotocol Processor (IMP) to build a network interface to LocalTalk™, also known as AppleTalk™. LocalTalk refers to the 230.4-kbps Local Area Network (LAN) that connects multiple MacIntosh™ computers and printers.

The LA provides LocalTalk support for any two of the three IMP serial channels. Combinations of multiple LA and/or IMP devices may be used to support additional LocalTalk channels. Non-LocalTalk applications can use the LA device with the IMP to build proprietary HDLC-based LANs at up to 2.5 Mbps using bi-phase space (FMO) encoding.

MC68605

X.25 Protocol Controller, XPC

The XPC implements the 1984 CCITT X.25 Recommendation Data Link Procedure (level 2) LAPB. In addition to handling the lower level communications functions (HDLC framing, CRC generation/checking, and zero insertion/deletion), the XPC also independently handles higher level communications functions (frame sequencing, retransmission, flow control, retries limit and timeout conditions). This allows the host to operate almost totally isolated from the task of ensuring error-free transmission and reception of data.

MC68606

Multi-Link LAPD Controller CCITT Q.920/Q.921, LAPD

The MC68606 Multi-link LAPD (MLAPD) Protocol Controller fully implements CCITT Recommendation Q.920/Q.921 Link Layer Access Procedure (LAPD) protocol for ISDN networks. The MLAPD is designed to handle both signalling and data links in high-performance ISDN primary rate applications.

This VLSI device provides a cost-effective solution to ISDN link-level processing with simultaneous support for up to 8K logical links. The MC68606 is an intelligent communications protocol controller compatible with AT&T specifications for ISDN devices and features low power consumption and high performance, with an aggregate data rate in excess of 2.048 Mbps.

Data Communication Devices

MC68681

MC2681

Dual Universal Asynchronous Receiver/Transmitter, DUART

The MC68681 features two completely independent full-duplex asynchronous receiver/transmitter channels that interface directly to the M68000 microprocessor bus. Receiver data registers are quadruple buffered and transmitter data registers are double buffered for minimum MPU intervention. Each has its own independently selectable baud rate. Multifunction 6-bit input port and 8-bit output port, a 16-bit programmable counter/timer, interrupt handling capabilities, and a maximum one-megabyte per second transfer rate make the DUART an extremely powerful device for complex data communication applications. Full device functionality with an M6800 bus interface is provided by the MC2681.

General Purpose I/O

MC68230

Parallel Interface/Timer, PI/T

The PI/T provides versatile double-buffered parallel interfaces and a system-oriented timer for M68000 systems. The parallel interfaces operate either in a unidirectional or bidirectional mode, either 8- or 16-bit wide. The timer is 24 bits with full programmability and a 5-bit prescaler. The PI/T has a complete M68000 bus interface and is fully compatible with the MC68450 DMAC.

MC68901

Multifunction Peripheral, MFP

The MFP provides basic microcomputer function requirements as a single companion chip to the M68000 Family of Microprocessors. Features provided via a direct M68000 system bus interface include a full-function, single-channel Universal Serial Asynchronous Receiver/Transmitter (USART) for data communication, an 8-source interrupt controller, eight parallel I/O lines, and four 8-bit timers.

Fiber Distributed Data Interface

Fiber Distributed Data Interface (FDDI) is defined as a dual fiber-optic token ring LAN (Local Area Network) that can support rates up to 100 Mbps. It can accommodate rings with 1,000 stations. Two kilometers between stations, and up to 200 kilometers in total length. This technology is driven by the need to support high performance distributed computer systems which are becoming faster and more powerful, thus imposing a greater need for network speed and bandwidth. Other uses for FDDI include backbone networks connecting Ethernet, Token Bus, and Token Ring segments and back end networks connecting high-speed peripherals. FDDI is an American National Standards Institute (ANSI) standard. Motorola's FDDI chip set includes the MC68836, MC68837, MC68838, and MC68839.

MC68836

FDDI Clock Generator

The MC68836 FDDI Clock Generator (FCG) implements part of the Physical Layer (PHY) functions of the FDDI standard including clock recovery, data recovery, and NRZI conversions. The FCG also does a five-bit parallel to serial conversion during transmission, and a serial to five-bit parallel conversion during reception. The FCG uses the five-bit parallel interface to communicate with the MC68837 device. The FCG directly connects to fiber optic modules through differential driver/receiver pins. Features include full duplex operations, 125 MHz clock recovery from incoming serial NRZI data stream, and 125 MHz transmit clock generation.

MC68837

Elasticity Buffer and Link Manager

The Elasticity Buffer and Link Manager (ELM) implements the remaining of the PHY functions of the FDDI standard including data framing, elasticity buffer, encoding, decoding, smoothing, line state detection, and repeat filter. The ELM also implements some Station Management (SMT) functions such as the Connection Management (CMT), Physical Connection Management (PCM), Physical Connection Insertion (PCI), and Link Error Monitor (LEM).

MC68838

Media Access Controller

The Media Access Controller (MAC) implements the MAC portion of the FDDI standard. The MAC protocol is the lower sub-layer of the ISO OSI data link layer and provides for fair and deterministic sharing of the physical medium, address recognition, frame check sequence generation and verification, frame insertion, frame repetition, frame removal, token generation, and certain error recovery procedures. Features on the MC68838 include independent receive and transmit data paths and state machines, bridging support including a bit order reversal option, a count and void frame bridge stripping algorithm, and CRC appendage on a per frame basis. The MAC also contains an interface to Content Addressable Memory (CAM) for individual and multicast address recognition.

MC68839

FDDI System Interface

The FDDI System Interface (FSI) is a high performance interface device which can easily connect to any bus including high speed processors, little- and big-endian busses, and multiplexed/non-multiplexed address data busses. Its primary purpose is to interface the FDDI protocol devices to the user system bus. FSI features include support for a ring buffer structure, addressing flexibility, programmable partitioned 8K bytes internal RAM for temporary data storage, two 32-bit ports, the ability to sustain up to 250 μs bus latencies, support for synchronous and asynchronous frames, and the ability to chain multiple buffers per frame.

Development Tools

Application Development System

The M68302ADS is a stand-alone board developed by Motorola that includes software modules (driver code, LAPB, LAPD, and X.25), a real-time kernel, and a monitor/debugger. The board consists of the MC68302, memory (512K bytes of RAM expandable to 1M bytes, 256 bytes of EPROM and EEPROM), and an MC68681 DUART (to allow all MC68302 serial ports to be available to the user). It is an inexpensive, ideal platform for software development and testing.

M68EC0x0IDP

Evaluation Boards for Embedded Controllers

The M68000 family IDP is a board set designed to provide a low-cost evaluation platform, yet flexible environment for developing both software and hardware for the family products. The platform provides the means for M68000 microprocessor and tool evaluation which enables users to properly select the microprocessor and associated tools for their next application. Because the turnkey development system requires the user to do very little to power up the system and begin development, significant time savings is realized by reducing the overall time that the product takes to get to market.

The IDP consists of an M68000 Family microprocessor-based CPU module as well as a generic IDP motherboard designed to support each CPU module. The IDP also includes two software debug monitor programs: Integrated Systems' ROM68K™ and Intermetrics' SmartROM™. This configuration allows the user to take advantage of an entire suite of features, including tracing, assembling, disassembling and downloading, that are offered by the monitors. Optional software is available to expand the development environment of the IDP by allowing the user to design, debug and evaluate the M68000 microprocessor-based applications in real-time and non-real-time operating system environments. The IDP also functions as a tool for final test or fault analysis of user target systems.

The IDP only requires a user-supplied power supply and an RS-332 ASCII terminal or host computer with an RS-232 serial port. Although the IDP will function using a terminal, the preferred communication device is a host computer. Operating the IDP with a host computer allows the user to develop, compile and debug code using one of many optional software tools. Once code is developed, the program can be saved and downloaded to the IDP from the host computer.

M68340EVS

Evaluation System

The M68340EVS is an inexpensive three-board evaluation and development system which allows the user to design, debug and evaluate 68340-based applications. It interfaces easily to traditional emulation tools and includes its own software debugger.

Support Software

M68KESW-PC1

This Intermetrics software package is for the 68K Family (68000, 68008, 68HC001, 68010, 68020, 68030, 68EC030, 68040, 683xx). The M68KESW InterTools package includes C compiler, assembler/linker, run-time libraries, and one year of support from Intermetrics.

M68040FPSP

This software provides 68040 floating point emulation of unimplemented 68881/68882 functions. Contact factory for license agreement.

Table 4. Selector Guide

Device Number	Package	Speeds	Device Type
MC68000	64-Lead L*, P 68-Lead R, RC*, FN	8, 10, 12, 12F* 8, 10, 12, 12F*	Microprocessor
MC68EC000	68-Lead FN	8, 10, 12, 16	Embedded Controller
MC68HC000	64-Lead P 68-Lead R, RC*, FN 68-Lead FC	8, 10, 12, 12F*, 16 8, 10, 12, 16 8, 10, 12, 16	Microprocessor
MC68HC001	68-Lead R, RC*, FN	8, 10, 12, 16	
MC68008	48-Lead P 52-Lead FN	8, 10 8, 10	Microprocessor
MC68010	64-Lead P 68-Lead R, RC*, FN	8, 10, 12 8, 10, 12	Microprocessor

* Not recommended for new design
All package/speed combinations may not be valid – consult factory to verify

Table 4. Selector Guide (continued)

Device Number	Package	Speeds	Device Type
MC68020	114-Lead RC 132-Lead FE* 114-Lead RP 132-Lead FC	12, 16, 20, 25, 33 16, 20, 25 16, 20, 25 16, 20, 25	Microprocessor
MC68EC020	100-Lead FG, RP	16, 25	Embedded Controller
MC68030	128-Lead RC 124-Lead RP 132-Lead FE	16, 20, 25, 33, 40, 50 16, 20, 25, 33 16, 20, 25, 33	Microprocessor
MC68EC030	124-Lead RP 132-Lead FE	25, 40 25, 40	Embedded Controller
MC68040	179-Lead RC	25, 33, 40	Microprocessor
MC68EC040	179-Lead RC 184-Lead FE	20, 25, 33 20, 25	Embedded Controller
MC68LC040	179-Lead RC 184-Lead FE	20, 25, 33 20, 25	Microprocessor
MC68040V	184-Lead FE	25, 33	Microprocessor
MC68060	223-Lead RC TBD-Lead FE	50, 66 50, 66	Microprocessor
MC68184	40-Lead P, L	–	Network
MC68185	44-Lead FN 68-Lead RC	– –	Network
MC68194	52-Lead FJ	–	Network
MC68195	44-Lead FN	–	Network
MC68230	48-Lead P 52-Lead FN	8, 10 8, 10	General Purpose I/O
MC68302	132-Lead RC, FE, FC, FD	16, 20	Integrated Processor
MC68306	128-Lead FC 132-Lead FG	16 16	Integrated Processor
MC68330	132-Lead FC	16, 25 8, 16 @ 3.3 V	Integrated Processor
MC68331	132-Lead FC	16	Integrated Processor
MC68332	132-Lead FC	16	Integrated Processor
MC68340	144-Lead FE 145-Lead RP	16, 25 16, 25	Integrated Processor
MC68340V	144-Lead FE 145-Lead RP	8, 16 @ 3.3 V 8, 16 @ 3.3 V	Integrated Processor
MC68360	240-Lead FC 241-Lead RC	0 - 25 0 - 25	Integrated Communication Controller
MC68440	68-Lead L, P 68-Lead R, FN	8, 10 8, 10	DMA Controller
MC68450	68-Lead L, P 68-Lead R, FN	8, 10 8, 10	DMA Controller
MC68605	84-Lead R, RC 84-Lead FN	10, 12, 16 10, 12, 16	Network
MC68606	84-Lead RC 84-Lead FN	12, 16 12, 16	Network

* Not recommended for new design
All package/speed combinations may not be valid – consult factory to verify

Table 4. Selector Guide (continued)

Device Number	Package	Speeds	Device Type
MC2681	40-Lead P, L* 44-Lead FN	– –	Data Communication
MC68681	40-Lead P, L* 44-Lead FN	– –	Data Communication
MC68824	84-Lead R, RC 84-Lead FN	10, 12, 16 10, 12, 16	Network
MC68836	52-Lead FN	– –	Fiber Distributed Data Interface
MC68837	120-Lead KB 120-Lead FC	– –	Fiber Distributed Data Interface
MC68838	120-Lead KB 120-Lead FC	– –	Fiber Distributed Data Interface
MC68839	184-Lead RC 184-Lead FE	– –	Fiber Distributed Data Interface
MC68851*	132-Lead RC	12, 16, 20	CoProcessor
MC68881	68-Lead RC, FN	12, 16, 20	CoProcessor
MC68882	68-Lead RC 68-Lead RN	16, 20, 25, 33, 40, 50 16, 20, 25, 33, 40	CoProcessor
MC68901	48-Lead P 52-Lead FN	– –	General Purpose I/O

FC = Plastic Quad (Gull Wing)	FN = Plastic Quad Pack (PLCC)	P = Plastic DIP
FD = Plastic Quad w/Molded Carrier Ring	KB = Ceramic PGA w/Ceramic Lid	R = Pin Grid Array, Solder Lead Finish
FE = Ceramic Quad (Gull Wing)	L = Ceramic DIP	RC = Ceramic PGA, Gold Lead Finish
FG = Plastic Quad Flat Pack (PQFP)	LC = Ceramic DIP, Gold Lead Finish	RP = Plastic Pin Grid Array

* Not recommended for new design
All package/speed combinations may not be valid – consult factory to verify

The M88000 RISC Family

In Brief . . .

The life of a successful microprocessor architecture can be expected to span decades. The 88000 RISC architecture was designed as an extensible architecture allowing generations of higher performance of future product family members.

Motorola's 88000 RISC Microprocessors

. . . a performance architecture

Architecture, Performance, and Software Compatibility

The 88000 RISC was designed from the start for superscaler implementations. In fact, the design of the second generation 88110 microprocessor is a unique superscaler implementation called Symmetric Superscalar™. The Symmetric Superscaler design allows you to execute multiple instructions in a single clock cycle without any restrictions on instruction ordering. So there are no wait states or performance penalties because of out of order instructions.

Also, while other RISC microprocessors may be limited in the instructions they can execute in a single clock cycle, members of the 88000 are able to execute multiple instructions per clock cycle, thus providing the performance edge required for next generation system designs.

Performance Plus Software Compatibility

Although high performance is recognized as a key feature for systems design, software compatibility is also important. Motorola's 88000 Family comes from the only company committed to long term upward software compatibility through such features as hardware interlocked and protected pipelines. Our goal is to make sure each generation of the 88000 RISC family delivers a high performance level while maintaining software compatibility. This gives the opportunity for designing one of the industry's highest performance systems, while leveraging your largest dollar investment in new systems, your software.

Software compatibility is also promoted through standards to provide an open systems environment benefitting system companies, software developers, and end users because 88000 based systems from different vendors will run all of the same software.

Microprocessors

MC88100RC
32-Bit RISC Microprocessor

The MC88100 is the first processor in the 88000 Family of RISC (reduced instruction set computer) microprocessors. Implemented with Motorola's HCMOS technology, the MC88100 incorporates 32-bit registers, data paths, and addresses. In designing the MC88100, Motorola has incorporated a high degree of fine-grain parallelism; four independent execution units maintain separate, fully concurrent execution pipelines. Most instructions operate in one machine cycle or effective concurrent execution can be accomplished through internal pipelines in one machine cycle. A common register file provides data sharing and synchronization control among the execution units through register scoreboarding.

The MC88100 addresses a variety of applications requiring high operational speeds and efficient, fast-execution architectures. All data manipulation instructions are nondestructive register to register or register with immediate operations, allowing both fast operand access and operand reuse. IEEE 754 floating-point arithmetic is supported in the processor. Instruction and data memory space are accessed through separate memory ports, allowing simultaneous access to dedicated memory areas. The 88000 Family includes the MC88200 CMMU (cache/memory management unit), which adds high-speed memory caching, two-level, demand-paged memory management, and support for shared-memory multiprocessing. The 88000 Family also includes a full line of highly optimizing compilers, operating systems, development boards, and development tools.

MC88110 RC
32-Bit RISC Microprocessor

The MC88110 is the second implementation of the 88000 family of reduced instruction set computer (RISC) microprocessors. The MC88110 is a Symmetric Superscalar machine capable of issuing and retiring two instructions per clock without any special alignment, ordering, or type restrictions on the instruction stream. Instructions are issued to multiple execution units, execute in parallel, and can complete out of order, with the machine automatically keeping results in the correct program sequence. The Symmetric Superscalar design allows sustained performance to approach the peak performance capability.

The MC88110 uses dual instruction issue and simple instructions with extremely rapid execution times to yield maximum efficiency and throughput for 88000 systems. Instructions either execute in one clock cycle, or effective one clock cycle execution is achieved through internal pipelining. Ten independent execution units communicate with a general register file and an extended register file through multiple 80-bit internal buses. Each of the register files has sufficient bandwidth to supply four operands and receive two results per clock cycle. Each of the pipelined execution units, including those that execute floating-point and data movement instructions, can accept a new instruction and retire a previous instruction on every clock cycle.

In a single chip implementation, the MC88110 integrates the central processing unit, floating point unit, graphics processing unit, virtual memory address translation, instruction cache, and data cache. The MC88110 maintains compatibility with MC88100 user application software.

Cache/Memory Management Units

MC88200RC 16-Kilobyte Cache/Memory Management Unit (CMMU)

The MC88200 CMMU is a high-performance, HCMOS VLSI device providing zero-wait-state memory management and data caching. The MMU (memory management unit) efficiently supports a demand-paged virtual memory environment with two logical address ranges (user/supervisor) of 4 gigabytes each. Translated addresses are provided by one of two ATCs (address translation caches), providing address translation in one clock cycle for most memory accesses. The PATC (page address translation cache) is a 56-entry, fully associative cache containing recently used translations for 4-kilobyte memory pages and is maintained by MC88200 hardware. The BATC (block address translation cache) is a 10-entry cache, loaded by software, containing translations for 512-kilobyte memory blocks. The BATC translations are used for operating system software or for other memory-resident instructions and data. In addition, the MMU provides access control for the two logical address spaces. The CMMU data cache is a 16-kilobyte, four-way, set-associative cache for instruction or data storage. The cache incorporates memory-update policies and cache-coherency mechanisms that support multiprocessor applications. The MC88200 CMMU also includes an MC88100-compatible P bus (processor bus) interface and an M bus (memory bus) interface. A processor may use two or more CMMUs for increased data cache and ATC sizes.

MC88204RC 64K-Byte Cache/Memory Management Unit (CMMU)

The MC88204 CMMU is a high-performance, HCMOS VLSI device providing zero-wait-state memory management and data caching. The memory management unit (MMU) efficiently supports a demand-paged virtual memory environment with two logical address ranges (user/supervisor) of 4 Gbytes each. Translated addresses are provided by one of two address translation caches (ATCs), providing address translation in one clock cycle for most memory accesses. The page address translation cache (PATC) is a 56-entry, fully associative cache containing recently used translations for 4K-byte memory pages and is maintained by MC88204 hardware. The block address translation cache (BATC) is a 10-entry cache, loaded by software, containing translations for 512K-byte memory blocks. The BATC translations are used for operating system software or for other memory-resident instructions and data. In addition, the MMU provides access control for the two logical address spaces. The CMMU data cache is a 64K-byte, four-way set-associative cache for instruction or data storage. The cache incorporates memory-update policies and cache-coherency mechanisms that support multiprocessor applications. The MC88204 CMMU also includes an MC88100-compatible processor bus (P bus) interface and memory bus (M bus) interface.

The MC88204 CMMU is completely software and pin-level compatible with the MC88200 16K-byte CMMU. The functionality of the MC88204 is identical to that of the MC88200. With board layout constraints in mind, a central processing unit (CPU) may use up to two MC88204 CMMUs on the data P bus and up to two MC88204 CMMUs on the instruction P bus to increase data cache and ATC sizes.

MC88410 Secondary Cache Controller

The MC88410 is a highly integrated secondary cache controller for the MC88110 microprocessor that reduces memory latency and extends multiprocessing capability for those seeking the highest level of system performance. Used with the MCM62110 Fast Static RAM, it provides a functionally complete secondary cache solution for both uniprocessor and multiprocessor environments. The MC88410 provides tag, control and buffering for 1/4, 1/2, and 1 Mbyte secondary cache configurations, all in a single chip cache controller. The MC88410 eliminates external logic between the processor and the secondary cache, provides bus arbitration for the MC88110, and requires no external programming.

The MC88410 and MCM62110 are optimized to provide low latency memory access to the MC88110 processor. Initial accesses incur only one wait state. Subsequent transactions in a burst incur zero wait states. Data streaming to the processor reduces the penalty on secondary cache misses.

The MC88410 expands the MC88110's system flexibility by providing a choice of secondary cache line size, burst byte ordering, and system clock frequency. The MC88410 extends the MC88110 multiprocessing capability by significantly reducing system bandwidth consumption. This increased available bandwidth, along with the MC88410's hardware enforced cache coherency protocol, enable the implementation of dual bus systems and scalable shared-bus multiprocessing systems.

The PowerPC™ RISC Family Microprocessor

In Brief . . .

The PowerPC architecture is derived from the IBM Performance Optimized with Enhanced RISC (POWER) architecture. The PowerPC architecture shares all of the benefits of the POWER architecture but is optimized for single-chip implementations. The architecture design emphasizes parallel instruction execution and high throughput and allows for exceptional floating-point performance. The PowerPC architecture is powerful today and is scalable from palmtops to mainframes. The MPC601 is a 32-bit implementation of the 64-bit PowerPC architecture.

Page

MPC601 RISC Microprocessor

The MPC601 is the first implementation of the PowerPC family of Reduced Instruction Set Computer (RISC) microprocessors. The MPC601 implements the 32-bit portion of the PowerPC architecture, which provides 32-bit effective addresses, integer data types of 8, 16, and 32 bits, and floating-point data types of 32 and 64 bits. For 64-bit PowerPC implementations, the PowerPC architecture provides 64-bit integer data types, 64-bit addressing, and other features required to complete the 64-bit architecture.

The MPC601 is a superscalar processor capable of issuing and retiring three instructions per clock, one to each of three execution units. Instructions can complete out of order for increased performance; however, the MPC601 makes execution appear sequential.

The MPC601 integrates three execution units — an integer unit (IU), a branch processing unit (BPU), and a floating-point unit (FPU). The ability to execute three instructions in parallel and the use of simple instructions with rapid execution times yield high efficiency and throughput for MPC601-based systems. Most integer instructions execute in one clock cycle. The FPU is pipelined so a single-precision multiply-add instruction can be issued every clock cycle.

The MPC601 includes an on-chip, 32-Kbyte, eight-way set-associative, physically addressed, unified instruction and data cache and an on-chip memory management unit (MMU). The MMU contains a 256-entry, two-way set-associative, unified translation look-aside buffer (UTLB) and provides support for demand paged virtual memory address translation and variable-sized block translation. Both the UTLB and the cache use least recently used (LRU) replacement algorithms.

The MPC601 has a 64-bit data bus and a 32-bit address bus. The MPC601 interface protocol allows multiple masters to compete for system resources through a central external arbiter. Additionally, on-chip snooping logic maintains cache coherency in multiprocessor applications. The MPC601 supports single-beat and burst data transfers for memory accesses; it also supports both memory-mapped I/O and I/O controller interface addressing.

The MPC601 uses an advanced, 3.6-V CMOS process technology and maintains full interface compatibility with TTL devices.

MPC601 Features

Major features of the MPC601 are as follows:

- High-performance, superscalar microprocessor
  - As many as three instructions in execution per clock (one to each of the three execution units)
  - Single clock cycle execution for most instructions
  - Pipelined FPU for all single-precision and most double-precision operations
- Three independent execution units and two register files
  - BPU featuring static branch prediction
  - A 32-bit IU
  - Fully IEEE 754-compliant FPU for both single- and double-precision operations
  - Thirty-two GPRs for integer operands
  - Thirty-two FPRs for single- or double-precision operands
- High instruction and data throughput
  - Zero-cycle branch capability
  - Programmable static branch prediction on unresolved conditional branches
  - Instruction unit capable of prefetching eight instructions per clock from the cache
  - An eight instruction prefetch queue that provides look-ahead capability
  - Interlocked pipelines with feed-forwarding that control data dependencies in hardware
  - Unified 32-Kbyte cache — eight-way set-associative, physically addressed; LRU replacement algorithm
  - Cache write-back or write-through operation programmable on a per page or per block basis
  - Memory unit with a two-element read queue and a three-element write queue
  - Run-time reordering of loads and stores
  - BPU that performs condition register (CR) look-ahead operations
  - Address translation facilities for 4-Kbyte page size, variable block size, and 256-Mbyte segment size
  - A 256-entry, two-way set-associative UTLB
  - Four-entry BTLB providing 128-Kbyte to 8-Mbyte blocks
  - Four-entry, first-level ITLB
  - Hardware table search (caused by UTLB misses) through hashed page tables
  - 52-bit virtual address; 32-bit physical address
- Facilities for enhanced system performance
  - Bus speed defined as selectable division of operating frequency
  - A 64-bit split-transaction external data bus with burst transfers
  - Support for address pipelining and limited out-of-order bus transactions
  - Snooped copyback queues for cache block (sector) copyback operations
  - Bus extensions for I/O controller interface operations
  - Multiprocessing support features that include the following:
    - Hardware enforced, four-state cache coherency protocol (MESI)
    - Separate port into cache tags for bus snooping
- In-system testability and debugging features through boundary-scan capability

Block Diagram

Figure 1 provides a block diagram of the MPC601 that illustrates how the execution units — IU, FPU, and BPU — operate independently and in parallel.

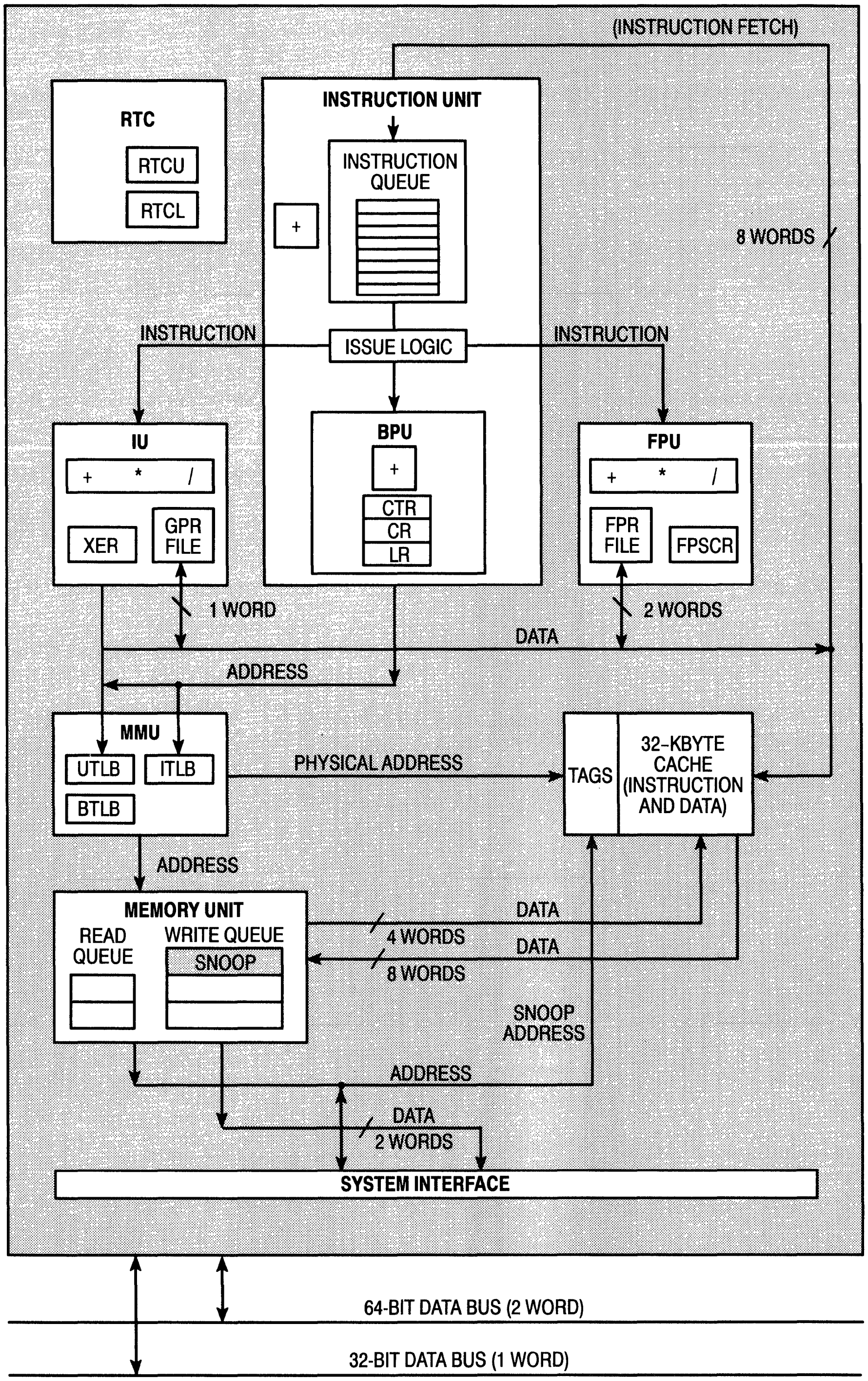


Figure 1. MPC601 Block Diagram

Single-Chip Microcontrollers (MCU)

In Brief . . .

Motorola offers the most comprehensive selection of high-performance single-chip control systems available from a single source. Microcontroller device families range from industry-standard 8-bit controllers to state-of-the-art 16- and 32-bit modular controllers. Within the price and performance categories of each family, there are a variety of on-chip capabilities to match specific applications.

Motorola device families are structured so that upward migration need not involve complete code development. The M68HC11 Family is upward code compatible with M6800 and M6801 software, while the M68HC16 family is source-code compatible with the M68HC11 family. Motorola's newest 8-bit MCU product line, the M68HC08 family, is fully upward object code compatible with the M68HC05 and M6805 families. In addition, M68300 and M68HC16 devices share standard internal modules and bus configurations.

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M68HC05 CSIC Family

There are now more than 130 different standard products in the M68HC05 family. This family of products offers more on-chip memory and peripheral options than any other microcontroller line.

The M68HC05 Family is the basis for the Motorola Customer Specified Integrated Circuit (CSIC) design program. The CSIC program is targeted for high-volume projects that require the cost-efficiency of standard devices, but have requirements that cannot be met by "off the shelf" components.

To develop a CSIC, the user selects the 68HC05 microcontroller that best meets design specifications, then specifies additional features, such as on-chip memory (including RAM, ROM, EPROM, and EEPROM), communications interfaces (such as SCI, SPI, SIOP and I^2C), timers, A/D converters, pulse-width modulators, or display drivers. Motorola design engineers evaluate customer requests to create a device that best meets the needs of the market. The resulting CSIC often becomes a standard product in the M68HC05 Family.

Motorola has an extensive line of one-time programmable (OTP) microcontrollers that can be used to prototype new products. Code changes can be made quickly in OTP devices, and OTP microcontrollers cost much less than windowed EPROM devices. OTP devices can also be used for low-to-medium quantity production runs, or for products that require different code for model variation.

M68HC05 General Purpose Microcontrollers

M68HC05 C-Series devices offer a wide variety of memory options capable of handling complex programs. An on-chip SCI provides asynchronous communications with software-selectable baud rates from 75 Hz to 131 kHz. The SPI, a high-speed, synchronous 4-wire serial system, is ideal for driving off-chip displays and peripherals. C-Series devices include a powerful 16-bit free running programmable counter in conjunction with input capture and output compare functions for simultaneous input waveform measurement and output waveform generation. A watchdog timer is available to guard against software runaway in noisy environments.

The M68HC05 E Series includes the 68HC05E0, the first expandable M68HC05 without on-chip ROM. Designed as an expanded part, the 68HC05E0 can address up to 64K bytes of external memory and is available off the shelf without mask production.

The G Series was created to support the demands of portable computer applications. With features like dual SCI, keyboard control, PLL, and power management, the G-Series provides an extremely versatile control solution for the next generation of laptop computers.

The H Series is a LDMOS (Lateral Diffusion Metal-Oxide Silicon) device. LDMOS is capable of driving high current and high voltage without external components, making it ideal for portable applications using brushless motors.

To address the special requirements of CD-I (Compact Disk-Interactive) applications, the I Series features an on-chip 68000 interface module and dual SCI for multiple peripheral control.

The J Series has developed an affordable 20-lead tier of the 8-bit M68HC05 Family. The powerful 68HC05 CPU is combined with a flexible, 15-stage multifunction timer and real-time interrupt capability.

The K Series is our lowest-cost, lowest-pin count microcontroller series to date. The K Series includes the first 68HC05 microcontrollers to be offered in compact 16-lead DIP and SOIC packages, and it provides the optimum solution for cost-sensitive applications requiring 8-bit performance at 4-bit prices.

Born out of the CSIC design concept, the P Series offers a 28-lead family of microcontrollers with a variety of ROM sizes and special features such as a Serial Input/Output Port (SIOP) to control display drivers and communicate with other peripherals. Other options include A/D input and on-chip EEPROM for non-volatile data storage.

M68HC05 Telephone Microcontrollers

The F Series is designed for a broad range of telecommunications applications, particularly cordless and cellular phones. Options include an on-chip Dual-Tone Multi-Frequency (DTMF) generator and receiver, LED drive, tone generator, and keyboard interrupts.

M68HC05 Analog I/O + EEPROM Microcontrollers

The 68HC05 B-Series features on-chip EEPROM, an 8-channel 8-bit A/D converter, and pulse-width modulation (PWM) outputs making it ideal for a wide range of automotive, industrial, and consumer applications. Non-volatile EEPROM can retain user-programmed settings or factory codes. The A/D system can convert information provided from optical, temperature, and pressure sensors into digital signals for processing. Software stored in EEPROM can also be used to monitor and calibrate sensors, greatly reducing overall system cost. PWM outputs can then be used for precise motor control, minimizing additional circuitry, or to generate analog signals.

M68HC05 Display Microcontrollers

The L-Series is a versatile selection of very powerful microcontrollers capable of driving the large liquid crystal display (LCD) modules utilized in today's advanced handheld equipment. The series is designed specifically for low-power applications where minimum chip count is essential. On-chip options include a tone generator for alert functions found in pagers, telephones, and dashboard displays; full expanded bus with a Memory Management Unit (MMU) for efficient external data handling; real-time clock; and key-pressed wake-up from sleep mode. The L-Series is ideal for multi-language translator and pocket directory applications.

M68HC05 Display Microcontrollers (continued)

The T Series offers a features suited for many video and television applications. The On-Screen Display (OSD) system provides a multi-color display capability for menu-driven features. The A/D converter can be used to control fine tuning, while PWM converter systems can control volume, brightness, and other analog functions. Future versions will include closed-caption capability.

The D Series offers additional D/A output capability combined with a high-current LED drive for a variety of applications with display requirements.

The M Series is designed specifically for appliance and audio/visual applications utilizing vacuum fluorescent display (VFD). The on-chip VFD driver provides 40-volts on 24 bidirectional I/O lines. An additional 8-bit free-running modulus timer makes the M series suited to applications with complex timing requirements. Other features include a 6-channel 8-bit A/D system, SCI, and a large ROM option.

M68HC05 Smart Card Microcontrollers

Motorola is the leading designer and manufacturer of secure microcontrollers for smart card and conditional access systems. With over 10 years experience in smart card applications, Motorola has extensive knowledge of the technical requirements and can offer full hardware and software support. The SC Series is designed specifically for use in smart card applications, and has some of the smallest available microcontroller die sizes.

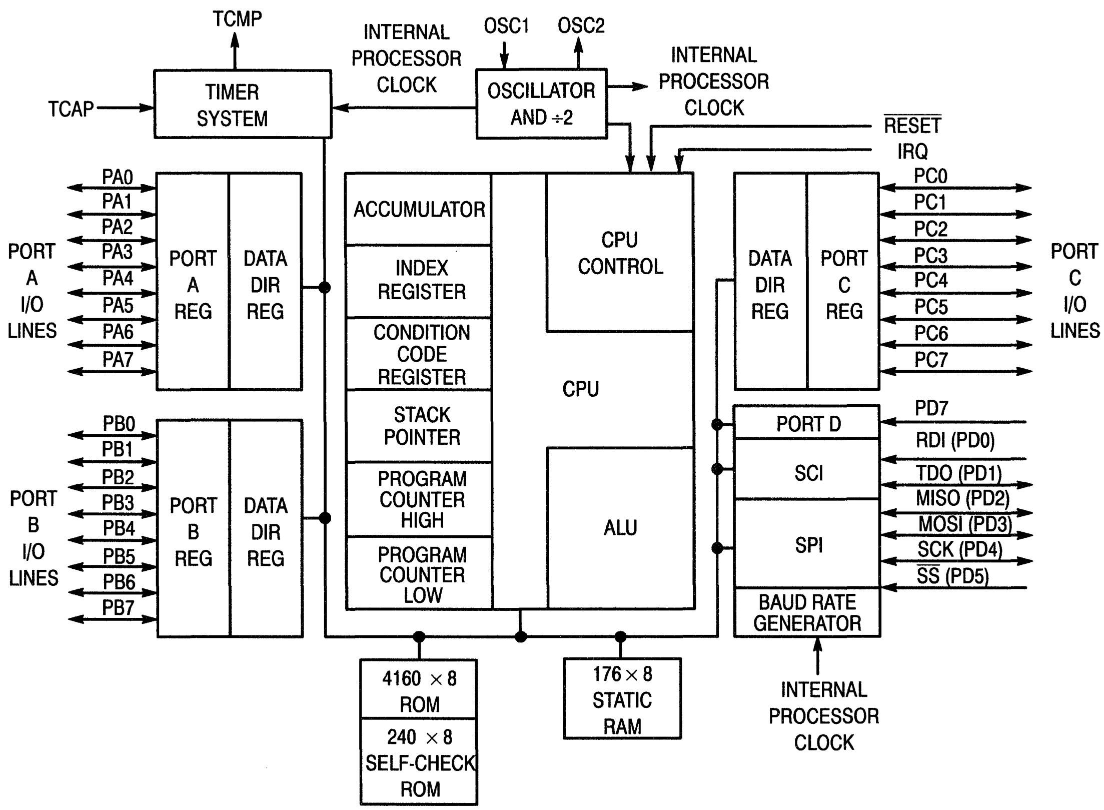


Figure 1. MC68HC05C4 Block Diagram

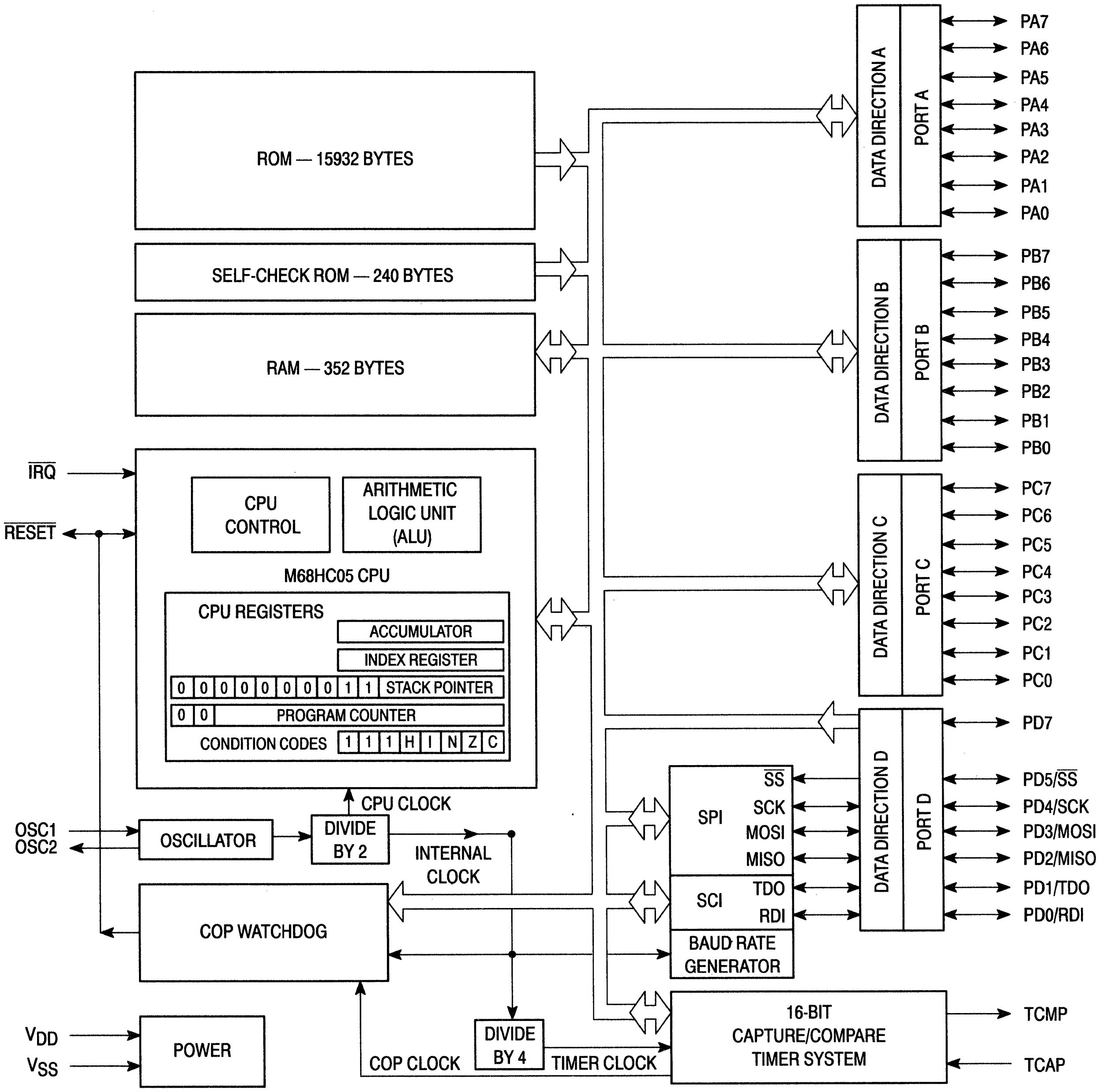


Figure 2. MC68HC05C9 Block Diagram

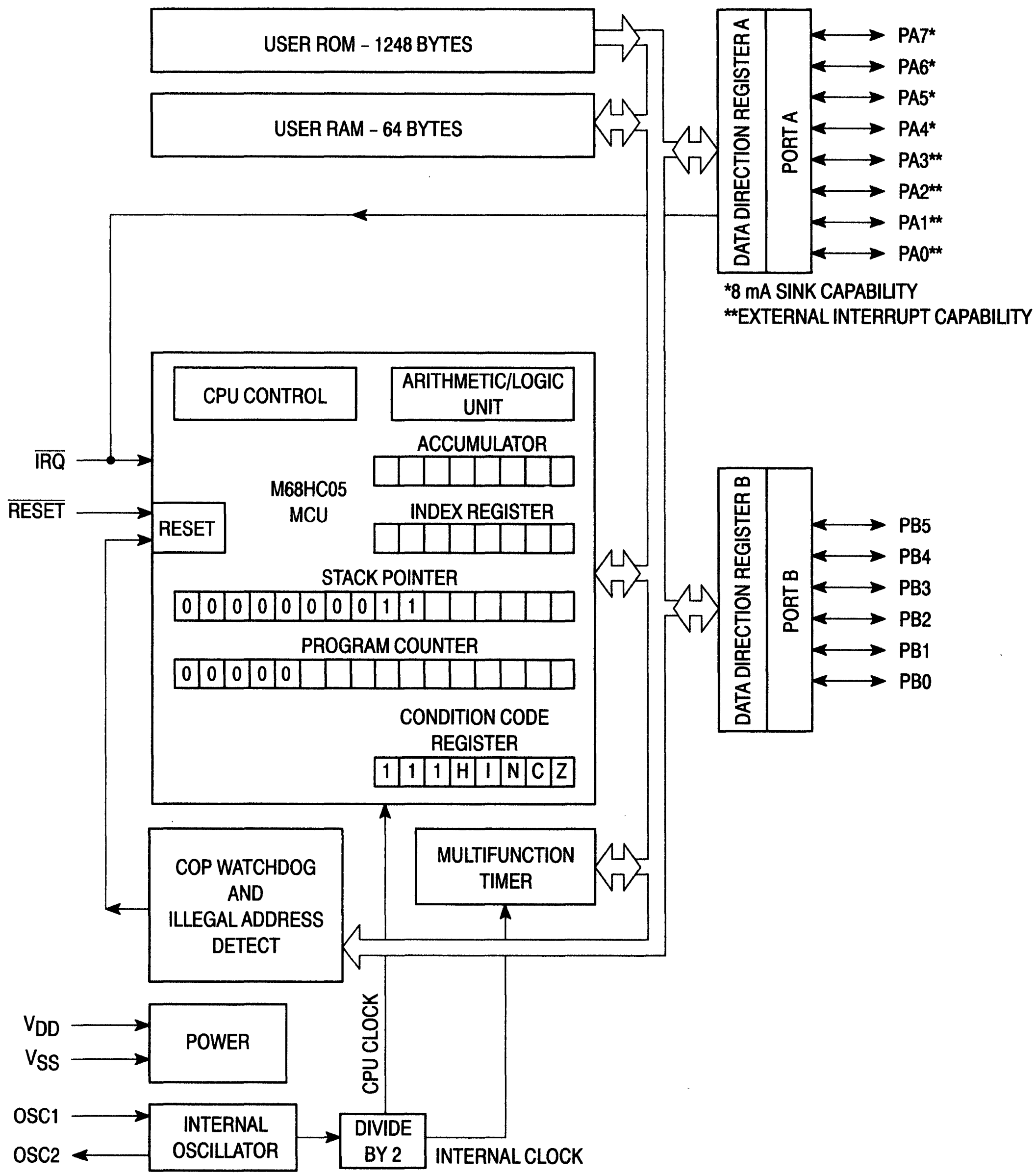


Figure 3. MC68HC05J1A Block Diagram

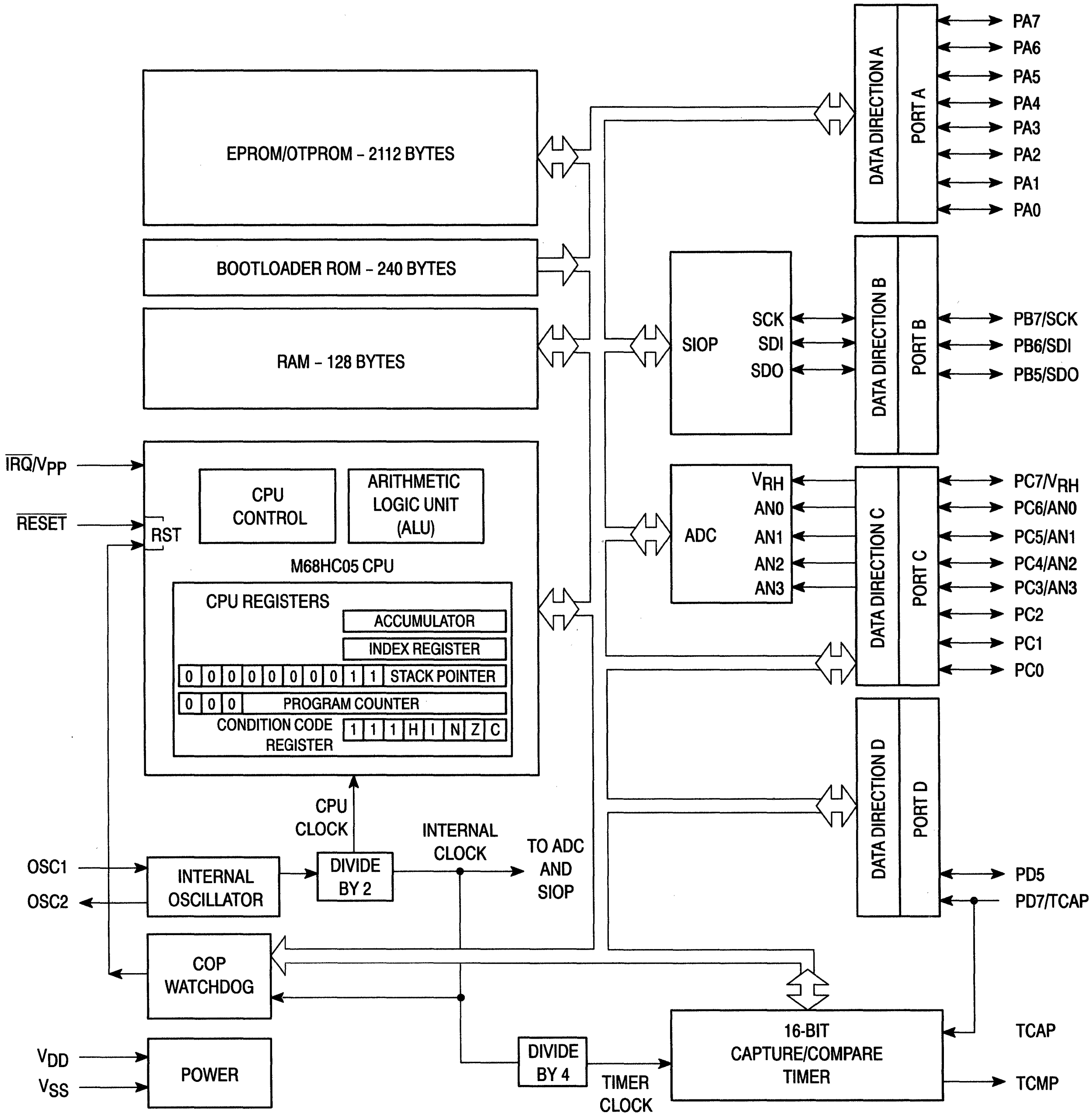


Figure 4. MC68HC705P9 Block Diagram

Table 1. 68HC05 General-Purpose Microcontrollers

Part Number	ROM	RAM	EEPROM	Timer	I/O*	Serial	A/D	PWM	Display Drive	Package Option	Comments
68HC05B4	4K	176	-	16-Bit – 2 IC, 2 OC, WDOG	32	SCI	8 Ch, 8-Bit	2 Ch, 8-Bit	-	56-B, 52-FN	
68HC05B6	6K	176	256	16-Bit – 2 IC, 2 OC, WDOG	32	SCI	8 Ch, 8-Bit	2 Ch, 8-Bit	-	56-B, 52-FN	On-Chip Charge Pump
68HC05B8	8K	176	256	16-Bit – 2 IC, 2 OC, WDOG	32	SCI	8 Ch, 8-Bit	2 Ch, 8-Bit	-	56-B, 52-FN	On-Chip Charge Pump
68HC05B16	15K	352	256	16-Bit – 2 IC, 2 OC, WDOG	32	SCI	8 Ch, 8-Bit	2 Ch, 8-Bit	-	52-FN, 64-FU	On-Chip Charge Pump
68HC05C4	4K	176	-	16-Bit – 1 IC, 1 OC	31	SPI, SCI	-	-	-	40-P, 44-FN, 44-FB	Low-Voltage and High-Speed Ver. Available
68HC05C5	5K	176	128	16-Bit – 1 IC, 1 OC, WDOG	32	SIOP	-	-	8 Ch LED	40-P, 44-FN	LVI Option, 10 mA, Sink Port
68HC05C8	8K	176	-	16-Bit – 1 IC, 1 OC	31	SPI, SCI	-	-	-	40-P, 44-FN, 44-FB	Low-Voltage and High-Speed Ver. Available
68HC05C9	16K	352	-	16-Bit – 1 IC, 1 OC, WDOG	31	SPI, SCI	-	-	-	40-P, 44-FN, 44-FB	Expanded Port D
68HC05C12	12K	176	-	16-Bit – 1 IC, 1 OC, WDOG	31	SPI, SCI	-	-	-	40-P, 44-FB	Power Saving Stop and Wait Modes
68HC05D9	16K	352	-	16-Bit – 1 IC, 1 OC	31	SCI	-	5 Ch, 6-Bit	8 Ch LED	40-P, 44-FN	24 mA Sink Port
68HC05D24	24K	352	-	16-Bit – 1 IC, 1 OC, WDOG	31	SCI	-	5 Ch, 6-Bit	8 Ch LED	40-P, 44-FN	24 mA Sink Port
68HC05D32	32K	352	-	16-Bit – 1 IC, 1 OC, WDOG	31	SCI	-	5 Ch, 6-Bit	8 Ch LED	40-P, 44-FN	24 mA Sink Port
68HC05E0	-	480	-	2 Periodic Timers, WDOG	36	SPI or I^2C	-	-	-	68-FN	0 – 4.0 MHz Bus Speed, 64K External Address Bus
68HC05E1	4K	368	-	15-Stage – RTI, RTC, WDOG	20	-	-	-	-	28-P, 28-DW	PLL, Clock Synthesizer, 0 – 4.0 MHz Bus Speed
68HC05F2	2K	256	-	16-Bit – 1 IC, 1 OC	30	SPI	-	-	4 Ch LED	42-B, 44-FB	DTMF
68HC05F6	4K	320	-	16-Bit – 1 IC, 1 OC	30	SPI	-	-	8 Ch LED	42-B, 44-FB	DTMF, Tone Generator
68HC05F8	8K	320	-	16-Bit – 1 IC, 1 OC	50	SPI	-	-	8 Ch LED	64-FU	DTMF
68HC05G1	8K	176	-	16-Bit – 1 IC, 1 OC, WDOG, RTC	40	SPI +8 Fixed	4 Ch, 8-Bit	-	-	56-B, 64-FU	PLL, Two Power Saving Standby Modes
68HC05G3	24K	768	-	16-Bit – 1 IC, 1 OC, 8-Bit - 1 IC, 1 OC	68	Dual SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	-	80-FU	Keyboard Wake Up, Watchdog Timer
68HC05G8	8K	172	-	15-Stage – RTC, RTI, WDOG	68	Dual SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	-	160-FT	Power Management, PLL, Keyboard Control
68HC05G9	12K	304	-	15-Stage – RTC	68	Dual SCI	8 Ch, 8-Bit	-	-	160-FT	Keyboard Control, Power Management
68HC05G10	12K	304	-	15-Stage – RTC	65	-	8 Ch, 8-Bit	-	-	100-FU	Keyboard Control, Power Management
68HC05H2	2K	128	-	15-Stage — RTI, WDOG	16	SIOP	-	2 Ch, 8-Bit	-	40-P, 42-B, 44-FB	LDMOS Power, 4 Comparators
68HC05I8	8K	224	-	16-Bit – 2 IC, 1 OC, WDOG	42	Dual SCI	-	-	-	64-FU	68000 Interface Module
68HC05J1	1K	64	-	15-Stage – RTI, WDOG	14	-	-	-	-	20-P, 20-DW	Low Cost
68HC05K0	0.5K	32	-	15-Stage – RTI, WDOG	10	-	-	-	-	16-P, 16-DW	8 mA Sink Port, Lowest Pin Count
68HC05K1	0.5K	32	-	15-Stage – 1RTI, WDOG	10	-	-	-	-	16-P, 16-DW	8 mA Sink Port, 8 Bytes, Personality EPROM
68HC05L1	4K	128	-	16-Bit – 1 IC, 1 OC 8-Bit – 1 IC, 1 OC	27	SCI	6 Ch, 8-Bit	-	16x4 Seg LCD	56-B, 64-FU	Programmable Timer

Table 1. 68HC05 General-Purpose Microcontrollers (continued)

Part Number	ROM	RAM	EEPROM	Timer	I/O*	Serial	A/D	PWM	Display Drive	Package Option	Comments
68HC05L4	8K	224	-	2/16-Bit – 1 IC, 1 OC 15-Stage – RTI, WDOG	32	SCI	-	-	96 Seg LCD	64-FU	2 Programmable Timers
68HC05L5	8K	256	-	16-Bit – 1 IC, 1 OC 8-Bit – 1 IC, 1 OC	28	SIOP	-	-	Seg LCD	80-FU	External Address
68HC05L6	6K	176	-	16-Bit – 1 IC, 1 OC	24	SPI	-	-	24x4 Seg LCD	68-FN	Tone Generator
68HC05L7	6K	176	-	16-Bit – 1 IC, 1 OC, RTC	27	SCI	-	-	60x8/16 Seg LCD	128-FT, DIE	LVI Option, Tone Generator
68HC05L9	6K	176	-	16-Bit – 1 IC, 1 OC, RTC	27	SCI	-	-	40x8/16 Seg LCD	128-FT, DIE	LVI Option, Tone Generator
68HC05L10	13K	352	-	16-Bit – 1 IC, 1 OC	28	SPI SCI	-	-	32x8 Seg LCD	128-FT, DIE	2 On-Chip Oscillators, MMU, External Address
68HC05L11	3.5K	448	-	16-Bit – 1 IC, 1 OC	38	SPI, SCI	-	-	640 Seg LCD	100-FU, DIE	MMU, Programmable Tone Generators, PLL
68HC05M4	4K	128	-	16-Bit – 1 IC, 1 OC 8-Bit – 1 IC, 1 OC, WDOG	32	-	6 Ch, 8-Bit	-	24 Lines VFD	52-FN	
68HC05M6	6K	208	-	16-Bit – 1 IC, 1 OC,15-Stage – RTI, WDOG	59	-	-	-	38 Lines VFD	68-FU, 68-FN	Keyboard Interrupt
68HC05P1	2K	128	-	16-Bit – 1 IC, 1 OC	21	-	-	-	-	28-P, 28-DW	
68HC05PE0	-	128	-	16-Bit – 1 IC, 1 OC, WDOG	21	-	-	-	-	28-P, 28-W	8 Bytes Personality EPROM
68HC05P2	3K	96	-	15-Stage – RTI, WDOG	32	-	4 Ch, 8-Bit	-	-	28-P, 28-DW, 32-FA	Slave-Only MBUS
68HC05P3	3K	128	128	16-Bit – 1 IC, 1 OC, WDOG	22	-	-	-	-	28-P, 28-DW	Keyboard Interrupt
68HC05P4	4K	176	-	16-Bit – 1 IC, 1 OC, WDOG	21	SIOP	-	-	-	28-P, 28-DW	
68HC05P6	4K	128	-	16-Bit – 1 IC, 1 OC, WDOG	21	SIOP	4 Ch, 8-Bit	-	-	28-P, 28-DW	
68HC05P7	2K	128	-	16-Bit – 1 IC, 1 OC, WDOG	21	SIOP	-	-	-	28-P, 28-DW	
68HC05P8	2K	112	32	15-Stage – RTI, WDOG	20	-	4 Ch, 8-Bit	-	-	28-P, 28-DW	LVI Option on EEPROM (LVPI)
68HC05P9	2K	128	-	16-Bit – 1 IC, 1 OC, WDOG	21	SIOP	4 Ch, 8-Bit	-	-	28-P, 28-DW	Low-Cost
68HC05SC11	6K	128	-	-	5	-	-	-	-	DIE	8K EPROM, Smart Card, MCU With Security
68HC05SC21	6K	128	3K	-	5	-	-	-	-	DIE	Smart Card MCU, With Security
68HC05SC24	3K	128	1K	-	5	-	-	-	-	DIE	Smart Card MCU, With Security
68HC05SC27	16K	240	-	-	5	-	-	-	-	DIE	Smart Card MCU, With Security
68HC05T1	8K	320	-	16-Bit – 1 IC, 1 OC, WDOG	30	SIOP	1 Ch, 6-Bit	9 Ch, 6-Bit	On-Screen Display	40-P	
68HC05T2	15K	320	-	16-Bit – 1 IC, 1 OC, WDOG	30	SIOP	1 Ch, 6-Bit	9 Ch, 6-Bit	On-Screen Display	40-P	On-Chip Oscillator
68HC05T3	24K	512	-	16-Bit – 1 IC, 1 OC, WDOG	30	SIOP	1 Ch, 6-Bit	9 Ch, 6-Bit	On-Screen Display	40-P	
68HC05T4	5K	96	-	16-Bit – 1 IC, 1 OC, RTC	16	-	1 Ch, 4-Bit	5 Ch, 6-Bit	On-Screen Display	42-B	Pulse Accumulator, DAC

Single-Chip Microcontrollers (MCU)

Table 1. 68HC05 General-Purpose Microcontrollers (continued)

Part Number	ROM	RAM	EEPROM	Timer	I/O*	Serial	A/D	PWM	Display Drive	Package Option	Comments
68HC05T7	8K	320	-	16-Bit – 1 IC, 1 OC, RTC	28	I2C	1 Ch, 8-Bit	9 Ch, 6-Bit	On-Screen Display	56-B	
68HC05T10	12K	320	-	16-Bit – 1 IC, 1 OC, RTC	28	I2C	1 Ch, 8-Bit	8 Ch, 6-Bit	On-Screen Display	56-B	
68HC05X4	5K	176	-	16-Bit – 1 IC, 1 OC, RTI, WDOG	16	MCAN	-	-	-	28-DW	

*I/O Category includes Inputs, Outputs, and Bidirectional

Table 2. MC68HC05 One-Time Programmable/Emulator Microcontrollers

Part Number	EPROM	RAM	EEPROM	Timer	I/O*	Serial	A/D	PWM	Display Drive	Devp.	Comments
68HC705B16	15K	352	255	16-Bit – 2 IC, 2 OC, WDOG	32	SCI	8 Ch, 8-Bit	2 Ch, 8-Bit	-	52-FN, 64-FU	Software Selectable Slow Mode
68HC705B5	6K	176	-	16-Bit – 1 IC, 1 OC, WDOG	32	SCI	8 Ch, 8-Bit	2 Ch, 8-Bit	-	56-B, 52-FN	2 Channel PWM
68HC705C5	5K	176	128	16-Bit – 1 IC, 1 OC, WDOG	32	SIOP	-	-	-	40-P, 40-S, 44-FN	10 mA Sink Port, LVI Option
68HC705C8	8K	304	-	16-Bit – 1 IC, 1 OC	31	SPI, SCI	-	-	-	40-P, 40-S, 44-FB,44-FN	0 — 4.0 MHz Bus Speed, LVI Option
68HC705C9	16K	352	-	16-Bit – 1 IC, 1 OC, WDOG	31	SPI, SCI	-	-	-	40-P, 40-S, 44-FN	Expanded Port D
68HC705D9	16K	352	-	16-Bit – 1 IC, 1 OC, WDOG	31	SCI	-	5 Ch 6-Bit	8 Ch LED	40-P, 40-S, 44-FN	24 mA Sink Port
68HC705E1	4K	368	-	15-Stage – RTI, WDOG, RTC	20	-	-	-	-	28-P, 28-S, 28-DW	Internal PLL, Clock Synthesizer
68HC705F6	4K	320	-	16-Bit – 1 IC, 1 OC	30	SPI	-	-	8 Ch LED	42-B	DT MF, Tone Generator
68HC705G1	12K	176	-	16-Bit – 1 IC, 1 OC, WDOG, RTC	40	SPI	4 Ch, 8-Bit	4 Ch, 8-Bit	-	56-B, 64-FU	PLL, Two Power Saving Standby Modes
68HC705G10	12K	304	-	15-Stage – RTC	65	-	8 Ch, 8-Bit	-	-	100-FU	Keyboard Control, Power Management
68HC705G9	12K	304	-	15-Stage – RTC	68	Dual SCI	8 Ch, 8-Bit	-	-	160-FT	Keyboard Control, Power Management
68HC705H2	2K	128	-	15-Stage – RTI, WDOG	16	SIOP	-	2 Ch, 8-Bit	-	40-P, 44-FN	Dual LDMOS, H-Bridge Drivers
68HC705J2	2K	112	-	15-Stage – RTI, WDOG	14	-	-	-	-	20-P, 20-S, 20-DW	Low Cost
68HC705K1	0.5K	32	-	15-Stage – RTI, WDOG	10	-	-	-	-	16-P, 16-DW	8 mA Sink Port, 8 Bytes Personality EPROM
68HC705L1	6K	128	-	-	-	-	-	-	-	56-B	
68HC705L5	8K	256	-	16-Bit – 1 IC, 1 OC	39	SPI, SIOP	-	-	39x4 Seg LCD	80-FU	8-Bit Event Counter
68HC705P6	4.6K	176	-	16-Bit – 1 IC, 1 OC, WDOG	21	SIOP	4 Ch, 8-Bit	-	-	28-P	
68HC705P9	2K	128	-	16-Bit – 1 IC, 1 OC, WDOG,	21	SIOP	4 Ch, 8-Bit	-	-	28-P, 28-S, 28-DW	Low-Cost
68HC705T10	12K	320	-	16-Bit – 1 IC, 1 OC, RTC	28	I2C	1 Ch, 8-Bit	8 Ch, 6-Bit	On-Screen Display	56-B	
68HC705T3	24K	512	-	16-Bit – 1 IC, 1 OC, WDOG	30	SIOP	1 Ch, 6-Bit	9 Ch, 6-Bit	On-Screen Display	40-P	
68HC705T4	6K	96	-	16-Bit – 1 IC, 1 OC, WDOG	16	-	1 Ch, 4-Bit	5 Ch, 6-Bit	On-Screen Display	42-B	

Table 2. MC68HC05 One-Time Programmable/Emulator Microcontrollers (continued)

Part Number	EPROM	RAM	EEPROM	Timer	I/O*	Serial	A/D	PWM	Display Drive	Devp.	Comments
68HC705X4	5K	176	-	16-Bit – 1 IC, 1 OC, WDOG, RTI	16	MCAN	-	-	-	28-DW	
68HC805B6	-	176	6K + 256	16-Bit – 2 IC, 2 OC, WDOG	32	SCI	8 Ch, 8-Bit	2 Ch, 8-Bit	-	52-FN	432 Bytes ROM
68HC805C4	-	176	4K	16-Bit – 1 IC, 1 OC	28	SPI, SCI	-	-	-	40-P, 44-FN	Low-Voltage and High Speed Vers. Available

Definitions for Tables 1 and 2

General Definitions

DTMF	Dual-Tone Multi-Frequency
IC	Input Capture
I2C	Inter-Integrated Circuit
LVI	Low-Voltage Interrupt
LVPI	Low Voltage Program Inhibit
MMU	Memory Management Unit
OC	Output Compare
OSD	On-Screen Display
PLL	Phase-Lock Loop
PWM	Pulse Width Modulation
RTC	Real-Time Clock
RTI	Real-Time Interrupt
SCI	Serial Communications Interface
SIOP	Simple Serial I/O Port
SPI	Serial Peripheral Interface
VFD	Vacuum Fluorescent Display
WDOG	Watch Dog Timer

Package Definitions

B	Shrink Dual-in-Line Plastic
DW	Small Outline (Wide-Body SOIC)
FA	7x7 mm Quad Flat Pack (QFP)
FB	10x10 mm Quad Flat Pack (QFP)
FN	Plastic Quad (PLCC)
FS	Cerquad
FT	28x28 mm Quad Flat Pack (QFP)
FU	14x14 mm Quad Flat Pack (QFP)
L	Ceramic Sidebraze
P	Dual-in-Line Plastic
S	Cerdip (windowed or non-windowed)

M68HC08 Family

The M68HC08 Family offers a unique combination of high-speed, low-power, enhanced processing performance for cost-sensitive 8-bit applications. Full upward object code compatibility with the world's leading 8-bit microcontroller allows current M68HC05 users to leverage their resource and time investment. M68HC08 modular design utilizes a growing library of on-chip peripherals. Future family members will integrate special technologies like fuzzy logic and DSP for embedded control applications.

Features

- Architecturally enhanced 8-bit CPU
  - 8 MHz bus speed yields 125ns minimum instruction cycle
  - 16-bit stack with stack pointer operations and addressing modes
  - 16-bit index register
  - 78 new instructions including advanced looping control
  - Eight new addressing modes
- Fully upward object code compatible with the M68HC05 and M6805 families
- Direct Memory Access module
  - Memory-to-memory transfer
  - Peripheral-to-memory and memory-to-peripheral transfer
- Timing Interface Module
  - Four independently programmable channels
  - Input capture, output compare, buffered and unbuffered PWM configurations
- Interface modules
  - Serial Communications Interface (UART)
  - Serial Peripheral Interface
- System Control Modules
  - Low voltage inhibit, PLL, COP, and System Integration Module

OTP versions of M68HC08 devices will be available Q4/93. ROM versions available in the second half of 1994.

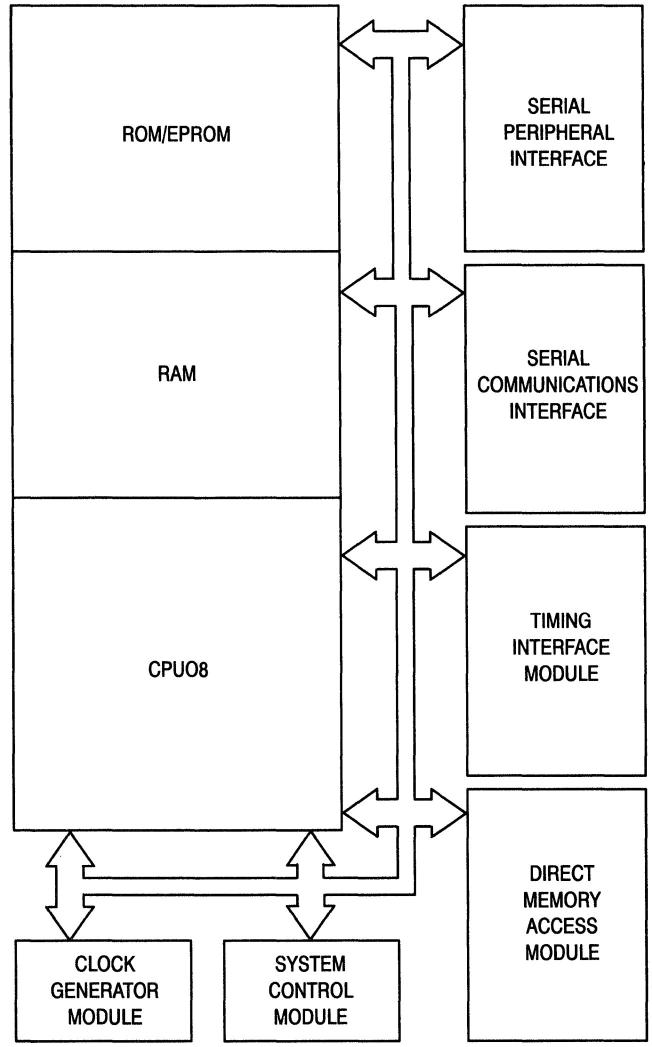


Figure 5. Block Diagram of Typical M68HC08 MCU

M68HC11 Family

The M68HC11 Family incorporates a flexible central processing unit and a large number of control-oriented on-chip peripherals. M68HC11 MCU are upward code compatible with 6800, 6801, and 68HC05 software.

Central Processing Unit

The 68HC11 CPU is optimized for low power consumption and high-performance operation at bus frequencies up to 4 MHz. Key features include:

- Two 8-bit or one 16-bit accumulator
- Two 16-bit index registers
- Powerful bit-manipulation instructions
- Six powerful addressing modes
  - Immediate, Extended, Direct, Indexed, Inherent, and Relative
- Power saving STOP and WAIT modes
- Memory mapped I/O and special functions
- 16x16 Integer and Fractional Divides
- 8x8 Multiply

Timer

M68HC11 timer architecture is based on a 16-bit free running counter driven through a software-programmable prescaler. Features include multiple Input Captures, Output Compares, Real-Time Interrupt, Pulse Accumulator, and Watchdog functions.

On-Chip Memory

Since its introduction, the M68HC11 Family has provided versatile combinations of popular memory technologies, including the first EEPROM on a CMOS microcontroller. The family has a memory option to fit virtually any application.

- ROM sizes range from 0 to 32K bytes. ROM is typically factory programmed to contain custom software. ROMless versions of most M68HC11 Family members are also available.
- RAM sizes range from 192 bytes to 1.25K bytes. M68HC11 RAM utilizes a fully static design, and all devices feature a standby power supply pin for battery back-up of RAM contents.
- EPROM sizes range from 4K to 32K bytes. EPROM is especially suited to prototype development and small production runs. EPROM versions are available in both windowed and OTP packaging.
- EEPROM sizes range from 0 to 2K bytes. EEPROM is ideal for storage of calibration, diagnostic, data logging, and security information. Each M68HC11 device with EEPROM includes an on-chip charge pump to facilitate single-supply programming and erasing.

Digital-to Analog Conversion

The M68HC11 Family provides powerful, on-chip, multi-channel A/D converter systems. Multi-conversion and multi-channel options allow single or continuous conversion on single or multiple channels. M68HC11 A/D systems have eight input channels, and most offer 8-bit resolution, although some provide 10-bit resolution. A 2 channel, 8-bit D/A is also available.

Pulse-width Modulation

Some M68HC11 Family members have up to six channels of 8-bit PWM. At a 4 MHz bus frequency, signals can be produced from 40 KHz to less than 10 Hz. PWM signals with a period greater than one minute are possible in the 16-bit mode.

Serial Communication

All members of the M68HC11 Family include a Serial Peripheral Interface (SPI) and a Serial Communications Interface (SCI). These on-chip peripherals are designed to minimize CPU intervention during data transfer.

- The SCI is a full duplex UART-type asynchronous system that uses standard Non-Return-to-Zero (NRZ) data format. An on-chip Baud rate generator derives standard rates from the microcontroller oscillator. Both transmitter and receiver are double buffered.
- The SPI is a four-wire synchronous communications interface used for high-speed communication with specialized peripheral devices and other microcontrollers. Data is transmitted and received simultaneously; the Baud rate is software programmable.

Digital I/O and Special Functions

M68HC11 Family I/O is extremely flexible, allowing pins to be configured to match application requirements. Most I/O lines are controlled by bits in a Data Direction Register (DDR) which can configure pins for either input or output. Most lines have a dedicated port data latch.

Some M68HC11 Family members include a 4-channel Direct Memory Access (DMA) and a Memory Management Unit (MMU). The DMA provides fast data transfer between memories and registers, and includes externally mapped memory in the expanded mode. The MMU allows up to 1 megabyte of address space in a physical 64 kbyte allocation. Integrated chip selects help to reduce glue logic.

Several members of the M68HC11 Family also include programmable chip select circuits. These circuits can be used to enable external peripherals whenever an access to a predefined block of memory addresses is made. These circuits help to reduce external logic requirements.

Math Coprocessor

New M68HC11 Family members offer a 16-bit on-chip math coprocessor that accelerates multiply and divide operations by as much as 10 times. The coprocessor functions independently of the CPU and requires no special instructions. The coprocessor is well-suited to low-bandwidth DSP functions such as closed loop control, servo positioning, and signal conditioning.

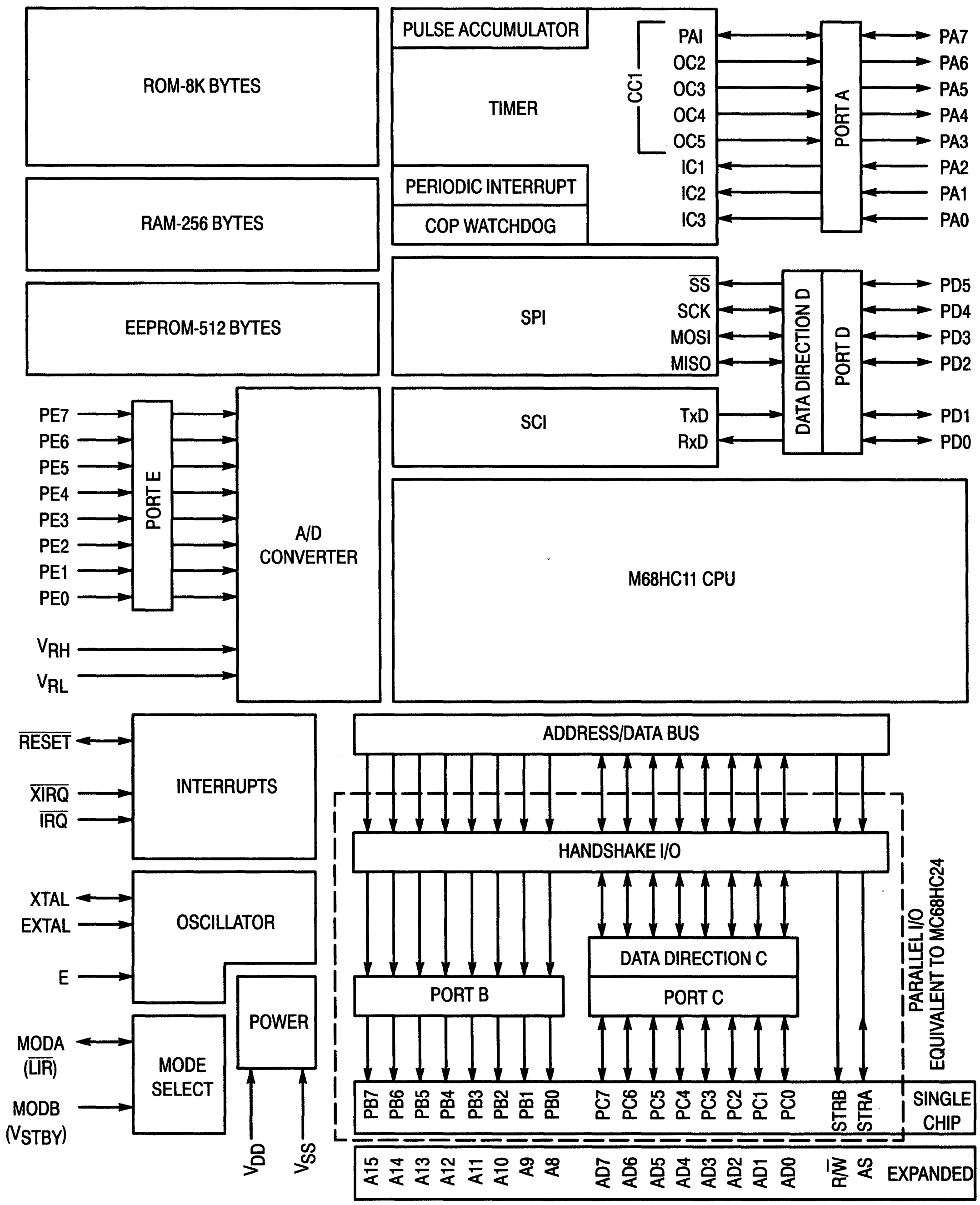


Figure 6. MC68HC11A8 Block Diagram

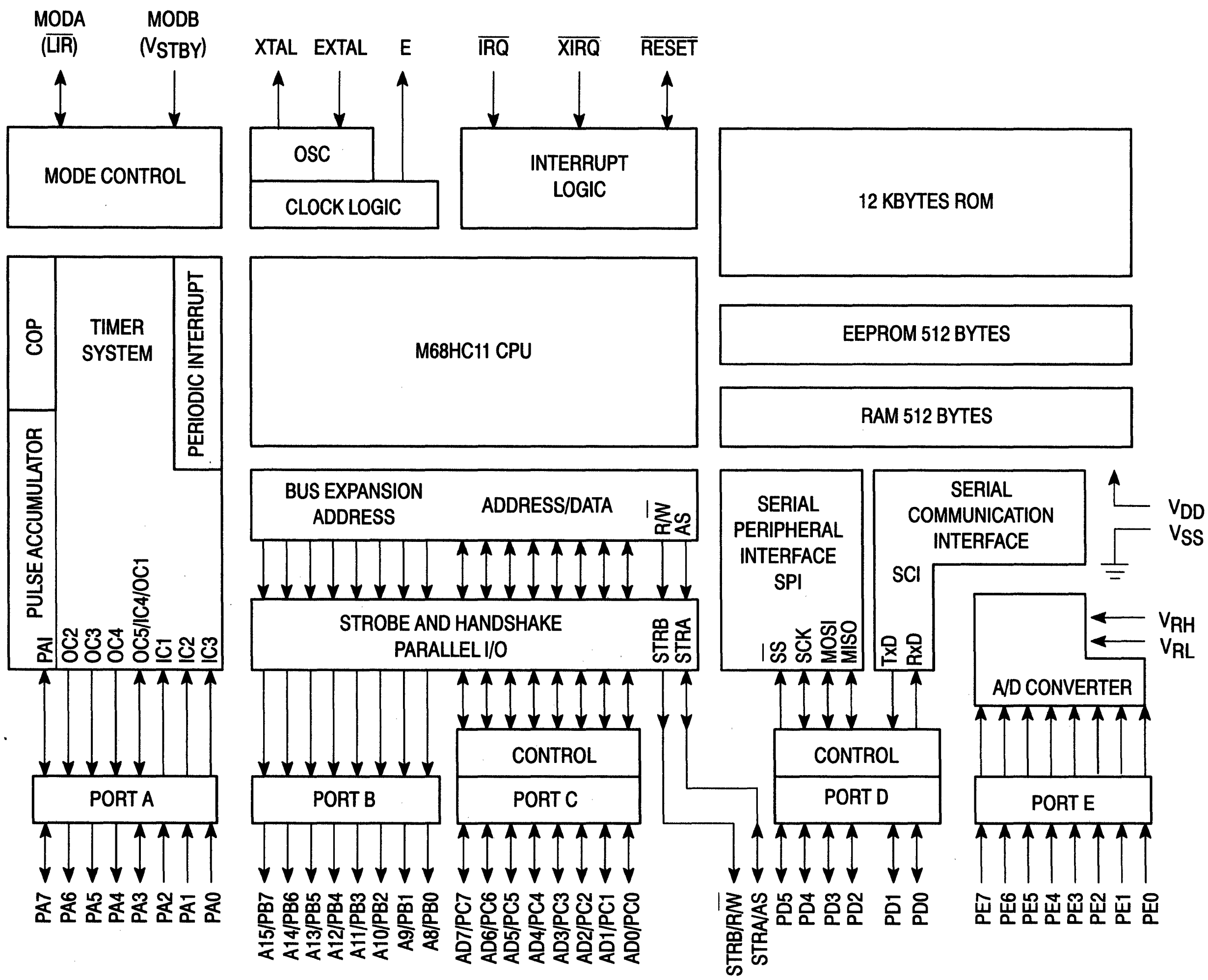


Figure 7. MC68HC11E9 Block Diagram

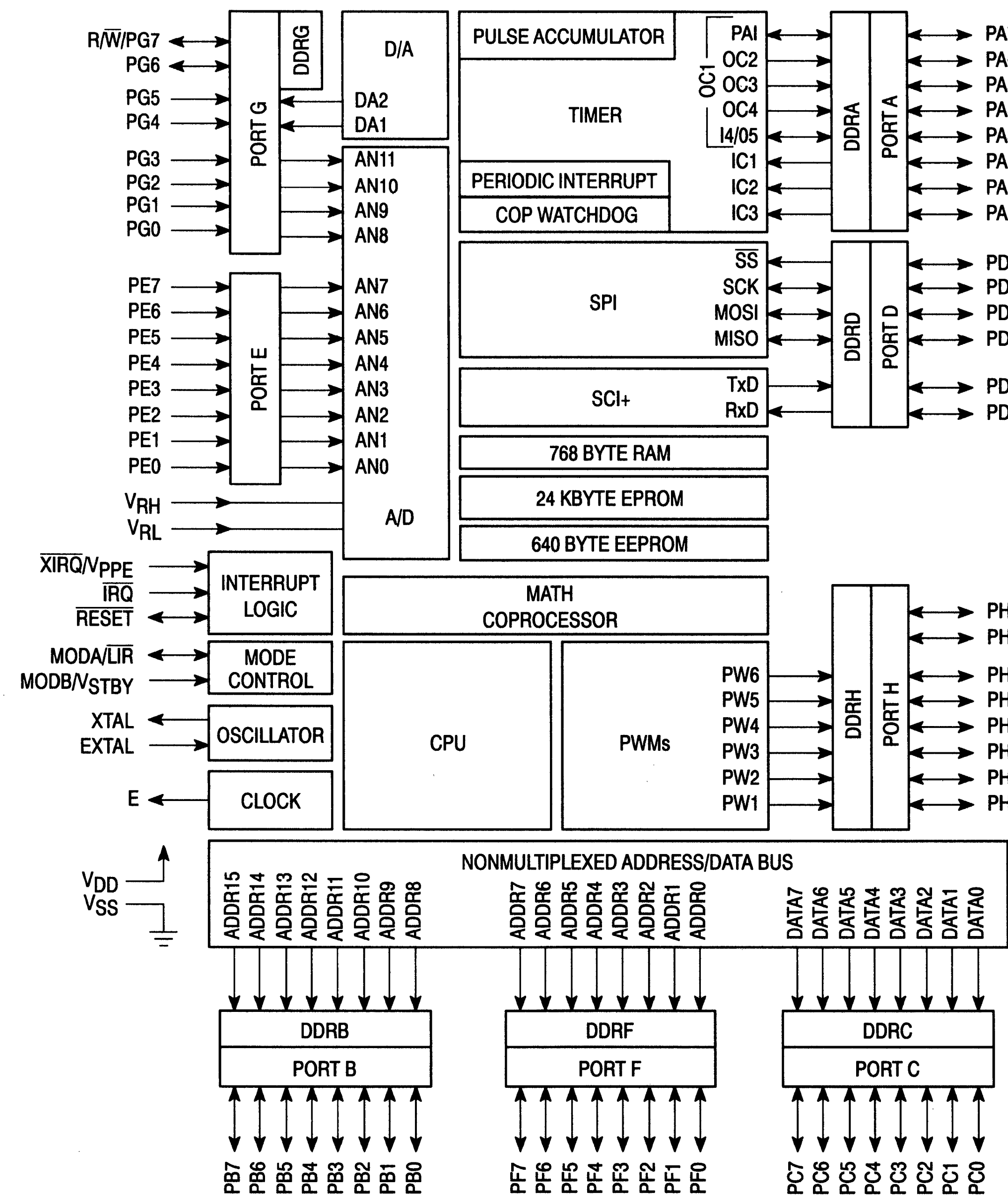


Figure 8. MC68HC711N4 Block Diagram

Table 3. M68HC11 Family Microcontrollers

Part Number	EPROM	RAM	EEPROM	Timer	I/O	Serial	A/D	PWM	Package	Comments
68HC11A0	-	256	-	16-Bit - 3 IC, 5 OC, RTI, WDOG Pulse Accumulator	22	SPI, SCI	8 Ch, 8-Bit	-	52-FN 64-FU 48-P	64K External Address Bus, 68HC24 PRU, 3.0 V Version Available
68HC11A1	-	256	512	16-Bit - 3 IC, 5 OC, RTI, WDOG Pulse Accumulator	22	SPI, SCI	8 Ch, 8-Bit	-	52-FN 64-FU 48-P	64K External Address Bus, 68HC24 PRU, 3.0 V Version Available
68HC11A7	8K	256	-	16-Bit - 3 IC, 5 OC, RTI, WDOG, Pulse Accumulator	38	SPI, SCI	8 Ch, 8-Bit	-	52-FN 64-FU 48-P	3 MHz Version Available, 64K External Address Bus, 68HC24 PRU, 3.0 V Version Available
68HC11A8	8K	256	512	16-Bit - 3 IC, 5 OC, RTI, WDOG, Pulse Accumulator	38	SPI, SCI	8 Ch, 8-Bit	-	52-FN 48-P	3 MHz Version Available, Low Voltage Version (3.0-5.5V) at 2 MHz, 64K External Address Bus, 68HC24 PRU
68HC11C0	-	256	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	36	SPI, SCI	4 Ch, 8-Bit	2 Ch, 8-Bit	68-FN 64-FU	256K Externed Memory, 6 Chip Selects
68HC11D0	-	192	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	14	SPI, SCI	-	-	44-FB 44-FN 40-P	64K External Address Bus, 68HC27 PRU, 3.0V Version Available
68HC11D3	4K	192	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	32	SPI, SCI	-	-	44-FB 44-FN 40-P	3 MHz Version Available, Low Voltage Version (3.0-5.5V) at 2 MHz, 64K External Address Bus, 68HC27 PRU
68HC11ED0	-	512	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	30	SPI, SCI	-	-	44-FB 44-FN 40-P	Pin Compatible with 68HC11D3
68HC11E0	-	512	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	22 SCI	SPI, 8-Bit	8 Ch,	-	52-FN	64K External Address Bus, 68HC24 PRU, 3.0 V Version Available
68HC11E1	-	512	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	22	SPI, SCI	8 Ch, 8-Bit	-	52-FN 64-FU	64K External Address Bus, EEPROM Block Protect, 68HC24 PRU, 3.0 V Version Available
68HC11E8	12K	512	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	38 SCI	SPI, 8-Bit	8 Ch,	-	52-FN	3 MHz Version Available, 64K External Address Bus, 3.0 V Version Available
68HC11E9	12K	512	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	38	SPI, SCI	8 Ch, 8-Bit	-	52-FN 64-FU	EEPROM Block Protect, 3 MHz Version Available, Low Voltage Version (3.0-5.5V) at 2 MHz, 64K External Address Bus
68HC11E20	20K	768	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	38	SPI, SCI	8 Ch, 8-Bit	-	52-FN 64-FU	3 MHz Mux Bus
68HC811E2	-	256	2048	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	38	SPI, SCI	8 Ch, 8-Bit	-	52-FN	EEPROM Block Protect, 64K External Address Bus, 68HC24 PRU
68HC11F1	-	1K	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	54	SPI, SCI	8 Ch, 8-Bit	-	68-FN 80-FU	Programmable Chip Selects, EEPROM Block Protect, 64K External Address Bus, 68HC27 PRU, 4 MHz Non-Mux Address/Data Bus
68HC11G0	-	-	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	38	SPI, SCI	8 Ch, 10-Bit	4 Ch, 8-Bit	84-FN 80-FU	
68HC11G5	16K	512	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	66	SPI, SCI	8 Ch, 10-Bit	4 Ch, 8-Bit	84-FN 80-FU	
68HC11G7	24K	512	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	66	SPI, SCI	8 Ch, 10-Bit	4 Ch, 8-Bit	84-FN 80-FU	

Table 3. M68HC11 Family Microcontrollers (continued)

Part Number	EPROM	RAM	EEPROM	Timer	I/O	Serial	A/D	PWM	Package	Comments
68HC11J6	16K	-	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	29	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 80-FU	
68HC11K0	-	768	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	37	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 80-FU	4 MHz Non-Mux Address/Data Bus, Chip Selects, Extended Memory Map, 68HC27 PRU, 3.0 V Version Available
68HC11KA0	-	768	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	26	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	68-FN 64-FU	4 MHz Non-Mux Address/Data Bus, Chip Selects, Extended Memory Map, 68HC27 PRU
68HC11K1	-	768	640	16-Bit - 3/4 IC, 4/5 OC, RTI,WDOG, Pulse Accumulator	37	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 80-FU	4 MHz Non-MuxBus,Chip Selects, EEPROM Block Protect, Extended Memory Map, 68HC27 PRU, 3.0 V Version Available
68HC11KA1	-	768	640	16-Bit - 3/4 IC, 4/5 OC, RTI,WDOG, Pulse Accumulator	26	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	68-FN 64-FU	4 MHz Non-Mux Address/Data Bus, Chip Selects,EEPROM Block Protect, Extended Memory Map, 68HC27 PRU
68HC11K3	24K	768	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 80-FU	4 MHz Non-Mux Address/Data Bus, Chip Selects, Extended Memory Map, 68HC27 PRU, 3.0V Version Available
68HC11KA3	24K	768	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	51	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	68-FN 64-FU	4 MHz Non-Mux Address/Data Bus, Chip Selects, Extended Memory Map, 68HC27 PRU
68HC11K4	24K	768	640	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 80-FU	4 MHz Non-Mux Bus, Low Voltage Version (3.0-5.5V) at 3 MHz, Chip Selects, EEPROM Block Protect, Extended Memory Map, 68HC27 PRU
68HC11KA4	24K	768	640	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	51	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	68-FN 64-FU	4 MHz Non-Mux Address/Data Bus, Chip Selects, EEPROM Block Protect, Extended Memory Map
68HC11L0	-	512	-	16-Bit - 3/4 IC, 4/5 OC,RTI, WDOG, Pulse Accumulator	30	SPI, SCI	8 Ch, 8-Bit	-	68-FN 64-FU	64K External Address Bus, 68HC24 PRU, 3.0 V Version Available
68HC11L1	-	512	512	16-Bit - 3/4 IC, 4/5 OC,RTI, WDOG, Pulse Accumulator	46	SPI, SCI	8 Ch, 8-Bit	-	68-FN 64-FU	64K External Address Bus, EEPROM Block Protect, 68HC24 PRU, 3.0 V Version Available
68HC11L5	16K	512	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	46	SPI, SCI	8 Ch, 8-Bit	-	68-FN 64-FU	64K External Address Bus, 68HC24 PRU, 3.0 V Version Available
68HC11L6	16K	512	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	46	SPI, SCI	8 Ch, 8-Bit	-	68-FN 64-FU	3 MHz Version Available, Low Voltage Version (3.0-5.5V) at 2 MHz, 64K External Address Bus, 68HC24 PRU
68HC11M2	32K	1.25K	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, 2-SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 80-FU	16-Bit Math Coprocessor, 4 MHz Non-Mux Bus, 4 Ch DMA Controller
68HC11N4	24K	768	640	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, SCI	12 Ch, 8-Bit	6 Ch, 8-Bit	84-FN 80-QFP	16-Bit Math Coprocessor, 4 MHz Non-Mux Bus, 2 Ch 8-Bit D/A
68HC11P2	32K	1K	640	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, 3-SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 80-FU	PLL Clock Option

Table 4. M68HC11 One-Time Programmable/Emulator Microcontrollers

Part Number	EPROM	RAM	EEPROM	Timer	I/O	Serial	A/D	PWM	Package	Comments
68HC711D3	4K	192	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	32	SPI, SCI	-	-	44-FB 44-FN 40-P	64K External Address Bus

Table 4. M68HC11 One-Time Programmable/Emulator Microcontrollers (continued)

Part Number	EPROM	RAM	EEPROM	Timer	I/O	Serial	A/D	PWM	Package	Comments
68HC711E9	12K	512	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	38	SPI, SCI	8 Ch, 8-Bit	-	52-FN 64-FU	EEPROM Block Protect, 64K External Address Bus
68HC711E20	20K	768	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	38	SPI, SCI	8 Ch, 8-Bit	-	52-FN 52-FS 64-FU	EEPROM Block Protect, 64K External Address Bus
68HC711G5	16K	512	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	66	SPI, SCI	8 Ch, 10-Bit	4 Ch, 8-Bit	84-FN 84-FS	
68HC711J6	16K	512	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	54	SPI, SCI	-	-	68-FN 68-FS	1 Chip Select
68HC711K4	24K	768	640	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 84-FS 80-FU	4 MHz Non-Mux Bus, EEPROM Block Protect, Chip Selects, Extended Memory Map
68HC711L6	16K	512	512	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	46	SPI, SCI	8 Ch, 8-Bit	-	68-FN 68-FS 64-FU	EEPROM Block Protect, 64K External Address Bus
68HC711M2	32K	1.25K	-	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, SCI	8 Ch, 8-Bit	-	84-FN 84-FS 80-FU	16-Bit Math Coprocessor, 4 MHz Non-Mux Bus, 4 Ch DMA Controller
68HC711N4	24K	768	640	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, SCI	12 Ch, 8-Bit	6 Ch, 8-Bit	84-FN 84-FS	16-Bit Math Coprocessor, 4 MHz Non-Mux Bus, 2 Ch 8-Bit D/A
68HC711P2	32K	1K	640	16-Bit - 3/4 IC, 4/5 OC, RTI, WDOG, Pulse Accumulator	62	SPI, SCI	8 Ch, 8-Bit	4 Ch, 8-Bit	84-FN 84-FS 88-FU	PLL Clock

Definitions for Tables 3 and 4

General Definitions

ADC	Analog to Digital Converter Module
A/D	Analog to Digital Converter
CPU16	16 bit Central Processing Unit
CPU32	32 bit Central Processing Unit
D/A	Digital to Analog Converter
DMA	Direct Memory Access
IC	Input Capture
IIC	Inter-Integrated Circuit
MCCI	Multi-Channel Communication Interface
PLL	Phase Lock Loop
OC	Output Capture
POQ	Preferred Order Quantity Multiple
PWM	Pulse Width Modulation
QSM	Queued Serial Module (SCI + Queued SPI)
RPSCIM	Reduced Pin Count SCIM
RTC	Real-Time Clock
RTI	Real-Time Interrupt
SCI	Serial Communication Interface
SCIM	Single Chip Integration Module
SIM	System Integration Module
SPI	Serial Peripheral Interface
TPU	Time Processing Unit
UART	Universal Asynchronous Receiver/Transmitter
WDOG	Watch Dog Timer

Package Definitions

FB	10x10 mm Quad Flat Pack (QFP)
FC	Fine Pitch Plastic Quad Flat Pack (PQFP)
FD	Plastic Quad Flat Pack in Molded Carrier Ring
FE	Ceramic Quad Flat Pack (CQFP)
FM	Molded Carrier Flat Pack (CQFP)
FN	Plastic Leaded Chip Carrier (PLCC)
FS	Windowed Cerquad (Ceramic LCC)
FT	28x28 mm Quad Flat Pack (QFP)
FU	14x14 mm Quad Flat Pack (QFP)
FV	20x20 mm Quad Flat Pack (QFP)
L	Ceramic
P	Dual-in-Line Plastic
PB	Thin Quad Flat Pack (TQFP) 10x10 mm
PU	Thin Quad Flat Pack (TQFP) 14x14 mm
PV	Thin Quad Flat Pack (TQFP) 20x20mm
S	Cerdip (windowed or non-windowed)
TH	16x16 mm Quad Flat Pack (QFP)

M6800 Series Microprocessors and Peripherals

These devices are a testament to the staying power of Motorola microtechnology. The original MC6800 was Introduced in 1975, and is still in demand today. Quality M6801, M6804 and M6805 systems have been performing reliably in automotive, industrial, and office equipment applications for years. Each of these devices can be combined with various peripherals to meet the requirements of a microcontroller design.

Table 5. M6801 and M6803 (HMOS)

Part Number	ROM	RAM	EEPROM	Timer	Serial	A/D	I/O	Bus Speed, MHz	Package	Comments
6801	2048	192	0	16 bit: 1 IC, 1 OC	SCI	No	29	0.5-2.0	40 P	
68701	0	128	2048	16 bit: 1 IC, 1 OC	SCI	No	29	0.5-2.0	40 P	
6803	0	192	0	16 bit: 1 IC, 1 OC	SCI	No	13	0.5-2.0	40 P	
6801U4	4096	256	0	16 bit: 2 IC, 3 OC	SCI	No	29	0.5-1.25	40 P	
68701U4	0	128	4096	16 bit: 2 IC, 3 OC	SCI	No	29	0.5-1.25	40 P	
6803U4	0	256	0	16 bit: 2 IC, 3 OC	SCI	No	13	0.5-1.25	40 P	

Table 6. 8-Bit MPU/Peripherals

Device	Pins	Package	Part Description	Speed
68B00	40	P	8 Bit MPU, Addresses 64K Memory, 1 or 2 MHz Versions	2 MHz
6802	40	P	MC6800 + Int. Clock Oscillator; 128 Bytes RAM	1 MHz
68B09	40	P	High Performance MPU, 10 Powerful Addressing Modes	2 MHz
68B09E	40	P	MC6809 With External Clock Input for External Sync.	2 MHz
68B21	40	P	Peripheral Interface Adapter	2 MHz
68B40	40	P	Programmable Timer Module Contains 3 16-Bit Timers	2 MHz
6845	40	P	CRT Ctrl, Refresh Memory Addressing; 2nd Source HD6845R	1 MHz
68B50	40	P	Asynchronous Communication Interface Adaptor	2 MHz
68HC24	40, 44	P, FN	MC68HC11 Port Replacement (Expanded Mode) for A8, E9	2 MHz
68HC27	46, 68	FU, FN	Port Replacement for D3, K4, F1	2 MHz
68HCB34	40	P, FN	256 Byte Dual Port RAM, 6 Semaphore Registers	2 MHz
68B10	24	P	128 x 8 Random Access Memory	2 MHz
68B44	40	P	Direct Memory Access Controller	2 MHz
68B488	40	P	General Purpose Interface Adapter	2 MHz
68B52	24	P	Synchronous Serial Data Adapter	2 MHz
68B54	28	P	Advanced Data Link Controller	2 MHz

Table 7. M6805 (HMOS) Microprocessors

Part Number	ROM	RAM	EEPROM	Timer	Serial	A/D	I/O	Bus Speed, MHz	Package	EPROM or EEPROM Version	Comments
6805P2	1K	64	0	8-Bit	–	No	20	0.1-1.0	28-P 28-FN	705P3	LVI Option
6805P6	2K	64	0	8-Bit	–	No	20	0.1-1.0	28-P	705P3	LVI Option
6805R2	2K	64	0	8-Bit	–	Yes	32	0.1-1.0	40-P 44-FN	705R3	LVI Option, Prog. Prescaler Option
6805R3	4K	112	0	8-Bit	–	Yes	32	0.1-1.0	40-P 44-FN	705R3	7-Bit Prescaler, LVI Option
6805R6	4K	112	0	8-Bit, WDOG	–	Yes	32	0.1-1.0	40-P 44-FN	705R3	7-Bit Prescaler, LVI Option
6805S2	1K	64	0	16-Bit, 8-Bit	SPI	Yes	16	0.1-1.0	28-P	705S3	15-Bit Prescaler, LVI
6805S3	4K	104	0	2 8-Bit, 16-Bit	SPI	Yes	21	0.1-1.0	28-P	705S3	1 Extra 8-Bit Timer
6805U2	2K	64	0	8-Bit	–	No	32	0.1-1.0	40-P 44-FN	705U3	LVI Option
6805U3	4K	112	0	8-Bit	–	No	32	0.1-1.0	40-P 44-FN	705U3	7-Bit Prescaler, LVI Option

Table 8. 8-Bit MPU/Peripherals

Device	Pins	Package	Part Description
14618	24	P	Real Time Clock, 50 Bytes RAM, Programmable Square Wave
146818A	24, 28	P, FN	Enhanced Version of the MC146818
146823	40, 44	P, FN	Three 8-Bit Ports, Handshake Control Logic
146805E2	40, 44	P, FN	CMOS 8-Bit Microprocessor
68HC68L9	80	FU	LCD Expansion to the MC05L9

Modular Microcontrollers

Modular microcontrollers are another of the innovations that make Motorola a leader in single-chip control systems. Modular controllers are built up from standard modules that interface via a common intermodule bus (IMB). The modular concept allows rapid design and manufacture of controllers tailored for specific applications.

Intermodule Bus Peripherals

Each modular microcontroller incorporates a state-of-the art pipelined CPU module, a sophisticated integration module, and a number of special-purpose modules. The rapidly-growing library of special-purpose modules includes programmable timers, serial communication interfaces, analog-to-digital converters, and a variety of memory modules.

Central Processing Units

CPU16

- 16-Bit Architecture
- Full Set of 16-Bit Instructions
- Three 16-Bit Index Registers
- Two 16-Bit Accumulators
- One Megabyte of Program Memory and One Megabyte of Data Memory
- Source code compatible with the M68HC11 CPU
- Control-Oriented Digital Signal Processing Capability
- High-Level Language Support
- Fast Interrupt Response Time
- Fully Static Implementation
- Low Power Stop Operation
- Background Debugging Mode
- Hardware Breakpoint Signal

CPU32

- 32-Bit Internal Data Path and Arithmetic Hardware
- 32-Bit Internal Address Bus - 24-Bit External Address Bus
- Eight 32-Bit General-Purpose Data Registers
- Seven 32-Bit General-Purpose Address Registers
- Separate User and Supervisor Stack Pointers and Address Spaces
- Separate Program and Data Address Spaces
- Virtual Memory Implementation
- Enhanced Addressing Modes
- Object Code Compatible with M68000 Family
- Improved Exception Handling for Controller Applications
- Rich Instruction Set
- Fully Static Implementation
- Low Power Stop Operation
- Background Debugging Mode
- Hardware and Software Breakpoints
- Trace on Change of Flow

Integration Modules

System Integration Module (SIM)

- Manages controller internal and external bus interfaces
- Provides device interrupt arbitration
- Spurious interrupt monitor
- Twelve programmable chip-select outputs
- Watchdog timer, clock monitor, and bus monitor
- PLL clock synthesizer

Single-Chip Integration Module (SCIM)

- Manages controller internal and external bus interfaces
- Provides device interrupt arbitration
- Spurious interrupt monitor
- Single-chip operation with address and data bus pins configured as I/O ports
- Optional Fully or Partially-expanded bus operation
- Nine general-purpose chip select outputs
- Emulation mode chip-select outputs can be used to address a port replacement unit and external emulation RAM
- Watchdog timer, clock monitor, and bus monitor
- PLL clock synthesizer
- Interrupt request inputs can be configured for edge or level detection
- Reduced pin SCIM (RPSCIM) available with 5 chip selects

Timers

Time Processor Unit (TPU)

- On-chip microengine dedicated to high-speed timing tasks
- Two independent 16-bit counters used as basis for timing tasks
- Real-time task scheduler
- Executes a programmed series of functions to perform complex tasks
- Each of 16 orthogonal channels can perform available time functions
- Functions contained in dedicated control store or in MCU RAM
- TPU communicates to CPU via dual port RAM

General Purpose Timer (GPT)

- Two 16-bit free-running counters
- Three input capture channels
- Four output compare channels
- One input capture/output compare channel
- One pulse accumulator/event counter input
- Two pulse-width modulation outputs
- Pulse accumulator input

Configurable Timer Module (CTM)

- Modular timer system combining different configurations of timer submodules:
- CPSM–6 TAP counter prescaler
- FCSM–16-bit free running up counter
- MCSM–16-bit modulus up counter
- SASM–(Single Action) two I/O pins for 16-bit input capture or output compare functions
- DASM–(Dual Action) one I/O pin for 16-bit I/C, O/C, PWM, or output function

Timer Module (TM)

- 16-bit free-running counter with 8-bit prescaler
- Two TM can be externally cascaded to increase count width
- Software selected input capture, output compare, pulse accumulation, event counting, or pulse-width modulation functions

Communication Modules

Queued Serial Module (QSM)

- Queued full-duplex, synchronous three-line SPI with dedicated RAM
- Standard, asynchronous NRZ-format SCI
- Polled and interrupt-driven operation
- Pins can be configured as a parallel I/O port

Multi-Channel Communications Interface (MCCI)

- One full-duplex synchronous three-line SPI
- Two independent standard, asynchronous NRZ-format SCI
- Polled and interrupt-driven operation
- Pins can be configured as a parallel I/O port

Dual Universal Asynchronous/ Synchronous Receiver Transmitter (DUART)

- Dual NRZ Serial RS-232C channels
- Independently programmable TxD and Receiver Transmitter (DUART)
- RxD Baud rates for each channel up to 76.8K Baud
- Optional external input pins provide baud clock
- Transmit operations are double buffered, and receive operations are quadruple buffered
- RTS and CTS signals are directly supported

Analog To Digital Conversion Modules

Analog-to-Digital Converter (ADC)

- 8 or 10 bits of resolution
- Eight input channels
- Eight result registers
- Three result alignment formats
- Eight automated conversion modes
- Programmable sample and hold times are provided
- Three result alignment modes

Queued Analog-to-Digital Converter (QADC)

- 10 bits of resolution
- 16 analog input channels (up to 27 if multiplexed externally)
- Two independent conversion queues
- 32 result registers (16 per queue)
- Three result alignment formats
- Queued conversions can be performed continuously or can be retriggered by software or the QADC module periodic interval timer and external trigger
- Programmable sample and hold times
- Alternate voltage references

Specialized Control Modules

Direct Memory Access (DMA)

- Provides low-latency transfer to external peripheral or for memory-memory data transfer
- Two independent DMA channels with full programmability

Memory Modules

Standby RAM (SRAM)

- Fast Static RAM maintained by voltage from standby voltage pin
- Available in 1K, 1.5K, 2K, 3.5K, and 4K blocks
- Fast (2 clock) access speed
- Byte, word, and long-word operations supported

Standby RAM with TPU Emulation (TPURAM)

- Fast Static RAM maintained by voltage from standby voltage pin
- Available in 1K, 1.5K, 2K, 3.5K, and 4K blocks
- Fast termination (2 clock) access speed
- Supports TPU microcode ROM emulation
- Byte, word, and long-word operations supported

Masked ROM (MRM)

- Custom-masked non-volatile 16-bit wide memory
- Available in 4K increments from 8K to 48K bytes
- Fast (2 clock) access speed
- Byte, word, and long-word operations supported
- Boot ROM capability

Flash EEPROM (FLASH)

- Word programmable, bulk erasable non-volatile 16-bit wide memory
- Available in 8K increments from 8K to 64K bytes
- Fast (2 clock) access speed
- Byte, word, and long-word operations supported
- Boot ROM capability
- External 12 volt programming/erasure source required

Block Erasable Flash EEPROM (BEFlash)

- Available in 8K increments from 8K to 64K bytes
- Eight independently-erasable blocks
- Fast termination (2 clock) access speed
- Byte, word, and long-word operations supported
- Byte/Word programming with 12 volt external input

The M68HC16 Family

The MC68HC16 family is designed for embedded control applications. Each M68HC16 MCU incorporates a true 16-bit CPU module (CPU16) that is upwardly code-compatible with the M68HC11 CPU, a sophisticated integration module, and a number of special-purpose modules. M68HC16 devices can be placed in low-power stop mode to minimize power consumption during periods of inactivity. The M68HC16 family provides the flexibility and features of the M68300 family, and also provides a convenient way for users of M68HC11 devices to move up to 16-bit performance.

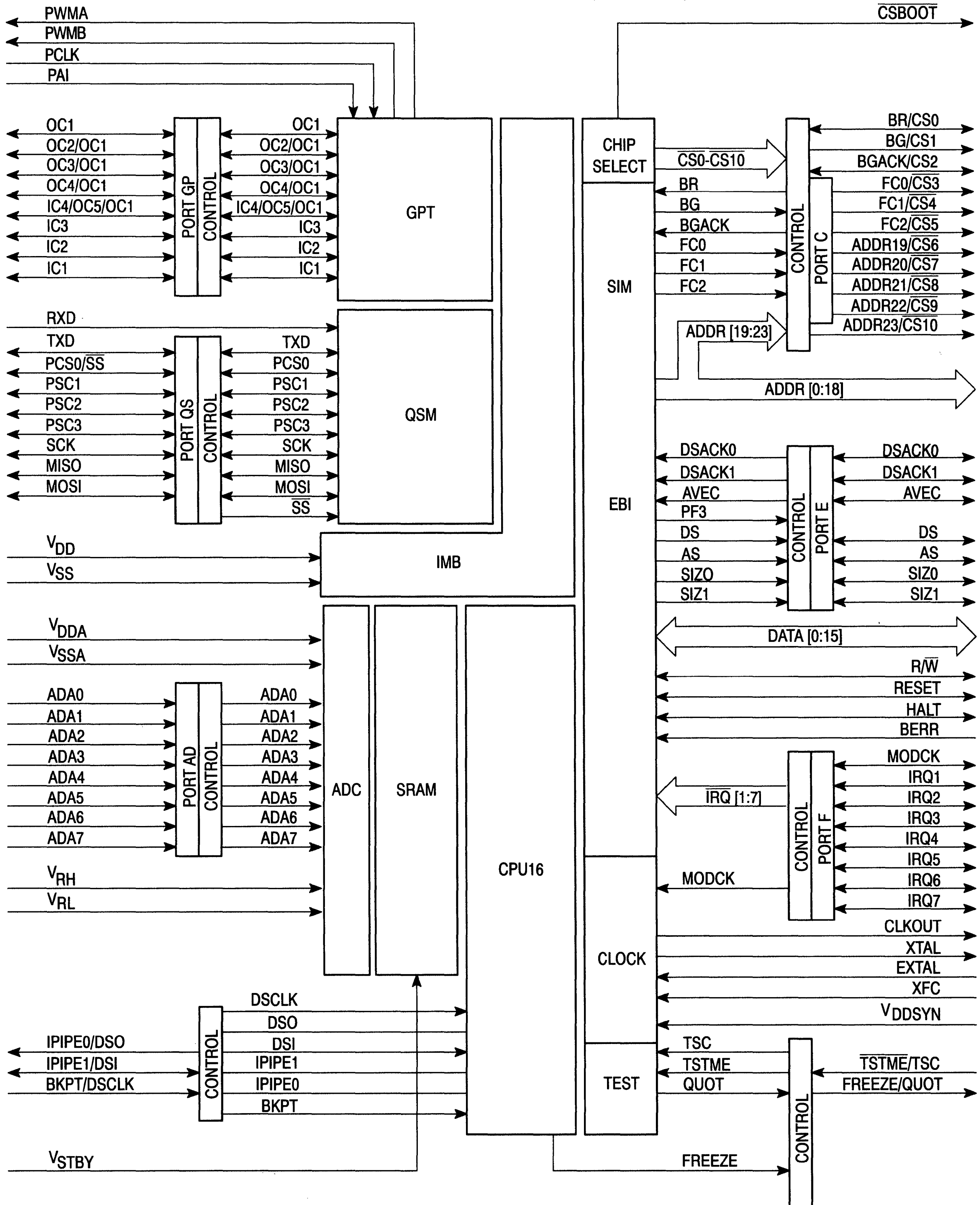


Figure 9. MC68HC16Z1 Block Diagram

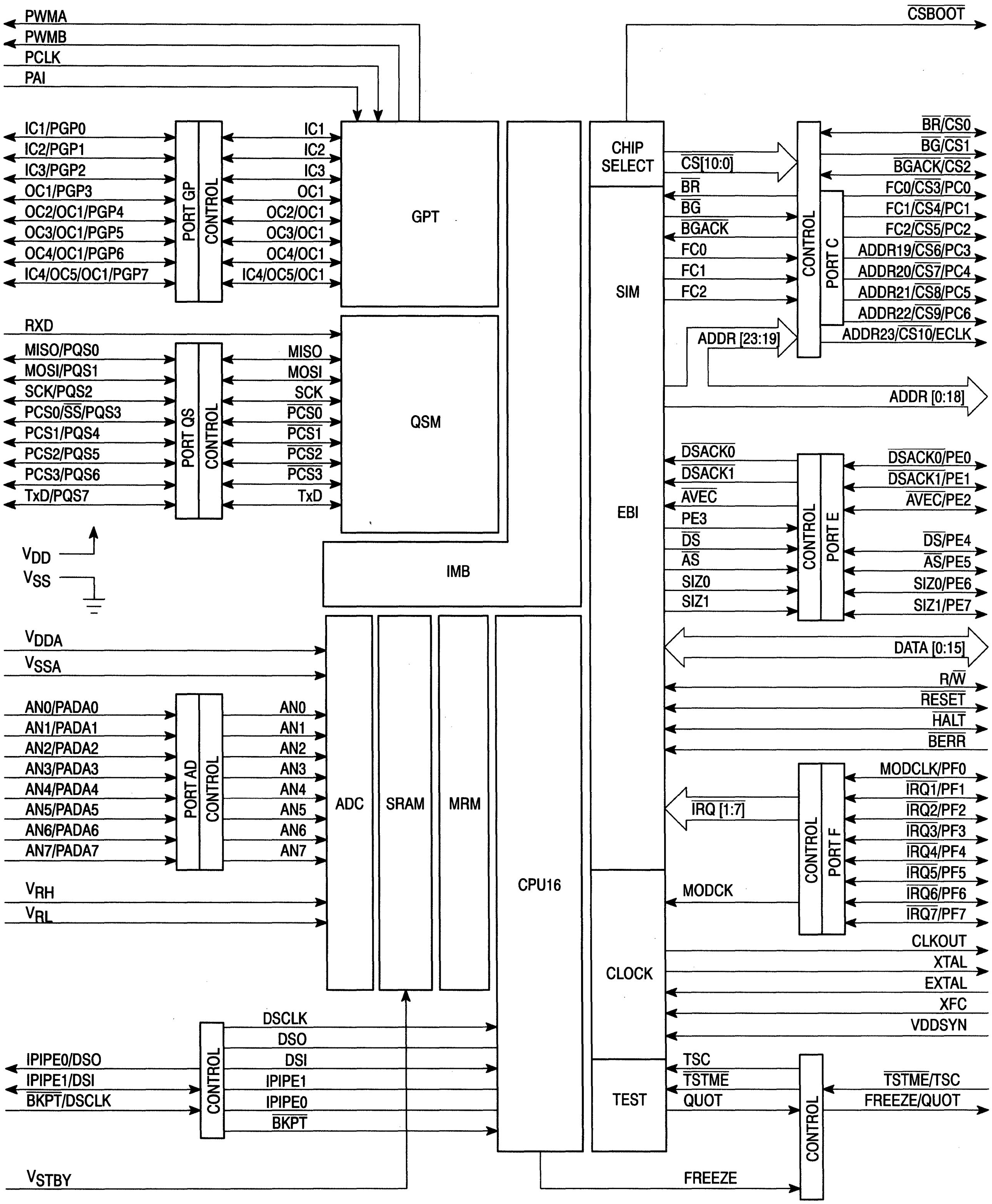


Figure 10. MC68HC16Z2 Block Diagram

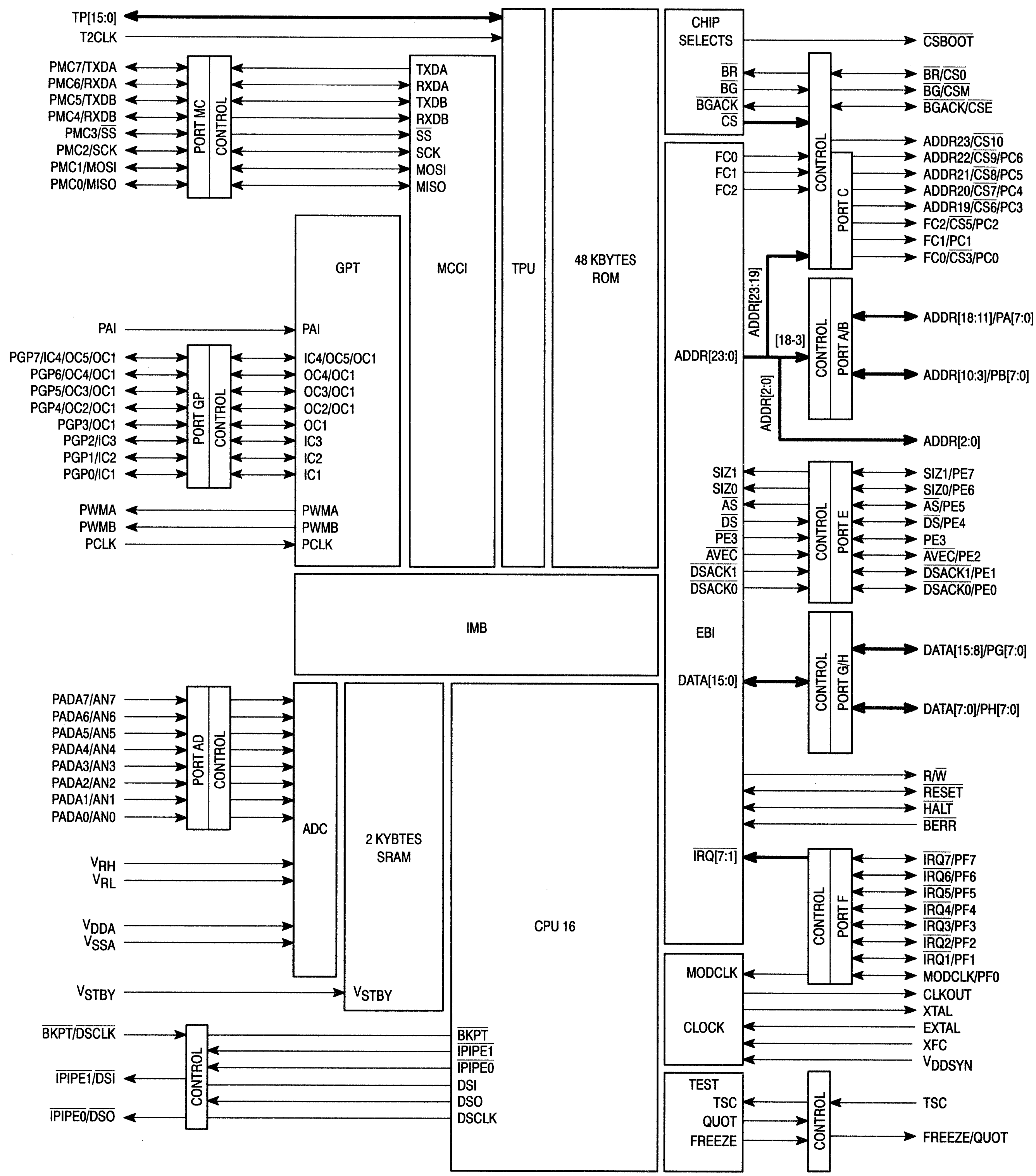


Figure 11. MC68HC16Y1 Block Diagram

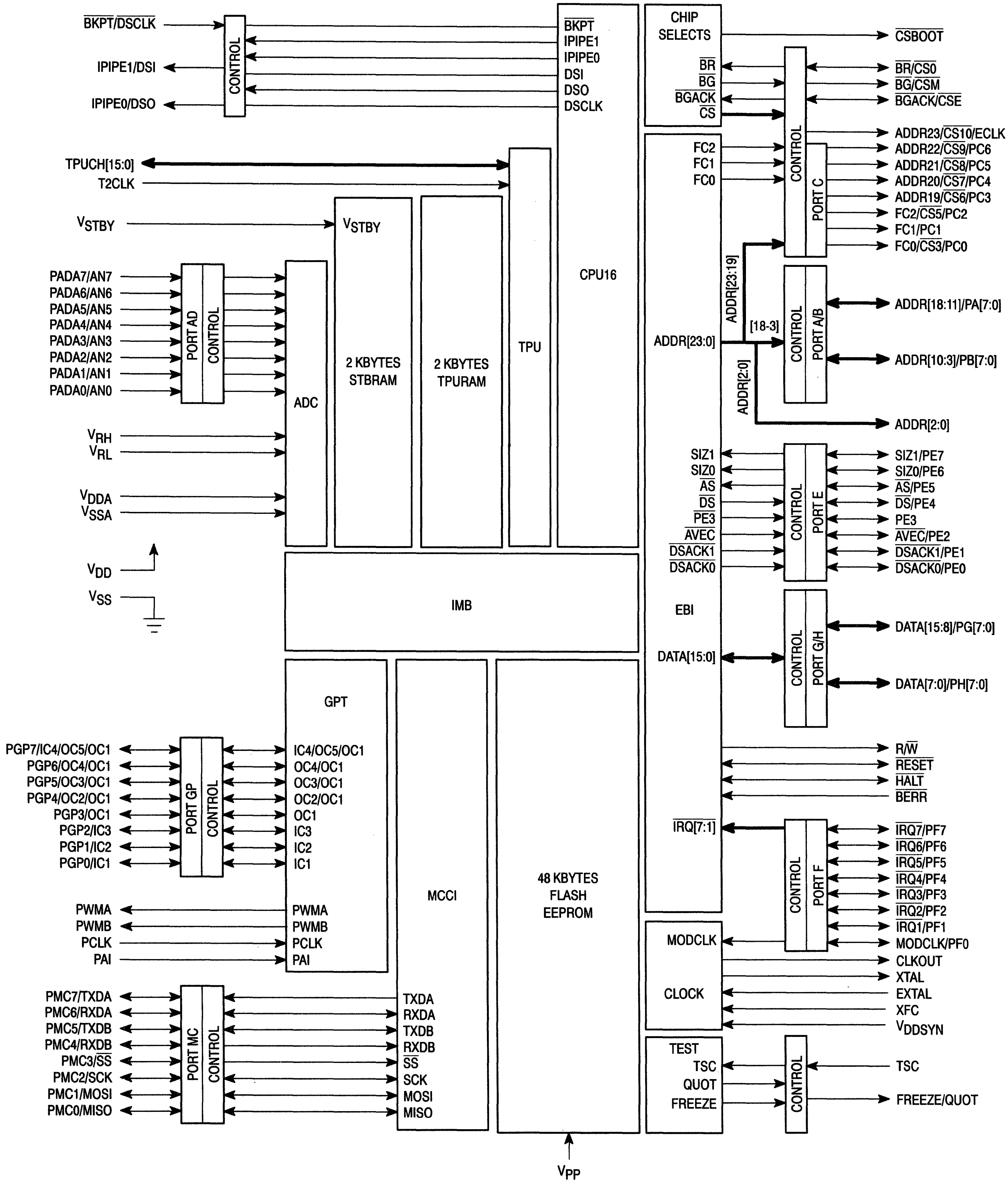


Figure 12. MC68HC916Y1 Block Diagram

Table 9. M68HC16 Family Modular Microcontrollers

Part Number	ROM	SRAM	EEPROM	Timer	I/O	Serial	ADC	Integration Module	Package	Comments
68HC16Z1	-	1K	-	GPT	46	QSM	8 Ch, 10-Bit	SIM	132-FC 132-FD 144-FM 144-FV	20 Address Lines, 12 Chip Selects, Synthesized Clock
68HC16Z2	8K	2K	-	GPT	46	QSM	8 Ch, 10-Bit	SIM	132-FC 132-FD	20 Address Lines, 12 Chip Selects, Synthesized Clock
68HC16Y1	48K	2K	-	TPU + GPT	95	MCCI	8 Ch, 10-Bit	SCIM	160-FT 160-FM	20 Address Lines, 9 Chip Selects, Single Chip or Expanded Mode
68HC916Y1	-	4K	48K Flash	TPU + GPT	95	MCCI	8 Ch, 10-Bit	SCIM	160-FT 160-FM	20 Address Lines, 9 Chip Selects, Single Chip or Expanded Mode
68HC16X1	32K	1K	2K BEFlash	GPT	66	QSM	8 Ch, 10-Bit	RPSCIM	120-TH	20 Address Lines, 5 Chip Selects, Single Chip or Expanded Mode
68HC16W1	-	3.5K	-	TPU + CTM	71	QSM + ABC	Queued 8 Ch, 10-Bit	SIM	160-FT 160-FM	20 Address Lines, 12 Chip Selects, Synthesized Clock

The M68300 Family

The high-performance M68300 family is designed for embedded control applications. Each M68300 MCU incorporates a 32-bit 68000-based CPU module (CPU32), a sophisticated integration module, and a number of dedicated special-purpose modules. In addition to utilizing a bus protocol similar to that of the M68020, the system integration module generates external bus-control signals for M6800 devices, and provides a variety of programmable chip-select functions. M68300 devices can be placed in low-power stop mode to minimize power consumption during periods of inactivity. The M68300 family provides great design flexibility, performance, and compatibility with exiting hardware and software.

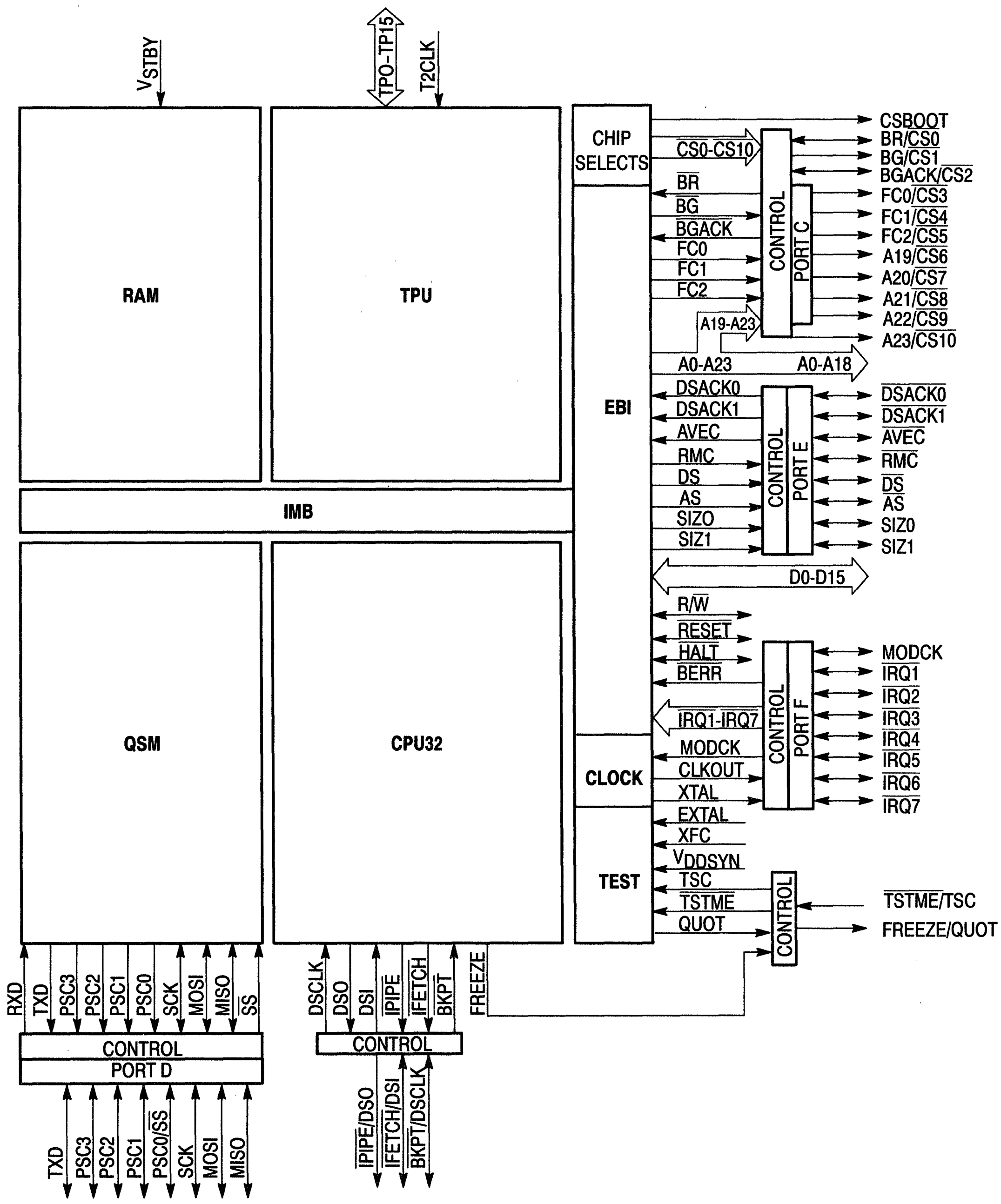


Figure 13. MC68332 Block Diagram

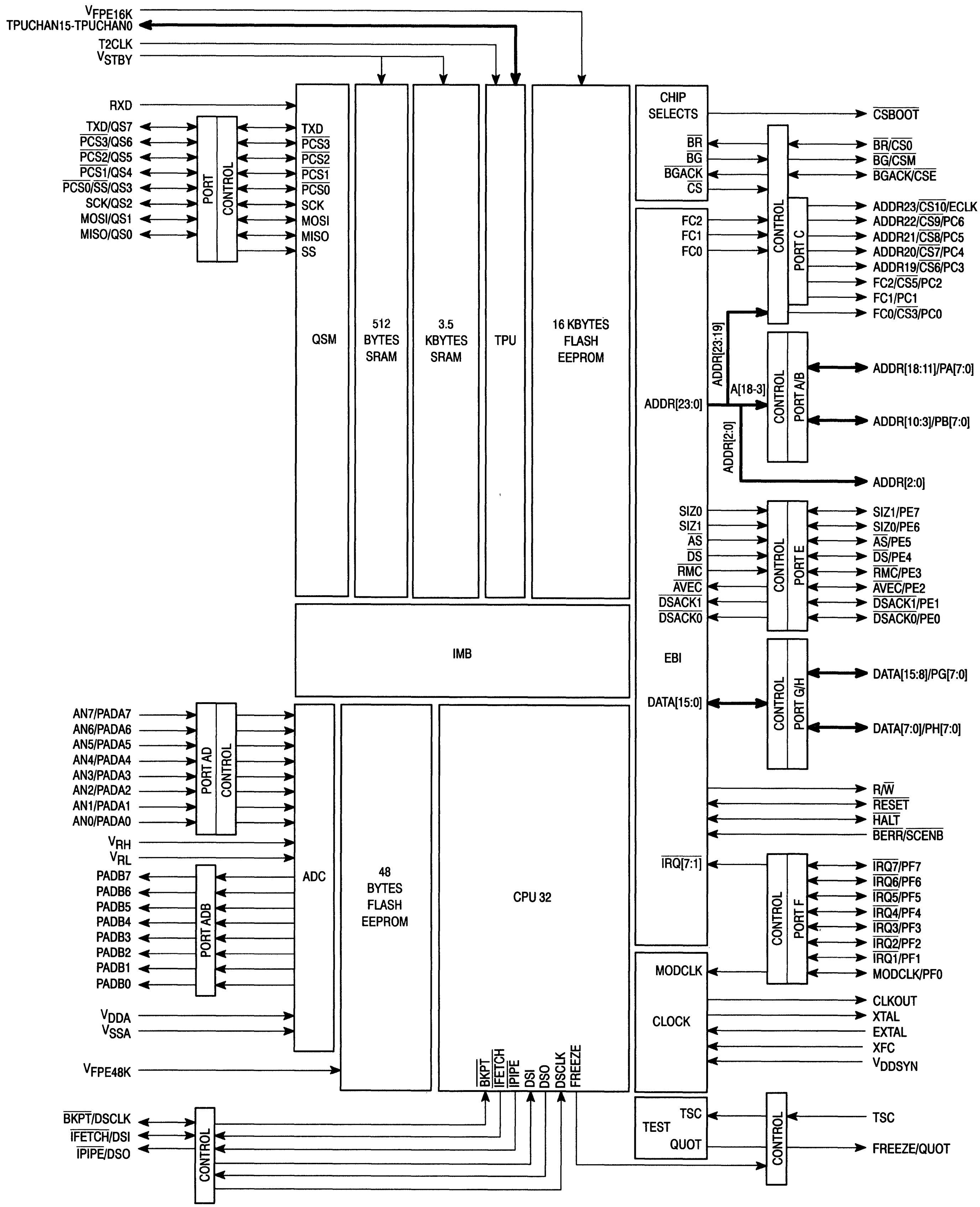


Figure 14. MC68F333 Block Diagram

Table 10. M68300 Family Modular Microcontrollers

Part Number	ROM	SRAM	EEPROM	Timer	I/O	Serial	ADC	Integration Module	Package	Comments
68330	-	-	-	-	16	-	-	SIM	132-FC, 132-FE	32 Address Lines, 2 Chip Selects
68331	-	-	-	GPT	43	QSM	-	SIM	132-FC, 132-FD 144-FM, 144-FV	12 Chip Selects, Synthesized Clock
68332	-	2K	-	TPU	47	QSM	-	SIM	132-FC, 132-FD 144-FM, 144-FV	12 Chip Selects, Synthesized Clock
68F333	-	4K	16K Flash, 48K Flash Emulator	TPU	96	QSM	8 Ch, 10-Bit	SCIM	160-FT, 160-FM	9 Chip Selects, Synthesized Clock
68334	-	1K	-	TPU	47	-	8 Ch, 10-Bit	SIM	132-FC, 132-FD	12 Chip Selects, Synthesized Clock, Single Chip or Expanded Mode
68340	-	-	-	2 TMs	28	DUART	-	SIM	144-FE, 145-RP	32 Address Lines, 2 Chip Selects, 2 DMA Channels

Definitions

A	Ada	FUZ	Fuzzy Logic Environment
ASM	Assembler	ICD	In-Circuit Debugger
BM	Behavior Model	K	Kernel
BRD	Bridge Software	M	Modula - 2
C	C Language	MON	Monitor
CDL	Cross Development Library	NET	Network Communications
CMP	Compiler	P	Pascal
D	Disassembler	RTX	Real Time Executive
DFD	Digital Filter Design	SDB	Symbolic Debugger
DSP	Digital Signal Processing	SIM	Simulator
F	Forth	SLD	Source Level Debugger
FM	File Manager	T	Tools
FP	Floating Point	V	VIsual Programming

Microcontroller Development Tools

M68HC05 Family

The M68HC05 Family is supported by a variety of development tools including Evaluation Modules (EVM) and Evaluation Systems (EVS). Both provide an economical means of designing, debugging, and evaluating 68HC05 microcontrollers in a target system environment.

Many new 68HC05 CSIC devices are supported by an MCU-specific EVS. The EVS is a two-board system consisting of a 68HC05 Platform Board (PFB) and an Emulator Module (EM) which contains the emulating microcontroller, and control circuits.

The M68HC05 Family is also supported by the Compact Development System (CDS) for 8-bit microcontrollers (68CDS8HC05), a powerful, portable, full-featured emulator for debugging hardware and software operations. The CDS8HC05 features high-speed, non-invasive, in-circuit emulation with real-time trace, and a powerful bus state analyzer. Commands are entered from an MS-DOS® host computer.

The Motorola Modular Development System for the M68HC05 Family, MMDS05, allows the use of Emulation Modules (EM) that are compatible with the existing EVS product line. The MMDS05 provides an upgrade for CDS8HC05 customers. The MMDS05 has all of the features of the CDS8HC05, and includes a notable enhancement. A dual-port RAM "memory window" allows a user to to modify memory while a program is running at full speed. An internal power supply and totally shielded enclosure assure compliance with FCC and EC92 regulations. The development software provided with the MMDS05 is an enhancement of the EVM05/EVM11 front end — it provides an integrated development environment with true Source Level Debug (SLD).

M68HC11 Family

The M68HC11 Family is supported by a variety of economical development tools. These include Evaluation Boards (EVB), Evaluation Modules (EVM), and Evaluation Systems (EVS).

An EVB allows a user to debug code under the BUFFALO (Bit User Fast Friendly Aid to Logical Operations) monitor/debugging program contained in the microcontroller ROM. The EVB emulates only the single-chip mode of operation and has no EPROM programmer. The EVBU, a "universal" version of the EVB, includes a wire-wrap area for custom interfacing.

EVM are low-cost tools for designing, debugging, and evaluating M68HC11 devices in a target system. An EVM provides essential microcontroller signals and timing, and on-board monitor/debugging firmware contains extensive commands for controlling I/O and debug operations.

An EVS is a two-board system consisting of a 68HC11 Platform Board (PFB) and an Emulator Module (EM). The EM contains control circuits and a 68HC11 MCU for the part or series of parts being emulated. An EVS provides expanded, multiplexed, special test, and single-chip mode emulation, a dual 64 kbyte memory map with 64 kbytes of emulation RAM, and an RS-232 port.

In addition, the Intermetrics Whitesmiths 68HC11 C Compiler/Assembler (M68S11CCAB) and 68HC11 Simulator Debugger (M68S11SIMAB) are now available through Motorola.

Modular Microcontroller Families

In-circuit debuggers for modular microcontroller families (M68ICD32 and M68ICD16) are economical development and debugging environments. ICD make use of the non-intrusive Background Debug Mode (BDM) interface, and provide sophisticated software debugging functions. The ICD consist of debugger and assembler development software, a small interconnect board, and target system cable. The IASM32 and IASM16 assemblers provide a single development environment that includes an editor and cross-assembler programs. ICD source-level debugger software uses easy-to-read screen windows to display register information for the CPU, the instruction pointer, breakpoints, program memory, and data memory.

The MC68331 and MC68332 are supported by evaluation kits (EVK). These multi-board systems include a common platform board, a Business Card Computer (BCC) that contains the MCU being emulated, and the CPU32BUG debug monitor program. The EVK is a cost-effective system for designing, debugging, and evaluating target system software and hardware. The MC68340 is supported by an evaluation system (EVS) similar to the EVK with the addition of a development interface board for a comprehensive development environment.

The M68HC16Z1 Evaluation Board (EVB) is an inexpensive tool for designing, debugging, and evaluating the MC68HC16Z1. Features include background-mode operation, an integrated assembly/editing/emulation environment, and logic analyzer pod connectors.

Modular evaluation boards (MEVB) for each modular family member are under development. The MEVB system is a multi-board evaluation system that consists of a common platform board (PFB) and interchangeable MCU personality boards (MPB). The MEVB system provides an economical development environment for downloading and debugging software generated with IASM16 and IASM32.

Motorola also sells the Intermetrics Whitesmiths 68HC16 C Compiler/Assembler (M68S16CCAB) and 68HC16 Simulator Debugger (M68S16SIMAB) for the M68HC16 Family. In addition, the Intermetrics InterTools™ 683XX C Compiler/Assembler (M68S32CCAB) and 683XX ROM Monitor Debugger (M68S32ROMAB) for the M68300 Family are now available through Motorola.

Table 11. Development Tools

Devices	Evaluation Boards	Evaluation Modules	Evaluation Systems/Kits	Programmer Boards
M6800 Development Tools				
6801		M68701EVM		
6801U4		M68701EVM		
68701		M68701EVM		
68701U4		M68701EVM		
6803		M68701EVM		
6803U4		M68701EVM		
M68HC05 Development Tools				
68HC05A6		M68HC05EVM		
68HC05B4/B6/B8/B16		M68HC05EVM		
68HC705B5		M68HC05EVM		M68HC705B5PGMR
68HC805B6		M68HC05EVM		
68HC05C2/C3/C4/C8/C9		M68HC05EVM		
68HC05C5 68HC705C5			M68HC05C5EVS	
68HC705C8		M68HC05EVM		M68HC05PGMR
68HC805C4		M68HC05EVM		
68HC705D9		M68HC05EVM		
68HC05E1 68HC705E1			M68HC05E1EVS	M68HC705ELPGMR
68HC05F6 68HC705F6		M68HC05F6EVM		
68HC05G8		M68HC05G8EVM		
68HC05H2 68HC705H2			M68HC05H2EVS	
68HC05J1			M68HC05P8EVS	
58HC705J2			M68HC05P8EVS	M68HC705J2PGMR
68HC705K1			M68HC05K1EV5	M68HC705K1PGMR
68HC05L5 68HC705L5			M68HC05L5EVS	M68HC705L5PGMR
68HC05L6		M68HC05EVM		
68HC05L7/L9		M68HC05L9EVM		
68HC05M4		M68HC05M4EVM		
68HC05P1/P4/P7		M68HC05EVM	M68HC05P9EVS	
68HC05P9			M68HC05P9EVS	
68HC05P8			M68HC05P8EVS	
68HC705P9			M68HC05P9EVS	M68HC705P9PGMR
68HC05T1/T2/T3			M68HC05T2EVS	
68HC05T4		M68HC05T4EVM		
68HC05T7/T10 68HC705T10		M68HC05T7EVM		

*EVS and EVM include an Integrated Development Environment (IDE) which contains an editor, assembler, hardware debugger and simulator.

Table 11. Development Tools (continued)

Devices	Evaluation Boards	Evaluation Modules	Evaluation Systems/Kits	Programmer Boards
M68HC05 Development Tools (continued)				
6805P2/P6 6805R2/R3 6805U2/U3 68705P3/P5 68705R3/R5 68705U3/U5		M68705EVM		
M68HC11 Development Tools				
68HC11A0/A1/A8	M68HC11EVB M68HC11EVB2 M68HC11EVBU	M68HC11EVM		
68HC11D0/D3		M68HC11EVM	M68HC11D3EVS	
68HC711D3	M68HC711D3EVB	M68HC11EVM	M68HC11D3EVS	M68HC711D3PGMR
68HC11E0/E1/E2/E9	M68HC11EVB M68HC11EVBU	M68HC11EVM		
68HC711E9	M68HC11EVBU	M68HC11EVM		M68HC711E9PGMR
68HC811A8/E2	M68HC11EVB M68HC11EVBU	M68HC11EVM		
68HC11F1			M68HC11F1EVS	
68HC11G5/G7 68HC711G5		M68HC11G7EVS		
68HC11KA4			M68HC11KA4EVS	
68HC11K0/K1/K4 68HC711K4			M68HC11K4EVS	
68HC11L0/L1/L6 68HC711L6			M68HC11L6EVS	
68HC11M2 68HC711M2			M68HC11KMNPEVS	
68HC11N4 68HC711N4			M68HC11KMNPEVS	
68HC11P2 68HC711P2			M68HC11KMNPEVS	
M68HC16 Development Tools				
68HC16Y1				
68HC16Z1	M68HC16Z1EVB			
M68300 Development Tools				
68331			M68331EVK	
68332			M68332EVS/ M68332EVK	

*EVS and EVM include an Integrated Development Environment (IDE) which contains an editor, assembler, hardware debugger and simulator.

Fuzzy Logic

Fuzzy logic replaces conventional programming techniques with a simpler approach to control algorithms. Fuzzy logic uses a series of case statements to create sophisticated features that do not require additional memory or excessive processing time.

Motorola's portfolio of fuzzy logic products is geared for every level of user. The fuzzy logic educational kit (part number FLEDKT00) includes everything needed to learn how to use fuzzy logic with M68HC05 and M68HC11 microcontrollers.

- An easy-to-follow PC-based tutorial
  - Explains fuzzy logic fundamentals, basic concepts and terminology
  - Methodology section teaches a five-step sequence or principles and procedures for designing a fuzzy logic system. These include defining the control system, writing rules and membership functions, tuning and debugging and optimizing the design.
  - Advanced topics section covers areas such as stability, adaptability, ambiguity, noise, alpha-cuts and contribution weights
- A Knowledge Base Generator (KBG)
  - Uses natural language inputs to generate a knowledge base (rules and membership functions)
  - Inference Engines for the M68HC11 and M68HC05 families implement the fuzzy logic in software ready to embed in your Motorola microcontroller application
  - Runs a software simulation of the inference engine and displays a two-dimensional plot of the control surface
  - Generates real-time code for the standard M68HC05 or M68HC11 microcontroller families which can be downloaded to an evaluation module (EVM) for in-circuit emulation
- Demonstration-version of Aptronix's Fuzzy Inference Development Environment (FIDE) software
  - Features powerful, time-saving debug functions to help determine the correct membership functions and rules for any application
  - Demonstrates easy-to-use graphical interface for designing and debugging integrated systems

Aptronix's Fuzzy Inference Development Environment (FIDE™) is a powerful software tool that allows users to easily edit, simulate, debug, and tune the membership functions and rules of a fuzzy logic application. FIDE offers graphical and natural language editing of source files. The user-friendly debug tools allow time domain simulations, three-dimensional surface displays of input-to-output relationships, and linkage of fuzzy and non-fuzzy modules. FIDE also generates assembler code that implements fuzzy logic on Motorola microcontrollers.

On-Line Help

Microcontroller Electronic Bulletin Board

Freeware Data Service provides a direct line to the latest information and software for Motorola microcontrollers. The Freeware bulletin board provides access to:

- Development Software for PC and Macintosh Computers
  - Cross Assemblers
  - Small C Compiler for 68HC11
  - EVM and EVB Monitor/Debugger Object Code
- Development software
  - Floating Point Routines
  - Fast Fourier Transform Routines
  - 16-Bit Math Packages
  - Utility Programs
  - User Group Library Routines and User-Donated Programs
  - Kermit File Transfer Program
  - Terminal Emulation Program
- Masked ROM information
- MCU literature listings
- Updates/Erratas to existing literature
- Press releases and updates concerning new and phase-out products
- Contests, promotions and seminars
- Electronic mail service

How to Access Freeware

You can access Freeware from anywhere in the world. To log on, you'll need the following equipment:

1. 2400/1200/300 baud modem
2. Terminal, MS-DOS personal computer or Macintosh computer
3. Telephone line

This equipment will allow the user to read files and post questions. However, with a file transfer program such as XMODEM, YMODEM or Kermit, all information can be downloaded to your terminal or PC.

To log on:

1. Dial (512) 891-FREE (891-3733). Be sure to set the character format to 8 data, no parity, 1 stop bit.
2. Follow directions from the system.
3. Read log-on messages, then follow the directions on the screen display. A log-on session is limited to 120 minutes.

Third-party Support

Development support for Motorola microcontrollers is available from a variety of independent suppliers.

Third-party Development Tools

Table 12. Software Products

M68HC05 Family	M68HC11 Family	M68HC16 Family	M68300 Family
Simulators			
Byte Craft Ltd. P&E Microcomputer Systems, Inc. PseudoCorp. TECi	Avocet Systems, Inc. Nohau Corp. P&E Microcomputer Systems, Inc.	P&E Microcomputer Systems, Inc.	Software Environments Ltd.
Assemblers			
2500AD Software, Inc. American Arium Byte Craft Ltd. Computer Systems Consultants, Inc. Eris Systems, Inc. Introl Corp. Lloyd I/O, Inc. LOGISOFT Micro Dialects, Inc. Onset Computer Corp. P&E Microcomputer Systems, Inc. PseudoCorp. TECi	2500AD Software, Inc. Archimedes Software, Inc. Avocet Systems, Inc. Computer Systems Consultants, Inc Eris Systems, Inc. Introl Corp. Lloyd I/O, Inc. LOGISOFT Micro Dialects, Inc.	2500AD Software, Inc. Byte Craft Ltd. Eris Systems, Inc. Introl Corp. Micro Dialects, Inc. P&E Microcomputer Systems, Inc.	Avocet Systems, Inc. Eyring Systems Software Division Introl Corp. Micro Dialects, Inc. Microtec Research, Inc. Oasys, Inc.
Symbolic Debuggers			
2500AD Software, Inc. Byte Craft Ltd. P&E Microcomputer Systems, Inc. TECi Wytec Company	2500AD Software, Inc. Microtec Research, Inc. P&E Microcomputer Systems, Inc. TECi	Byte Craft Ltd.	Eyring Systems Software Division Integrated Systems, Inc. JMI Software Consultants, Inc.
Compilers			
American Arium Byte Craft Ltd.	2500AD Software, Inc. Archimedes Software, Inc. Avocet Systems, Inc. Forth, Inc. Intermetrics Microsystems Software, Inc. Introl Corp. Laboratory Microsystems Inc. New Micros, Inc. Software Environments Ltd. SYNGEN Industrial Control	Byte Craft Ltd. Intermetrics Microsystems Software, Inc. Introl Corp. Software Environments Ltd.	Eyring Systems Software Division Forth, Inc. Integrated Systems, Inc. Intermetrics Microsystems Software, Inc. Introl Corp. Laboratory Microsystems Inc. Microtec Research, Inc. Microware Systems Corp. RAVEN Computer Systems Sierra Systems

Table 12. Software Products (continued)

M68HC05 Family	M68HC11 Family	M68HC16 Family	M68300 Family
Source Level Debuggers			
Byte Craft Ltd.	Huntsville Microsystems, Inc.	Huntsville Microsystems, Inc.	Embedded Support Tools Corp.
Yokogawa Digital Computer Corp.	Intermetrics Microsystems Software, Inc.	Intermetrics Microsystems Software, Inc.	Eyring Systems Software Division
	Introl Corp.	Introl Corp.	GreenSpring Computers, Inc.
	Yokogawa Digital Computer Corp.	Yokogawa Digital Computer Corp.	Huntsville Microsystems, Inc.
			Integrated Systems, Inc.
			Intermetrics Microsystems Software, Inc.
Introl Corp.			
			Microtec Research, Inc.
			Sierra Systems
			Yokogawa Digital Computer Corp.
Real-Time Executives			
	Accelerated Technology, Inc.	A. T. Barrett & Associates	Accelerated Technology, Inc.
	A. T. Barrett & Associates	U S Software Corporation	A. T. Barrett & Associates
	U S Software Corporation		Eyring Systems Software Division
			GreenSpring Computers, Inc.
			Integrated Systems, Inc.
			JMI Software Consultants, Inc.
			Microware Systems Corp.
			Ready Systems
			U S Software Corporation
Other			
PsuedoCorp	Logic Automation Inc.	Momentum Data Systems, Inc.	Avocet Systems, Inc.
	LOGISOFT	U S Software Corporation	CARDtools Systems Corp.
	PsuedoCorp		Eyring Systems Software Division
	U S Software Corporation		GreenSpring Computers, Inc.
			Integrated Systems, Inc.
			JMI Software Consultants, Inc.
			Logic Automation Inc.
			Microware Systems Corp.
			U S Software Corporation

Table 13. Hardware Products

M68HC05 Family	M68HC11 Family	M68HC16 Family	M68300 Family
Logic Analyzers			
	American Arium	Hewlett-Packard	Hewlett-Packard
	Hewlett-Packard	Tektronix, Inc.	
	Step Engineering		
	Tektronix, Inc.		
Emulators			
American Arium	Advance Electronic Diagnostics, Inc.	Embedded Support Tools Corp.	Advance Electronic Diagnostics, Inc.
			Applied Microsystems
Orion Instruments, Inc.	American Arium	Huntsville Microsystems, Inc.	Embedded Support Tools Corp.
Pentica Systems Inc.	Huntsville Microsystems, Inc.	Nohau Corp.	Hewlett-Packard
Sophia Systems & Technology	MetaLink Corp.	Pentica Systems, Inc.	Huntsville Microsystems, Inc.
TECi	Nohau Corp.	Yokogawa Digital Computer Corp.	Microtek International
Thorson Engineering Co.	Orion Instruments, Inc.		Nohau Corp.
Trace Technology Ltd.	Pentica Systems Inc.		Pentica Systems Inc.
Yokogawa Digital Computer Corp.	Sophia Systems & Technology		Yokogawa Digital Computer Corp.
	TECi		
	Thorson Engineering Co.		
	Wytec Company		
	Yokogawa Digital Computer Corp.		
Evaluation Boards			
Elan Digital Systems	Elan Digital Systems	New Micros, Inc.	GreenSpring Computers, Inc.
	Mosaic Industries, Inc.		New Micros, Inc.
	New Micros, Inc.		
Other			
3M Electronic Products Division	3M Electronic Products Division	AMP Inc.	Emulation Technology, Inc
AMP Inc.	AMP Inc.	P&E Microcomputer Systems, Inc.	Pentica Systems Inc.
EE Tools Co.	Elan Digital Systems		
Elan Digital Systems	Emulation Technology, Inc.		
Pentica Systems Inc.	Pentica Systems Inc.		
TECi	SYNGEN Industrial Control		

Table 14. Contact List

Company	Phone
3M Electronic Products Division	(512) 984-3441
2500AD Software, Inc.	(719) 395-8683
A. T. Barrett & Associates	(713) 728-9688
Accelerated Technology, Inc.	(205) 450-0707
Advance Electronic Diagnostics, Inc.	(602) 861-9359
American Arium	(714) 731-1661
AMP Inc.	(800) 52AMP52
Applied Microsystems	(800) 426-3925
Archimedes Software, Inc.	(415) 567-4010
Avocet Systems, Inc.	(800) 448-8500
Byte Craft Ltd.	(519) 888-6911
CARDtools Systems Corp.	(408) 559-4240
Computer Systems Consultants, Inc	(404) 483-4570
EE Tools Co.	(716) 346-6973
Elan Digital Systems	(4489) 579799
Embedded Support Tools Corp.	(617) 828-5588
Emulation Technology, Inc.	(408) 982-0660
Eris Systems, Inc.	(612) 374-2967
Eyring Systems Software Division	(801) 375-2434
Forth, Inc.	(213) 372-8493
GreenSpring Computers, Inc.	(415) 327-1200
Hewlett-Packard	(800) 447-3282
Huntsville Microsystems, Inc.	(205) 881-6005
Integrated Systems, Inc.	(408) 980-1500
Intermetrics Microsystems Software, Inc.	(617) 661-0072
Introl Corp.	(414) 327-7171
JMI Software Consultants, Inc.	(215) 628-0840
Laboratory Microsystems Inc.	(310) 306-7412
Lloyd I/O, Inc.	(503) 222-0702
Logic Automation Inc.	(503) 690-6900
LOGISOFT	(408) 773-8465
MetaLink Corp.	(602) 926-0797
Micro Dialects, Inc.	(513) 271-9100
Microtec Research, Inc.	(408) 980-1300
Microtek International	(503) 645-7333
Microware Systems Corp.	(515) 224-1929
Momentum Data Systems, Inc.	(714) 577-6894
Mosaic Industries, Inc.	(415) 790-1255
New Micros, Inc.	(214) 339-2204
Nohau Corp.	(408) 866-1820
Oasys, Inc.	(617) 862-2002

Table 14. Contact List (continued)

Company	Phone
Onset Computer Corp.	(508) 563-9000
Orion Instruments, Inc.	(800) 729-7700
P&E Microcomputer Systems, Inc.	(617) 944-7585
Pentica Systems Inc.	(617) 275-4419
PseudoCorp.	(804) 873-1947
RAVEN Computer Systems	(612) 636-0365
Ready Systems	(800) 228-1249
Sierra Systems	(510) 339-8200
Software Environments Ltd.	(714) 588-9685
Sophia Systems & Technology	(800) 824-9294
Step Engineering	(408) 733-7837
SYNGEN Industrial Control	(403) 986-1203
TECi	(802) 525-3458
Tektronix, Inc.	(503) 629-1773
Thorson Engineering Co.	(206) 334-4214
Trace Technology Ltd.	0234 266 455
U S Software Corporation	(503) 641-8446
Wytec Company	(708) 894-1440
Yokogawa Digital Computer Corp.	(415) 570-7050

LonWorks™ Products

In Brief . . .

Motorola's Neuron® Chip distributed communication and control processors are sophisticated VLSI devices that make it possible to implement low-cost Local Operating Network applications. The unique combination of hardware and firmware provides all the key functions necessary to process inputs from sensors and control devices intelligently, and propagate control information across a variety of network media.

Used in conjunction with the LonBuilder™ developer's workbench, the Neuron Chips make available to a system designer an object-oriented, high-level environment providing for the easy implementation of distributed sense and control networks, flexible reconfiguration capability after network installation, and management of LonTalk™ protocol messages on the network.

Applications include distributed sense and control systems, instrumentation, machine automation, processor control, diagnostic equipment, environmental monitoring and control, power distribution and control, production control, lighting control, building automation and control, security systems, data collection/acquisition, robotics, home automation, consumer electronics, and automotive electronics.

Page

Neuron Chips

The MC143150 is designed for sense and control systems that require large application programs. An external memory interface allows the system designer to use 58K of the available 64K of address space for application program storage. The MC143150 has no ROM on the chip. The communications protocol, operating system, and 24 I/O function object code is supplied with the LonBuilder development kit. The protocol and application code can be located in external ROM, EEPROM, NVRAM, or battery backup static RAM.

Both the MC143150FU (10 MHz clock rate) and the MC143150FU1 (5 MHz clock rate) are available in a 64-lead QFP package.

Request document MC143150/D for complete data.

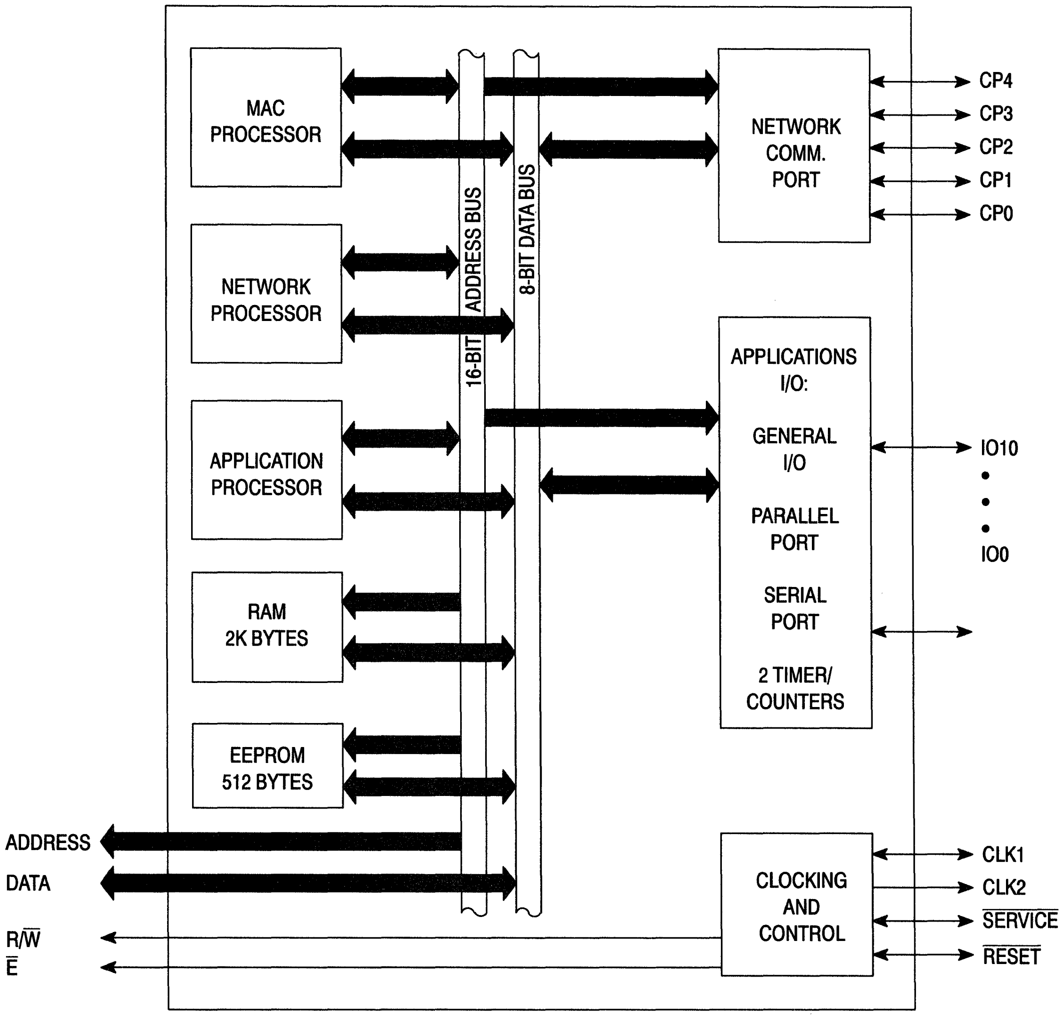


Figure 1. MC143150FU and MC143150FU1

Neuron Chips (continued)

The MC143120 has no external memory interface, and is designed for applications that require smaller application programs. It contains 10K of mask ROM that implements the communications protocol, operating system, and the 24 I/O functions that can be accessed by the application program. The application program resides in the internal 512 bytes of EEPROM, and utilizes the firmware in the mask ROM for the specific applications.

The MC143120DW is in a 28-lead SOJ package.

Request document MC143150/D for complete data.

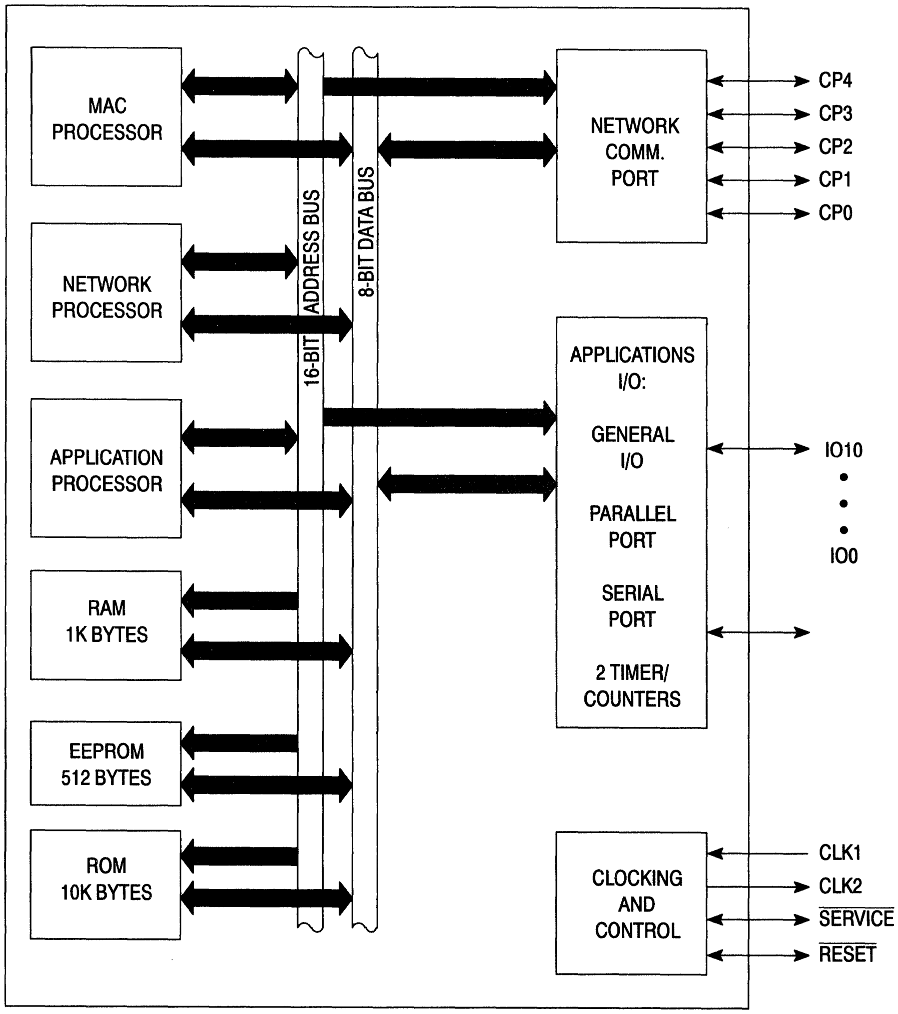


Figure 2. MC143120DW

LONWORKS Technology Overview and Architecture

LONWORKS technology is a complete platform for implementing distributed control networked systems. These systems consist of intelligent devices or *nodes* that interact with their environment, and communicate with one another over a variety of communications *media* using a common, message-based control *protocol*.

LONWORKS technology includes all of the elements required to design, deploy and support control networks, specifically the following components:

- MC143150 and MC143120 NEURON CHIPS
- LONTALK Protocol
- LONWORKS Transceivers
- LONBUILDER Developer's Workbench

The Motorola NEURON CHIP is a VLSI component that performs the network and application-specific processing within a node. A node typically consists of a NEURON CHIP, a power source, a transceiver for communicating over the network medium, and circuitry for interfacing to the device being controlled or monitored. The specific circuitry will depend on the networking medium and application.

LONWORKS technology can support a variety of network data rates up to and including 1.25 Mbps on twisted pair (using direct drive, EIA-485 or transformer coupled interfaces). Other media such as powerlines, RF, infrared, fiber-optics, and ultrasonics can be used with an appropriate transceiver.

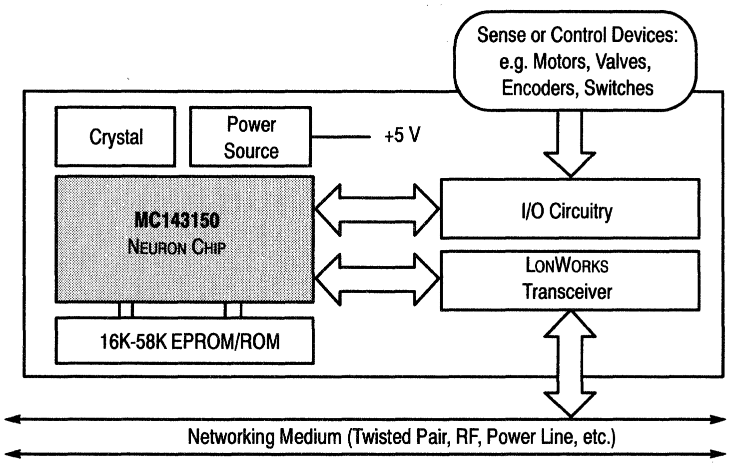


Figure 3. MC143150 in a Typical Node Block Diagram

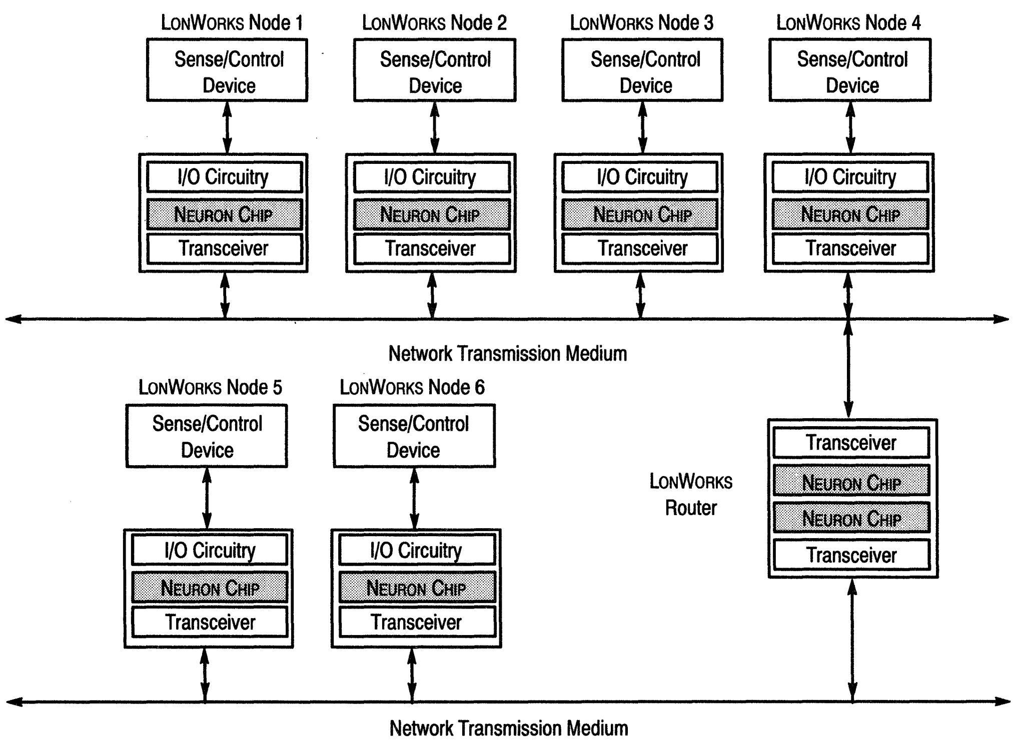
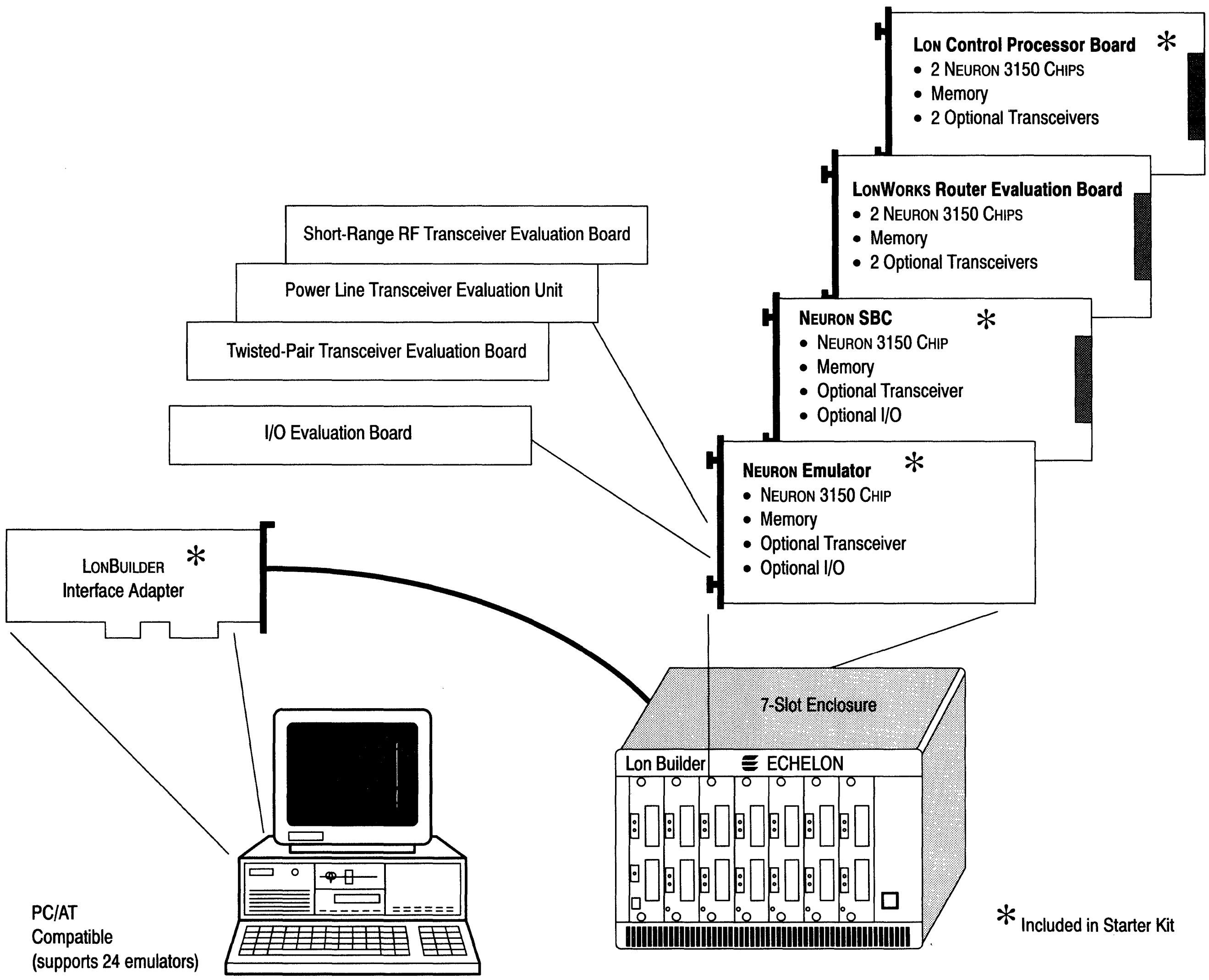


Figure 4. The MC143150 or MC143120 in a LONWORKS Network

LONBUILDER Developer's Workbench(See Note 1)

This integrated hardware and software environment provides the tools necessary to build a Local Operating Network (LON®). LONWORKS consist of intelligent nodes that interact with their environment, and communicate with one another over a variety of communications media using a common, message-based control protocol. Each node contains sufficient computing resources to implement the protocol and perform the node's control function. In addition, each node includes a transceiver that couples the node to the communications media.



LONBUILDER Starter Kit (See Note 1)

The LONBUILDER Starter Kit contains all the tools necessary to begin LONWORKS development on a PC/AT or compatible computer. The starter kit contains a LONBUILDER Development Station (7-slot enclosure and PC interface adapter board) and the Interactive Development Environment Software consisting of the Network Management Tools and the NEURON C Developer's Kit. The starter kit also contains two LONBUILDER NEURON CHIP Emulators. The backplane built into the enclosure can be used as an internal development network or optional LONBUILDER transceiver evaluation boards are available for external powerline, radio frequency, and twisted pair networks.

(1) Motorola supports these tools, but they should be purchased through Echelon Corporation (1-800-258-4566).

MOS Memories

In Brief . . .

Motorola's MOS memory product portfolio has been expanded to support a broad range of engineering applications.

Technological leadership is the main goal for fast static RAMs. These high-density, high-speed products are targeted for specific solutions in microprocessor applications, providing access times as fast as 8 and 10 ns. Included in this portfolio are application-specific FSRAMs, along with standard and custom fast static RAM modules. The CMOS and BiCMOS devices and the FSRAM modules are the technology process drivers for the future.

The dynamic RAM operation uses alliances as a vehicle for global customer support in this highly competitive commodity memory market. The portfolio includes high-density DRAMs in a variety of operating modes and packages, and standard and custom modules up to 16M bytes to reach a broad range of responsive engineering solutions. Application specific DRAM modules are available for many microprocessor applications.

Fast Static RAMs

Introduction

Motorola is designing the fastest, most technologically advanced fast SRAMs. From 1.2 micron technology to sub-micron dimensions, devices are progressively smaller, faster, and lower cost. SRAMs developed with double-layer metal and BiCMOS technology will keep pace with machines of the future. Selected fast SRAMs are also available on 2M and 8M memory modules.

Application specific memories are designed for high-performance microprocessors that require more specialization from memory cache than is available from standard devices. Products include those for use with digital signal processors as well as a variety of popular microprocessors.

Table 1. BiCMOS Fast Static RAMs (6 to 15 ns)

Density	Organization	Motorola Part Number	Pin Count	Packaging Package width in mils	Access Time (ns Max)	Technology	Production	Comments
4M	1Mx4/ 2Mx2	MCM101524	36	400 (WJ)SOJ, (TS)TSOP (TB)TAB	10/12/15	BiCMOS	3Q93	100K ECL compatible @ – 5.2 V.
	4Mx1	MCM101520	36	400 (WJ)SOJ, (TS)TSOP (TB)TAB	10/12/15	BiCMOS	3Q93	100K ECL compatible @ – 5.2 V.
1M	128Kx8	MCM6726	32	400 (WJ)SOJ	10/12/15	BiCMOS	Now	Revolutionary pinout.
		MCM6726A	32	400 (WJ)SOJ	8/10/12/15	BiCMOS	4Q93	Revolutionary pinout. Sampling 4Q93.
	256Kx4	MCM6728	28	400 (WJ)SOJ	10/12/15	BiCMOS	Now	Revolutionary pinout.
		MCM6728A	28	400 (WJ)SOJ	8/10/12/15	BiCMOS	4Q93	Revolutionary pinout. Sampling 4Q93.
		MCM6729	32	400 (WJ)SOJ	10/12/15	BiCMOS	Now	With output enable. Revolutionary pinout.
		MCM6729A	32	400 (WJ)SOJ	8/10/12/15	BiCMOS	4Q93	With output enable. Revolutionary pinout.
256K	32Kx8	MCM6706A	28	300 (J)SOJ	8/10/12	BiCMOS	Now	Use for new quals and designs. Evolutionary pinout. Fastest 256K on the market.
		MCM6706R	32	300 (J)SOJ	6/7/8	BiCMOS	4Q93	Revolutionary pinout. Sampling 3Q93.
	32Kx9	MCM6705A	32	300 (J)SOJ	10/12	BiCMOS	Now	Evolutionary pinout.
	64Kx4	MCM6708A	24	300 (J)SOJ	8/10/12	BiCMOS	Now	Use for new quals and designs. Evolutionary pinout.
		MCM6709A	28	300 (J)SOJ	8/10/12	BiCMOS	Now	Use for new quals and designs. Output enable. Evolutionary pinout.
		MCM6709R	28	300 (J)SOJ	6/7/8	BiCMOS	4Q93	Revolutionary pinout. Sampling 3Q93.

Table 2. CMOS Fast Static RAMs (12 to 45 ns)

Density	Organization	Motorola Part Number	Pin Count	Packaging Package width in mils	Access Time (ns Max)	Technology	Production	Comments
4M	512Kx8	MCM6246	36	400 (WJ)SOJ	25/30/35	HCMOS	4Q93	Output enable. Revolutionary pinout.
	1Mx4	MCM6249	32	400 (WJ)SOJ	25/30/35	HCMOS	4Q93	Output enable. Revolutionary pinout.
1M	128Kx8	MCM6226A	32	400 (WJ)SOJ	20/25/35/45	HCMOS	Now	Standard asynchronous.
	256Kx4	MCM6229A	28	400 (WJ)SOJ	20/25/35/45	HCMOS	Now	Standard asynchronous.
	1Mx1	MCM6227A	28	400 (WJ)SOJ	20/25/35/45	HCMOS	Now	Separate I/O.
256K	16Kx16	MCM62996	52	(FN)PLCC	15/20/25	HCMOS	Now	Choice of 5 V or 3.3 V power supplies for output buffers. For wide bus applications.
	32Kx8	MCM6206C	28	300 (J)SOJ/(P)DIP	15/17/20/25/35	HCMOS	Now	
		MCM6206D	28	300 (J)SOJ/(P)DIP	15/17/20/25/35	HCMOS	Now	Replaces MCM6206C.
		MCM62V06D	28	300 (J)SOJ/(P)DIP	25/35	HCMOS	3Q93	Sampling 3Q93. First 3.3 V power supply.
	32Kx9	MCM6205C	32	300 (J)SOJ	15/17/20/25/35	HCMOS	Now	
		MCM6205D	32	300 (J)SOJ	15/17/20/25/35	HCMOS	Now	Replaces MCM6205C.
	64Kx4	MCM6208C	24	300 (J)SOJ/(P)DIP	15/20/25/35	HCMOS	Now	
		MCM6209C	28	300 (J)SOJ/(P)DIP	15/20/25/35	HCMOS	Now	Output enable access time = 6 ns.

Table 2. CMOS Fast Static RAMs (12 to 45 ns) (continued)

Density	Organization	Motorola Part Number	Pin Count	Packaging Package width in mils	Access Time (ns Max)	Technology	Production	Comments
256K (cont.)	256Kx1	MCM6207C	24	300 (J)SOJ/(P)DIP	15/20/25	HCMOS	Now	Separate I/O.
64K	8Kx8	MCM6264C	28	300 (J)SOJ/(P)DIP	12/15/20/25/35	HCMOS	Now	Complementary chip enables.
	8Kx9	MCM6265C	28	300 (J)SOJ/(P)DIP	12/15/20/25/35	HCMOS	Now	Complementary chip enables.

Table 3. Application Specific Static RAMs

Description	Organization	Motorola Part Number	Pin Count	Packaging	Access Time (ns Max)	Technology	Production	Comments
Processor Specific	64Kx18	MCM67B618	52	(FN) PLCC	9/12/18	BiCMOS	3Q93	Burst mode for i486™/Pentium™ (non-pipeline). 3.3 V I/O compatible.
		MCM67C618	52	(FN) PLCC	9	BiCMOS	3Q93	Burst mode for i486/Pentium (pipeline). 3.3 V I/O compatible.
		MCM67M618	52	(FN) PLCC	11/14/19	BiCMOS	3Q93	Burst mode for '040/PowerPC (non-pipeline). 3.3 V I/O compatible.
	32Kx18	MCM67B518	52	(FN) PLCC	9/12/18	BiCMOS	4Q93	Burst mode for i486/Pentium. 3.3 V I/O compatible.
		MCM67M518	52	(FN) PLCC	10/14/19	BiCMOS	4Q93	Burst mode for '040/PowerPC (non-pipeline). 3.3 V I/O compatible.
	32Kx9	MCM62486A	44	(FN) PLCC	11/12/14/19/24	HCMOS	Now	Burst mode for i486 applications >50 MHz.
		MCM62486B	44	(FN) PLCC	11/12/14/19/24	HCMOS	1Q94	Replaces MCM62486A. Sampling 1Q94.
		MCM62V486B	44	(FN) PLCC	24	HCMOS	1Q94	First 3.3 V power supply burst RAM.
		MCM62940A	44	(FN) PLCC	11/12/14/19/24	HCMOS	Now	Burst Mode for '040/Power PC.
	8Kx24	MCM56824A	52	(FN) PLCC	20/25/35	HCMOS	Now	Designed for DSP56001 appl., replaces 3 8Kx8's.
Latched Address	64Kx18	MCM67A618	52	(FN) PLCC	12/15/20	BiCMOS	3Q93	General asynchronous, latched address and data.
		MCM67W618	52	(FN) PLCC	12/15/20	BiCMOS	3Q93	General asynchronous, latched address.
	16Kx16	MCM62995A	52	(FN) PLCC	15/20/25	HCMOS	Now	DSP96000 and MIPS R3000 applications. Latch on address inputs.
	8Kx20	MCM62820A	52	(FN) PLCC	17/23	HCMOS	Now	Designed for MIPS R3000 cache.
Synchronous	64Kx18	MCM67F618	52	(FN) PLCC	12/15	BiCMOS	3Q93	General CISC synchronous. Register to latch. Registered output enable. Registered chip enable. 3.3 V I/O compatible.
		MCM67P618	52	(FN) PLCC	8/10/12	BiCMOS	3Q93	General RISC, synchronous pipelined. Register to register. Registered output enable. Registered chip enable. 3.3 V I/O compatible.
	128Kx9	MCM67D709	52	(FN) PLCC	16/20	BiCMOS	4Q93	Synchronous dual I/O for 88110.
		MCM67Q709	52	(FN) PLCC	10/12	BiCMOS	1Q94	General synchronous separate I/O with write pass-through.
	256Kx4	MCM67F804	32	400 (WJ)SOJ	12/15	BiCMOS	3Q93	General synchronous; secondary cache RISC. Register to latch. Registered output enable. Revolutionary pinout. 3.3 V I/O compatible.
		MCM67P804	32	400 (WJ)SOJ	10/12	BiCMOS	3Q93	General synchronous; secondary cache RISC. Register to register. Registered output enable. Revolutionary pinout. 3.3 V I/O compatible.
		MCM67Q804	36	400 (WJ)SOJ	10/12	BiCMOS	3Q93	Graphics; general RISC. Register to register. Revolutionary pinout. 3.3 V I/O compatible. Write pass through. Separate I/O.
	16Kx16	MCM62990A	52	(FN) PLCC	15/20/25	HCMOS	Now	Designed for advanced RISC-CISC cache applications.

Table 3. Application Specific Static RAMs (continued)

Description	Organization	Motorola Part Number	Pin Count	Packaging	Access Time (ns Max)	Technology	Production	Comments
Synchronous (cont.)	32Kx9	MCM62110	52	(FN) PLCC	15/17/20	HCMOS	Now	Dual I/O's for 88110 and other multiprocessor applications.
		MCM62950A	44	(FN) PLCC	15/20/25	HCMOS	Now	General synchronous. Choice of 5 V or 3.3 V power supplies for output buffers.
	64Kx4	MCM62980	28	300 (J)SOJ	15/20	HCMOS	Now	For RISC and CISC systems; 1-stage pipeline.
		MCM62982	28	300 (J)SOJ	12/15	HCMOS	Now	Registered outputs for two stage pipeline.
	8Kx8	MCM62X308	28	300 (J)SOJ	20	HCMOS	3Q93	50 MHz FIFO line buffer.
	4Kx12	MCM62973A	44	(FN) PLCC	18/20	HCMOS	Now	Pipelined with chip select.
		MCM62974A	44	(FN) PLCC	18/20	HCMOS	Now	Pipelined with output enable.
		MCM62975A	44	(FN) PLCC	25/30	HCMOS	Now	Output enable.

Table 4. Fast Static RAM Modules (Contact Fast SRAM Marketing for Custom Fast SRAM Modules)

Description	Organization	Motorola Part Number	Pin Count	Packaging	Access Time (ns Max)	Technology	Production	Comments	
R4000 Secondary Cache Module	64Kx44	MCM4464 Series	80	(SG)SIMM	12/15/17	BiCMOS	Now	1MB cache using 4 modules, all TAG options available.	
	256Kx44	MCM44256 Series	80	(SG)SIMM	12/15/17	BiCMOS	Now	4MB cache using 4 modules, all TAG options available.	
Standard FSRAM Modules	2x32Kx36	MCM36232	76	(Z)IP	15/20	HCMOS	Now	Four bytes, with parity.	
	256Kx32	MCM32257	64	(Z)IP (SG) SIMM	20/25/35	HCMOS	Now 2Q93	Uses 1M Fast SRAMs, JEDEC standard.	
	128Kx32	MCM32128	64	(Z)IP (SG) SIMM	20/25/35	HCMOS	2Q93 Now	Industry standard, x32 family.	
	64Kx32	MCM3264A	64	(Z)IP	15/20	HCMOS	Now	Designed for 32-bit systems, JEDEC standard.	
	1Mx8	MCM81100	60	(SG)SIMM, (Z)IP	20/25/35	HCMOS	3Q93	Telecom applications.	
	256Kx8	MCM8256	60	(Z)IP	15/20	HCMOS	Now	JEDEC standard module.	
i486 Cache Module with Tag and Altered Bit	32Kx32	MCM32A32	64	(SG)SIMM	33/50 MHz	HCMOS	Now	128 KB	Compatible with Multiple i486 Chip Set; Opti, SIS, UMC, VLSI and others
	64Kx32	MCM32A64	64	(SG)SIMM	33/50 MHz	HCMOS	Now	256 KB	
	128Kx32	MCM32A128	64	(SG)SIMM	33/50 MHz	HCMOS	2Q93	512 KB	Compact dual readout SIMM.
	256Kx32	MCM32A256	64	(SG)SIMM	33/50 MHz	HCMOS	2Q93	1 MB	Jumperless cache upgrade.
Pentium Secondary Cache Module	32Kx72	MCM72PB32SG	68	(SG)SIMM	60/66 MHz	BiCMOS	3Q93	3Q93	Pentium compatible burst sequence.
	64Kx72	MCM72PB64SG	68	(SG)SIMM	60/66 MHz	BiCMOS	3Q93	3Q93	

Dynamic RAMs

Introduction

DRAMs offer the lowest cost per bit of any memory. Because of this, they are very popular for a wide range of applications, particularly for high-density memories involving very high memory capacity such as main-frame computers, personal computers, and work- stations. Motorola's dynamic RAM portfolio includes 1M, 4M and 16M devices with x1, x4, x16, and x18 organizations in fast page, nibble, and static column mode options that significantly reduce access time. These devices are also available on memory modules in densities to 64M, with or without parity and error correction.

All devices are fabricated using HCMOS technology and designed for single 5-volt power supply operation. All have $\overline{\text{CAS}}$ before $\overline{\text{RAS}}$ and $\overline{\text{RAS}}$-only refresh modes.

Table 5. Dynamic RAMs (HCMOS) (Contact DRAM Marketing)

Density	Organization	Motorola Part Number	Pin Count	Packaging Package width in mils	Address Access Time (ns Max)	Operating Current (mA Max)	Production	Comments
1M	1Mx1	MCM511000A	18, 20, 20/26	300 (P)DIP, 100 (Z)IP	70/80	80/70	Phase Out	No new customers. No orders after June93.
		MCM511000A	18, 20, 20/26	300 SO(J)	70/80	80/70	Phase Out	No new customers. Orders ltd. after Sept93.
		MCM511000A-C	18, 20, 20/26	300 (P)DIP, 100 (Z)IP, 300 SO(J)	70/80	85/75	Phase Out	No new customers. No orders after Apr/May93.
		MCM511000B	20, 20/26	100 (Z)IP, 300 SO(J)	60	90	Phase Out	No new customers. Orders ltd. after Sept93.
	256Kx4	MCM514256A	18/20, 20/26	300 (P)DIP, 100 (Z)IP, 300 SO(J)	70/80	80/70	Now	Fast page mode cycle time = 40/45/55 ns
		MCM514256A-C	18/20, 20/26	300 (P)DIP, 100 (Z)IP, 300 SO(J)	70/80	85/75	Now	Industrial temp range (– 40° to + 85° C)
		MCM514256B	20/26	100 (Z)IP, 300 SO(J)	60	90	Now	Fast page mode cycle time = 40 ns
4M	4Mx1	MCM54100A	20, 20/26	100 (Z)IP, 300 SOJ(N), 300 (T)SOP	60/70/80	120/100/85	Now	Fast page mode cycle time = 50/55/55 ns
		MCM54100A-C	20, 20/26	100 (Z)IP, 300 SOJ(N), 300 (T)SOP	70/80	100/85	Now	Industrial temp range (– 40° to + 85°C)
	1Mx4	MCM54400A	20, 20/26	100 (Z)IP, 300 SOJ(N), 300 (T)SOP	60/70/80	120/100/85	Now	Fast page mode cycle time = 45/45/50 ns
		MCM54400A-C	20, 20/26	100 (Z)IP, 300 SOJ(N), 300 (T)SOP	70/80	100/85	Now	Industrial temp range (– 40° to + 85°C)
		MCM54400A-V	20, 20/26	300 SOJ(N), 300 (T)SOP	80	60	2Q93	3.3 V fast page mode cycle time = 50 ns
	512Kx8	MCM54800A	28	400 SO(J), 400 (T)SOP	70/80	105/90	Now	Fast page mode cycle time = 45/50/60 ns
		MCM5L4800A	28	400 SO(J), 400 (T)SOP	70/80	105/90	Now	Fast page mode with low power battery backup
		MCM5V4800A	28	400 SO(J), 400 (T)SOP	70/80	105/90	Now	Fast page mode with low power self refresh
	256Kx16	MCM54170A	28	400 SO(J)	70/80/100	75/65/60	TBD	Fast page mode, 1 CAS, 2W, 1024 refresh
		MCM54260A	28	400 SO(J)	70/80/100	100/85/75	3Q93	Fast page mode, 2 CAS, 1W, 512 refresh
	256Kx18	MCM54190A	28	400 SO(J)	70/80/100	75/65/60	TBD	Fast page mode, 1 CAS, 2W, 1024 refresh
		MCM54280A	28	400 SO(J)	70/80/100	110/95/85	3Q93	Fast page mode, 2 CAS, 1W, 512 refresh
16M	4Mx4	MCM516400	24/28	400 SO(J), 400 (T)SOP	60/70/80	90/80/70	4Q93	4K refresh
		MCM517400	24/28	400 SO(J), 400 (T)SOP	60/70/80	85/100/120	4Q93	2K refresh
		MCM516400B	24/26	300 SO(J), 300 (T)SOP	50/60/70	???	4Q93	4K refresh, 5V/3.3V, Hyper Page Mode
		MCM517400B	24/26	300 SO(J), 300 (T)SOP	50/60/70	???	4Q93	2K refresh, 5V/3.3V, Hyper Page Mode

Table 6. Dynamic RAM Modules (Contact DRAM Marketing for Custom DRAM Modules)

Organization	Byte Density	Motorola Part Number	Pin Count	Packaging	Address Access Time (ns Max)	Operating Current (mA Max)	Production	Comments
256Kx8	256KB	MCM84256	30	(AS)IMM	70/80	160/140	Now	Fast page mode cycle time = 40/45 ns
1Mx8	1MB	MCM81430	30	(S)IMM	60/70/80	240/220/170	Now	Fast page mode cycle time = 40/45 ns
4Mx8	4MB	MCM84000	30	(AS)IMM	60/70/80	960/800/680	Now	Fast page mode cycle time = 45/50 ns
16Mx8	16MB	MCM81600	30	(S)IMM	60/70/80	960/800/680	4Q93	Fast page mode cycle time = 40/45/50 ns
256Kx9	256 KB with Parity	MCM94256	30	(AS)IMM	70/80	225/195	Now	Fast page mode cycle time = 40/45 ns
1Mx9	1MB with Parity	MCM91430	30	(S)IMM	60/70/80	330/280/240	Now	Fast page mode cycle time = 40/45 ns
4Mx9	4MB with Parity	MCM94000	30	(AS)IMM	60/70/80	1080/900/765	Now	Fast page mode cycle time = 45/50 ns
16Mx9	16MB with Parity	MCM91600	30	(S)IMM	60/70/80	1080/900/765	4Q93	Fast page mode cycle time = 40/45/50 ns
1Mx18	2MB with Parity	MCM18100	72	(AS)IMM, (ASG)-gold	60/70/80	240/220/170	Now	Half-populated MCM36100
2Mx18	4MB with Parity	MCM18200	72	(S)IMM, (SG)-gold	60/70/80	672/572/492	Now	Half-populated MCM36200
4Mx18	8MB with Parity	MCM18400	72	(AS)IMM, (ASG)-gold	60/70/80	720/600/510	Now	Half-populated MCM36400
8Mx18	16MB with Parity	MCM18800	72	(S)IMM, (SG)-gold	60/70/80	732/612/522	Now	Half-populated MCM36800
256Kx32	1MB	MCM32256	72	(AS)IMM, (ASG)-gold	70/80	640/560	Now	Fast page mode cycle time = 40/45 ns
512Kx32	2MB	MCM32512	72	(AS)IMM, (ASG)-gold	70/80	656/576	Now	Fast page mode cycle time = 40/45 ns
1Mx32	4MB	MCM32130	72	(SH)IMM, (SHG)-gold	60/70/80	960/800/680	Now	Fast page mode cycle time = 45/50 ns
2Mx32	8MB	MCM32230	72	(SH)IMM, (SHG)-gold	60/70/80	976/816/696	Now	Fast page mode cycle time = 45/50 ns
4Mx32	16MB	MCM32410	72	(S)IMM, (SG)-gold	60/70/80	3840/3200/2720	4Q93	Double-sided module using 4m DRAM
8Mx32	32MB	MCM32800	72	(S)IMM, (SG)-gold	60/70/80	976/816/696	4Q93	Fast page mode cycle time = 40/45/50 ns
256Kx36	1MB with Parity	MCM36256	72	(S)IMM, (SG)-gold	70/80	940/820	Now	MCM32256 with parity application
512Kx36	2MB with Parity	MCM36512	72	(S)IMM, (SG)-gold	70/80	964/844	Now	MCM32512 with parity application
1Mx36	4MB with Parity	MCM36100	72	(AS)IMM, (ASG)-gold	60/70/80	1320/1120/960	Now	MCM32130 with parity application
2Mx36	8MB with Parity	MCM36200	72	(AS)IMM, (ASG)-gold	60/70/80	1344/1144/984	Now	MCM32230 with parity application
4Mx36	16MB with Parity	MCM36400	72	(S)IMM, (SG)-gold	60/70/80	1440/1200/1020	4Q93	MCM32400 with parity application
8Mx36	32MB with Parity	MCM36800	72	(S)IMM, (SG)-gold	60/70/80	1464/1224/1044	4Q93	MCM32800 with parity application

Note: Package suffixes are enclosed by ( ) in packing column.
AS = SIMM (Board Revision)
ASG = Gold Pad SIMM (Board Revision)
L = SIP
LH = Low Height SIP
S = SIMM
SG = Gold Pad SIMM
SH = Short Height SIMM

Table 6. Dynamic RAM Modules (Contact DRAM Marketing for Custom DRAM Modules) (continued)

Organi-zation	Byte Density	Motorola Part Number	Pin Count	Packaging	Address Access Time (ns Max)	Operating Current (mA Max)	Pro-duction	Comments
256Kx40	1MB used for EDC	MCM40256	72	(AS)IMM, (ASG)-gold	70/80	800/700	Now	MCM32256 with error correction applications
512Kx40	2MB used for EDC	MCM40512	72	(AS)IMM, (ASG)-gold	70/80	820/720	Now	MCM32512 with error correction applications
1Mx40	4MB used for EDC	MCM40100	72	(AS)IMM, (ASG)-gold	60/70/80	1200/1000/850	Now	MCM32100 with error correction applications
2Mx40	8MB used for EDC	MCM40200	72	(AS)IMM, (ASG)-gold	60/70/80	1220/1020/870	Now	MCM32200 with error correction applications
4Mx40	16MB used for EDC	MCM40400	72	(S)IMM, (SG)-gold	60/70/80	1200/1000/850	4Q93	MCM32400 with error correction applications
8Mx40	32MB used for EDC	MCM40800	72	(S)IMM, (SG)-gold	60/70/80	1220/1020/870	4Q93	MCM32800 with error correction applications
1Mx72	8MB	MCM72100	100	(SG)-gold	60/70/80	2360/2000/1730	1Q93	64 bit data bus and 8 bit for EDC
2Mx72	16MB	MCM72200	100	(SG)-gold	60/70/80	2596/2236/1966	1Q93	64 bit data bus and 8 bit for EDC
4Mx72	32MB	MCM72400	100	(SG)-gold	60/70/80	2360/2000/1730	4Q93	64 bit data bus and 8 bit for EDC
8Mx72	64MB	MCM72800	100	(SG)-gold	60/70/80	2596/2236/1966	4Q93	64 bit data bus and 8 bit for EDC

Note: Package suffixes are enclosed by ( ) in packing column.
AS = SIMM (Board Revision)
ASG = Gold Pad SIMM (Board Revision)
L = SIP
LH = Low Height SIP
S = SIMM
SG = Gold Pad SIMM
SH = Short Height SIMM
SHG = Short Height Gold Pad SIMM

Table 7. General Memory Products (Contact DRAM Marketing)

Density	Organi-zation	Motorola Part Number	Pin Count	Packaging Package width in mils	Address Access Time (ns Max)	Operating Current (mA Max)	Pro-duction	Comments
2K	256Kx8	MCM2814	8	300 (P)DIP, 150 PSO(G)			Now	EEPROM, serial byte programmable, 3 V – 6 V supply read
16K	2Kx8	MCM2018A	24	300 PDIP (N)	35/45/55	135	Now	
256K	32Kx8	MCM60L256A-C	28	330 PSOG(F)	100	75	Now	Extended temp range (– 40° to + 85°C)
		MCM60L256A-V	28	330 PSOG(F)	100	75	Now	Extended temp range (– 40° to + 105°C)

TTL, ECL, CMOS and Special Logic Circuits

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In Brief . . .

Since the inception of IC technology, Motorola has earned a reputation as the supermarket for digital logic circuits. Although early circuit designs such as RTL, DTL, HTL, etc., have been largely supplanted by newer techniques, Motorola's reputation as a leading-edge supplier of standard logic families remains unchallenged.

Motorola currently concentrates on supplying those logic families and functions that advance the state-of-the-art as well as serving the needs of designers requiring interface circuits for more complex ICs and semicustom designs. It does so with three technologies:

ECL (four unique families) for high speed

TTL (two families) for high performance at lower cost

CMOS (three families), for lowest power dissipation

This selector guide contains only devices in production at Motorola's Logic I.C. Division, accurate to the date of publication.

There are numerous new devices introduced between printings of the Master Selector Guide. Therefore, the Logic Division publishes a selector guide on a quarterly basis. This selector guide, SG366/D, can be ordered from your nearest Motorola Sales Office or from the Motorola Literature Distribution Center.

The Logic I.C. Division publishes a New Product Calendar quarterly that reflects any recent device releases and the approximate dates new devices are expected to be released.

There are many new devices in various stages of development on Motorola's Logic I.C. Division's design schedule. Call your nearest Motorola Sales Office for the current status of any device not listed within this guide.

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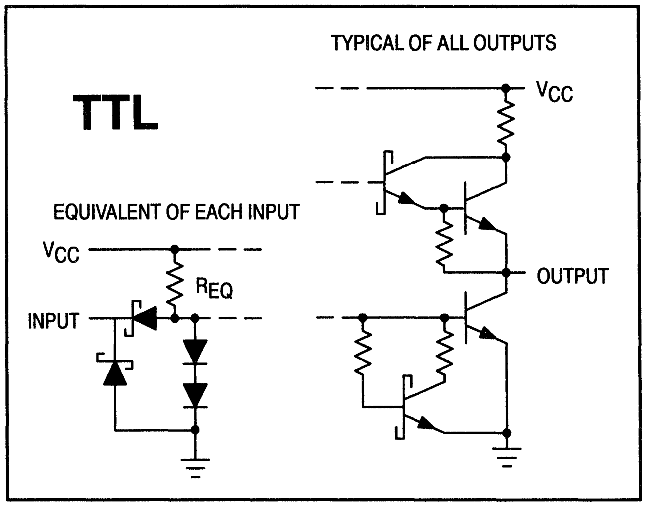


Which Logic Family Is Best for You?

By Gary Tharalson, Motorola, Inc., Mesa, AZ

Selecting a logic family for a new design from today's rapidly changing semiconductor technologies can be a perilous task. There are huge ratios between the highest and lowest values of several characteristics — for speed it's 250:1, power 83,000:1, and output drive 24:1. With the many choices available, it is easy to under- or over-supply an application with inadequate or excessive capabilities.

Logic Families

Although many family technologies are available, they can be divided into roughly three broad categories: transistor-to-transistor logic (TTL), complementary metal-oxide semiconductor (CMOS) technology, and emitter coupled logic (ECL). TTL and ECL are bipolar technologies that differ in implementation techniques while CMOS (an MOS technology) differs in fundamental transistor structure and operation.

The designation "bipolar" refers to the basic component of TTL ICs, the bipolar npn transistor. Since the output drivers and the input buffers both use transistors, there is a direct transistor-to-transistor connection. Older technologies were interconnected via passive components like resistors and diodes.

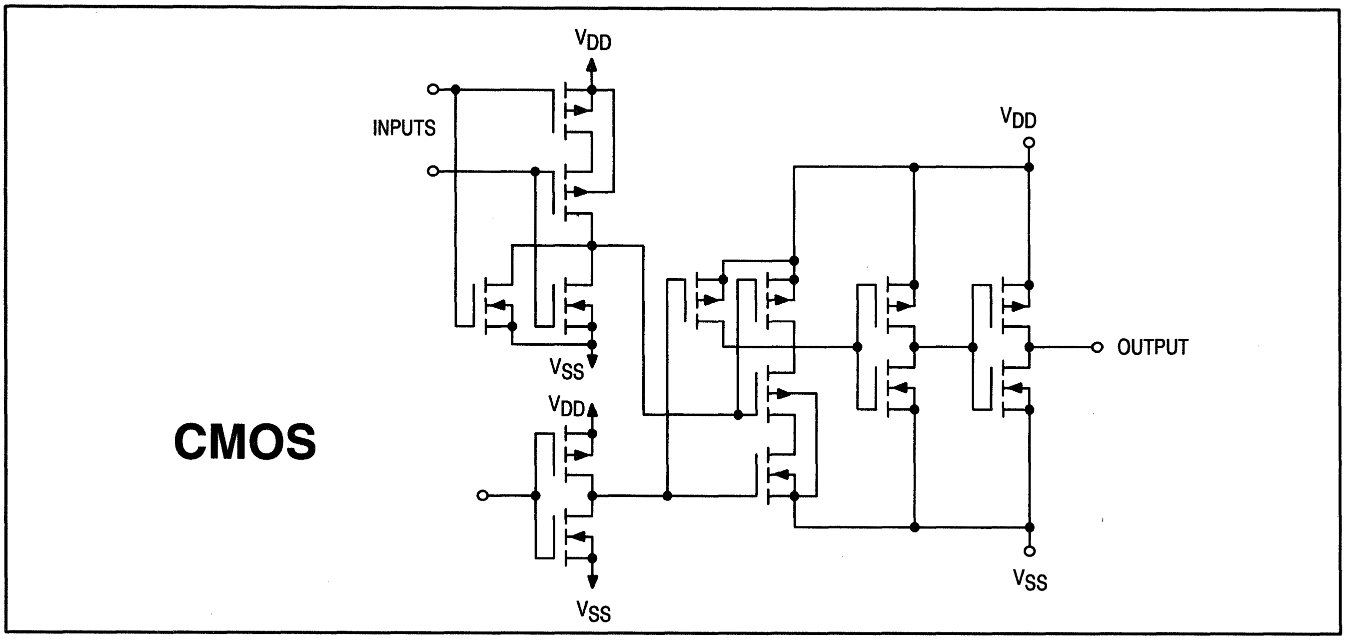
Since the original TTL design, several enhancements have reduced power and increased speed. Common to these has been the use of Schottky diodes, which, ironically, no longer result in strictly TTL connections. The two names, Schottky and TTL, are used in combination: LS (Low power Schottky), ALS (Advanced Low power Schottky), and National Semiconductor's FAST (Advanced Schottky) TTL.

The outstanding characteristics of TTL compared to CMOS in the past have been its higher speed, output drive, and transistor gain. These advantages are rapidly diminishing.

CMOS field-effect transistors differ from bipolar transistors both in structure and operation. The primary advantages of CMOS are its low power dissipation and small physical geometry. Recent advances in design and fabrication have brought CMOS devices into the same speed and output drive arena as TTL. Again, enhancements have resulted in additional classifications: MG (Metal-Gate CMOS), HC (High-speed silicon gate CMOS), and National Semiconductor's FACT (Advanced CMOS).

ECL derives its name from the common differential-amplifier configuration in which one side of the diff-amp consists of multiple input bipolar transistors with their emitters tied together. An input bias on the opposite side of the diff-amp causes the amplifier to operate continuously, rather than saturating high or low. Consequently, ECL consumes a lot of power in either state but results in the fastest switching speeds of all the logic families listed in the *table*, "Characteristics of Logic Families."

There have also been many evolutionary advancements in ECL. Three of the most recent families are 100K (1975), 10H (1981), and Motorola's ECLinPS (1987).



Speed

Speed is typically the first specification designers look at. When they are asked what features of a logic family they would like enhanced, usually they want more speed. But increased speed often brings potential problems, including increased noise generation, higher power consumption, increased component and system cost, and more difficult board layout. Obviously, the other family characteristics must be considered.

In the table, family speed is compared using typical values for three specs: propagation delay through a simple gate, flip-flop toggle frequency, and output switching time. Typical values can be misleading because they are frequently specified according to different vendors' criteria, but they are usually an average of minimum and maximum values.

For a final assessment of a particular component's performance, the minimum/maximum specifications in most vendors' data books should be examined. Furthermore, the switching (edge) rate is highly load dependent. Once again, data book specifics must be compared.

Power Consumption

The amount of power an application consumes and the heat generated are frequently of prime importance. Power dissipation, one of the major differences between the three families, may limit the designer's choices.

TTL power consumption is moderate and constant over operating frequencies up to about 10 MHz. It then begins to climb rapidly. Although only a few milliwatts are consumed by each device, a complete system may use substantial power.

CMOS power consumption, on the other hand, is highly frequency dependent. At quiescent (zero frequency), it consumes almost no power at all, measured in microwatts per device. However, its consumption grows almost linearly with frequency, so at maximum operating frequency it may be several milliwatts per device. The great power advantage of CMOS derives from the fact that in most applications, most of the devices will not be operating at high frequencies at any given time. Consequently, the average system power is greatly diminished.

Because of its inherent design, ECL consumes the most power at frequencies below about 30 MHz. However, at higher frequencies, TTL and CMOS can consume more. The power used by ECL is fairly constant over its entire operating frequency range. Designers of large, high-performance ECL systems may have to use more complex cooling and power distribution techniques.

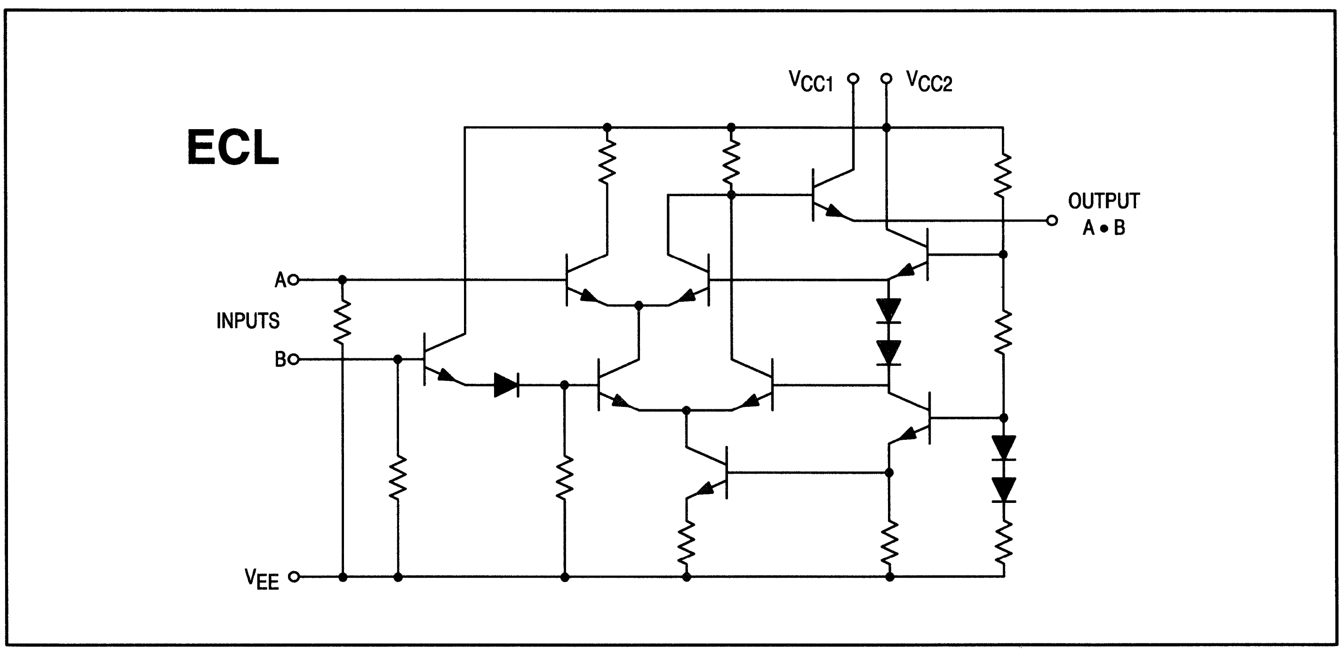
Characteristics of Logic Families

Typical Commercial Parameter (0°C To +70°C)	Logic Families								
	TTL			CMOS			ECL		
	LS	ALS	FAST	MG	HC	FACT	10H	100K	ECLinPS***
Speed									
OR gate propagation delay (t_{PLH}) (ns)	9	7	3	65	8	5	1	0.75	0.33
D flip-flop toggle rate (MHz)	33	45	125	4	45	160	330	400	1,000
Output edge rate (ns)	6	3	2	50	4	2	1	0.7	0.5
Power Consumption Per Gate (mW)									
Quiescent	5	1.2	12.5	0.0006	0.003	0.003	25	50	25
Operating (1 MHz)	5	1.2	12.5	0.04	0.6	0.8	25	50	25
Supply Voltage (V)	+4.5 to +5.5	+4.5 to +5.5	+4.5 to +5.5	+3 to +18	+2 to +6	+2 to +6	– 4.9 to – 5.5	– 4.2 to – 4.8	– 4.9 to – 5.5/ – 4.2 to – 4.8
Output Drive (mA)	8	8	20	1	4	24	50-Ω load	50-Ω load	50-Ω load
DC Noise Margin (%)*									
High Input	22	22	22	30	30	30	27	41	28/41
Low Input	10	10	10	30	30	30	31	31	31/31
Packaging									
DIP	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
SO	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
PLCC	No	Yes	Yes	No	No	Yes	Yes	No	Yes
Functional Device Types	190	210	110	123	103	80**	85	44	30
Relative 1-25 Quantity Price/Gate	0.9	1	1	0.9	0.9	1.5	2	10	28

* Typical noise margin expressed as a percentage of typical output voltage swing.
** Combined Motorola and National Semiconductor Corp. offering.
*** ECLinPS is available in both 10H- and 100K-compatible versions.

Manufacturers Referenced:

(LS) Motorola Low power Schottky TTL
(ALS) Texas Instruments Advanced Low
(FAST) Motorola Advanced Schottky TTL
(MG) Motorola 14000 Series Metal Gate CMOS
(HC) Motorola High-speed silicon gate CMOS
(FACT) Motorola Advanced CMOS
(10H) Motorola 10H Series ECL
(100K) National 100K Series ECL
(ECLinPS) Motorola advanced ECL



Supply Voltage

The power supply voltage required for TTL and ECL is restricted to fixed values. Only a narrow voltage variation is allowed for the device to remain within specifications. Since these families also consume substantial amounts of power, there is a large current flow through the power lines.

To avoid unacceptable voltage fluctuation, various preventive measures may be necessary, such as remote sensing of the supply regulator, heavy power buses and filters, and multilayer pc boards with separate power and ground planes. Typically, a high-speed energy-storage capacitor is required near each logic device. That capacitor maintains the correct device voltage during high current switching.

An important advantage of CMOS is the large range of supply voltage over which operation is specified, particularly at lower values. By allowing systems to be operated at voltages as low as 2 to 3V, not only is power consumption lowered but noise generation from fast signal switching is reduced. In similar fashion, the narrow switching level swings of ECL (about 800 mV) helps to moderate its noise generation.

Output Drive

An important characteristic of a logic device is its ability to drive relatively large loads directly. This eliminates the requirement for special interface buffers. The older families within TTL and especially CMOS had only limited drive capability (below 10mA). All of the advanced logic family versions have significantly increased drive capacity. Several (FACT and all ECL) are capable of driving 50-Ω transmission lines directly. Furthermore, because of the symmetrical sink/source capability of FACT, its rise and fall times are nearly equal, resulting in balanced delay times.

Noise Margin

Noise immunity refers to the resistance of a logic device to undesired switching. Depending on the input level, a noise glitch that causes a transient large enough to cross the input switch point can result in erroneous operation. Clearly, the larger the voltage difference between the switch point and the normal input high and low levels, the more the immunity to erroneous switching. In the table, these differences are expressed as a percentage of the swing between typical output high- and low-voltage logic levels.

The venerable dual-in-line package (DIP) has been, and still is, very popular. One reason is the ease with which prototype circuits using it can be fabricated and debugged. Particularly prominent is that an industry standard pinout arrangement, which puts power and ground on the end pins, has been adopted for all the TTL and CMOS families in the accompanying table.

Package Standardization

This standard package not only eases design procedures but also simplifies final production testing. This same standardization has been carried over to the new small-outline (SO) package for surface mounting. The SO package averages about 70% smaller in footprint than a DIP.

Fast switching of several outputs simultaneously (such as on an octal interface device) may result in a phenomenon called “ground bounce” voltage. This results partially from ground path current flow through internal lead inductance, and from the interaction between internal input and output ground paths.

Although present ground bounce voltage is well below CMOS trigger levels, TTL input devices may require special consideration. A number of approaches to internal circuit and package design have been developed to reduce ground current effects. Indications are that ground bounce will soon be reduced to nominal levels.

More Devices, Less Space

Lower product costs can result from packing more logic devices into less pc board space and then using automation to assemble and test the product. This opportunity is vastly enhanced by the ability of present technology to supply thousands of identical surface-mounting packages on a single large tape-and-reel for high-speed pick-and-place machines. A user’s package preference — SO or PLCC — is dictated mainly by the available production assembly capabilities.

Package material has also benefited from improvements in manufacturing technology. Thus, the majority of packages that are shipped today (for commercial applications) are constructed from relatively inexpensive plastic material.

Mix and Match

Many designers have found that the best approach to achieving their particular application performance goal is to combine devices from several families. This is particularly easy in the TTL and CMOS families because of their industry-standard pinouts, particularly for power and ground.

The obvious advantage of mixing and matching is to optimize the requirements of selected portions of a design, whether for speed, power consumption, output drive, or cost. Some disadvantages are that devices must be analyzed and tested for compatibility, inventories may increase, and some performance parameters may be compromised.

— *Reprinted from Electronic Products, May 1989.*

Selection by Function

Special Logic Circuits

Table 1. ALExIS — Advance Low-Power Expandable Interface Solutions

Function	Device	Family
Buffer		
20-Bit Buffer (3-State, Non-Inverting)	MC20LX244	BiCMOS
Flip-Flop		
20-Bit D Type Flip-Flop (3-State, Non-Inverting)	MC20LX374	BiCMOS
Transceiver		
20-Bit Transceiver (3-State, Non-Inverting)	MC20LX245	BiCMOS
Latch		
20-Bit Transparent Latch (3-State, Non-Inverting)	MC20LX373	BiCMOS

Table 2. Timing Solutions

Function	Device	Family
Clock Drivers		
1:2 Differential Clock Driver	MC10/100EL11	ECLinPS Lite
1:6 Differential Clock Distribution Chip	MC10/100E211	ECLinPS
1:9 Differential Clock Driver With Low Skew, Enable, V_{bb}	MC10/100E111	ECLinPS
1:9 TTL-TTL Clock Distribution Chip	MC10H645	MECL 10H
68030/040 PECL/TTL-TTL Clock Driver (Single @ 5.0 V)	MC10/100H640	MECL 10H
68030/040 PECL/TTL-TTL Clock Driver (Similar to H640)	MC10/100H642	MECL 10H
68030/040 PECL/TTL-TTL Clock Driver	MC10/100H644	MECL 10H
Clock Driver, Quad D-Type Flip-Flop, With Matched Propagation Delays	MC74F1803	FAST
Clock Driver, Quad D-Type Flip-Flop, With Matched Propagation Delays	MC74F803	FAST
Dual Supply ECL/TTL 1:8 Clock Driver	MC10/100H643	MECL 10H
Low Skew CMOS Clock Driver	MC88913	CMOS
Low Skew CMOS Clock Driver With Reset	MC88914	CMOS
Low Skew CMOS PLL Clock Driver	MC88915*55	CMOS
Low Skew CMOS PLL Clock Driver	MC88915*70	CMOS
Single Supply PECL/TTL 1:9 Clock Distribution Chip	MC10/100H641	MECL 10H
Programmable Delay Chips		
Programmable Delay Chip (Dig. 20ps Anal. Ps/mv)	MC10/100E196	MECL
Programmable Delay Chip (Digitally Selectable 20ps Res.)	MC10/100E195	MECL

Special Logic Circuits (continued)

Table 2. Timing Solutions (continued)

Function	Device	Family
Translators		
9-Bit ECL-TTL Translator	MC10H601 MC100H601	MECL 10H
9-Bit Latch/ECL-TTL Translator	MC10H603 MC100H603	MECL 10H
9-Bit Latch/TTL-ECL Translator	MC10H602 MC100H602	MECL 10H
9-Bit TTL-ECL Translator	MC10H600 MC100H600	MECL 10H
ECL-to-TTL Translator (Single P.S. @+ 5.0V)	MC10H350	MECL 10H
Hex MECL 10K-to-MST Translator	MC10191	MECL 10K
Hex TTL OR CMOS to CMOS Hex Level Shifter	MC14504B	CMOS
Quad CMOS-to-ECL Translator (Single P.S. @+ 5.0V)	MC10H352	MECL 10H
Quad MECL-to-TTL Translator	MC10H125	MECL 10H
Quad MECL-to-TTL Translator	MC10125	MECL 10K
Quad MST-to-MECL 10K Translator	MC10190	MECL 10K
Quad TTL/NMOS-to-PECL Translator (Single P.S. @+ 5.0V)	MC10H351	MECL 10H
Quad TTL-to-MECL Translator, With TTL Strobe Input	MC10H124	MECL 10H
Quad TTL-to-ECL Translator (ECL Strobe)	MC10H424	MECL 10H
Quad TTL-to-MECL Translator	MC10124	MECL 10K
Triple MECL-to-NMOS Translator	MC10177	MECL 10K
Registered Hex ECL/TTL Translator	MC10/100H605	MECL 10H
Registered Hex TTL/PECL Translator	MC10/100H606	MECL 10H
Registered Hex PECL/TTL Translator	MC10/100H607	MECL 10H
CBM		
Carrier Band Modem	MC68194	MECL
SCSI Bus Terminator		
9-Bit Switchable Passive SCSI Bus Terminator (220Ω to 330Ω)	MCCS142233	CMOS
9-Bit Switchable Active SCSI Bus Terminator (110Ω)	MCCS142234	CMOS
18-Bit Active SCSI Bus Terminator (Also Available in 32-Pin QFP Package)	MCCS142235	CMOS
Memory Support		
Quad Dual Output ECL-TTL DRAM Driver With Latch	MC10/100H660	MECL 10H
Industrial Control Unit		
Industrial Control Unit	MC14500B	CMOS
Bounce Eliminator		
Hex Contact Bounce Eliminator	MC14490	CMOS

Special Logic Circuits (continued)

Table 3. Phase-Locked Loop

Function	Device	Temperature Range
Prescalers		
1.1GHz ÷2 Low Power Prescaler with Stand-By Mode	MC12083	–40° to +85°C
1.1GHz ÷256 Prescaler	MC12074	0° to +70°C
1.1GHz ÷32/33, ÷64/65 Dual Modulus Prescaler	MC12028A	–40° to +85°C
1.1GHz ÷32/33, ÷64/65 Dual Modulus Prescaler	MC12028B	–40° to +85°C
1.1GHz ÷64 Prescaler	MC12073	0° to +70°C
1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	MC12022A	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	MC12022B	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	MC12022SLA	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	MC12022SLB	–40° to +85°C
1.1GHZ ÷64/65, ÷128/129 Dual Modulus Prescaler	MC12022TSA	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	MC12022TSB	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler with Stand-By Mode	MC12036A	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler with Stand-By Mode	MC12036B	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	MC12022LVA	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	MC12022LVB	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	MC12022TVA	–40° to +85°C
1.1GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	MC12022TVB	–40° to +85°C
1.3GHz ÷256 Prescaler	MC12076	0° to +85°C
1.3GHz ÷256 Prescaler	MC12078	0° to +85°C
2.0GHz ÷32/33, ÷64/65 Dual Modulus Prescaler	MC12034A	–40° to +85°C
2.0GHz ÷32/33, ÷64/65 Dual Modulus Prescaler	MC12034B	–40° to +85°C
2.0GHz ÷32/33, ÷64/65 Low Voltage Dual Modulus Prescaler	MC12033A	–40° to +85°C
2.0GHz ÷32/33, ÷64/65 Low Voltage Dual Modulus Prescaler	MC12033B	–40° to +85°C
2.0GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	MC12032A	–40° to +85°C
2.0GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	MC12032B	–40° to +85°C
2.0GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	MC12031A	–40° to +85°C
2.0GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	MC12031B	–40° to +85°C
225MHz ÷20/21 Dual Modulus Prescaler	MC12019	–40° to +85°C
225MHz ÷32/33 Dual Modulus Prescaler	MC12015	–40° to +85°C
225MHz ÷40/41 Dual Modulus Prescaler	MC12016	–40° to +85°C
225MHz ÷64 Prescaler	MC12023	0° to +75°C
225MHz ÷64/65 Dual Modulus Prescaler	MC12017	–40° to +85°C
480MHz ÷5/6 Dual Modulus Prescaler	MC12009	–30° to +85°C
520MHz ÷128/129 Dual Modulus Prescaler	MC12018	–40° to +85°C
520MHz ÷64/65 Dual Modulus Prescaler	MC12025	–40° to +85°C
550MHz ÷10/11 Dual Modulus Prescaler	MC12013	–30° to +85°C
550MHz ÷8/9 Dual Modulus Prescaler	MC12011	–30° to +85°C
750MHz ÷2 UHF Prescaler	MC12090	0° to +75°C

Table 3. Phase-Locked Loop (continued)

Function	Device	Temperature Range
Oscillators		
Crystal Oscillator	MC12061	0° to +75°C
Low Power Voltage Controlled Oscillator	MC12148	–40° to +85°C
Mixer		
Analog Mixer	MC12002	–30° to +85°C
Detectors		
Phase-Frequency Detector	MC4044	0° to +75°C
Phase-Frequency Detector	MC4344	–55° to +125°C
Phase-Frequency Detector	MC12040	0° to +75°C
Phase-Frequency Detector	MCH12140	–40° to +70°C
Phase-Frequency Detector	MCK12140	–40° to +70°C
Phase-Locked Loop		
Phase-Locked Loop	MC14046B	–55° to +125°C
Counters		
Counter Control Logic	MC12014	0° to +75°C
Phase Comparator and Programmable Counter	MC14568B	–55° to +125°C
Programmable Modulo-N Counters (N=0-9)	MC4016	0° to +75°C
Programmable Modulo-N Counters (N=0-9)	MC4018	0° to +75°C
Programmable Modulo-N Counters (N=0-9)	MC4316	–55° to +125°C
Multivibrators		
130MHz Voltage Controlled Multivibrator	MC12101	0° to +75°C
200 MHz Voltage Controlled Multivibrator	MC12100	0° to +75°C
Dual Voltage-Controlled Multivibrator	MC4024	0° to +75°C
Dual Voltage-Controlled Multivibrator	MC4324	–55° to +125°C

Selection by Function

Table 4. Cross-Functional Table

Function	TTL		CMOS			MECL		
	LS	FAST	STD	High Speed	FACT	10K	10H	ECLinPS E-Lite
AND Gates								
Quad 2-Input	08	08	081	08A	08	104	104	
Quad 2-Input, Open-Collector	09							
Triple 3-Input	11	11	073	11	11			
Triple 3-Input, Open-Collector	15							
Dual 4-Input	21	21	082					
Hex						197		
NAND Gates								
Quad 2-Input	00	00	011	00A	00			
Quad 2-Input, Open-Collector	01							
Quad 2-Input, Open-Collector	03			03A				
Quad 2-Input, High-Voltage	26							
Quad 2-Input Buffer	37	37						
Quad 2-Input Buffer, Open-Collector	38	38						
13-Input	133			133				
Triple 3-Input	10	10	023	10	10			
Triple 3-Input, Open-Collector	12							
Dual 4-Input	20	20	012	20	20			
Dual 4-Input, Open-Collector	22							
Dual 4-Input Buffer	40	40						
8-Input	30		068	30				
OR Gates								
Quad 2-Input	32	32	071	32A	32	103	103	
Dual 3-Input 3-0utput						110		
High-Speed Dual 3-Input 3-0utput						210	210	
Triple 3-Input			075	4075				
Dual 4-Input			072					
NOR Gates								
Quad 2-Input	02	02	001	02A	02	102	102	
Quad 2-Input Buffer	28							
Quad 2-Input Buffer, Open-Collector	33							
Dual 5-Input	260							
Triple 3-Input	27		025	27				
Quad 2-Input With Strobe						100	100	
Triple 4-3-3 Input						106	106	
Dual 3-Input 3-0utput						111		
High-Speed Dual 3-Input 3-0utput						211	211	
Dual 3-Input, Plus Inverter			000					
Dual 4-Input			002	4002				
8-Input			078					

Table 4. Cross-Functional Table (continued)

Function	TTL		CMOS			MECL		
	LS	FAST	STD	High Speed	FACT	10K	10H	ECLinPS E-Lite
Exclusive OR Gates								
Quad 2-Input	86	86	070	86	86	113	113	
Quad 2-Input	386							
Quad, Open-Collector	136							
Exclusive NOR Gates								
Quad, 2-Input Open Drain Output	266		077					
Quad, 2-Input				7266	810			
Complex Gates								
Quad OR/NOR						101	101	
Triple 2-3-2 Input OR/NOR						105	105	
Triple 2-Input Exclusive OR/Exclusive NOR						107	107	
Dual 4-5 Input OR/NOR						109	109	
Dual 4-5 Input OR/NOR							209	
Dual 2-Wide 2-3 Input OR-AND/OR-AND-Invert						117	117	
Dual 2-Wide 3-Input OR-AND						118	118	
4-Wide 4-3-3-3 Input OR-AND Gate						119	119	
OR-AND/OR-AND-INVERT Gate						121	121	
High-Speed Dual 3-Input 3-0utput OR/NOR						212		
Dual 4-Input OR/NOR								
Dual AND-OR-INVERT Gate	51	51	506	51				
3-2-2-3 Input AND-OR-INVERT Gate	54							
2-Wide and 4-Input AND-OR-INVERT Gate	55							
4-2-2-3 Input AND-OR-INVERT Gate		64						
Triple Gate (Dual 4-Input NAND Gate and 2-Input NOR/OR Gate or 8-Input AND/NAND Gate)			501					
4-Bit AND/OR Selector (Quad 2-Channel Data Selector or Quad Exclusive NOR Gate)			519					
Dual 5-Input Majority Logic Gate			530					
Hex Gate (Quad Inverter plus 2-Input NOR Gate plus 2-Input NAND Gate)			572					
2-Wide, 2-Input/2-Wide, 3-Input AND-OR Gate				58				
Quint 2-Input AND-OR								E104 EL04
Quint 2-Input XOR-OR								E107 EL07
Quad Differential AND-NAND								E404 EL05
Quad 4-Input OR-NOR								E101 EL01
8-Input OR-NOR				4078				

Table 4. Cross-Functional Table (continued)

Function	TTL		CMOS			MECL		
	LS	FAST	STD	High Speed	FACT	10K	10H	ECLinPS E-Lite
Inverters/Buffers (2-State)								
Hex Inverter	04	04	069	04A	04			
Hex Inverter, Open-Collector	05				05			
Dual Complementary Pair Plus Inverter			007					
Hex Buffer, Non-Inverting			050	4050				
Strobed Hex Inverter/Buffer			502					
Hex Buffer With Enable						188	188	
Hex Inverter With Enable						189	189	
Hex Inverter/Buffer			049	4049		195		
Hex Unbuffered Inverter			49U	U04				
9-Bit Buffer								E122
Quad Driver								E112 EL12
Translators								
Quad TTL to MECL, TTL Strobe						124	124	
Quad TTL to MECL, ECL Strobe							424	
Quad MECL to TTL						125	125	
Quad PECL to TTL, Single Supply							350	
Quad TTL/NMOS to PECL							351	
Quad CMOS to PECL							352	
TTL or CMOS to CMOS Hex Level Shifter			504					
Quad MST-to-MECL 10,000						190		
Hex MECL 10K to MST Translator						191		
9-Bit TTL-ECL Translator							600	
9-Bit ECL-TTL Translator							601	
9-Bit Latch/TTL-ECL Translator							602	
9-Bit Latch/ECL-TTL Translator							603	
Registered Hex ECL-TTL Translator							605	
Registered Hex PECL-TTL Translator							607	
Bus-Oriented 3-State Circuits								
Quad Buffer, Low Enable, 3-State	125A	125		125A	125			
Quad Buffer, High Enable, 3-State	126A	126		126A	126			
Octal Bus/Line Driver, Inverting, 3-State	240	240		240	240			
Octal Bus/Line Driver, 3-State	241	241		241	241			
Quad Bus Transceiver, Inverting 3-State	242	242		242				
Quad Bus Transceiver, Noninverting, 3-State	243	243						
Octal Driver, Noninverting, 3-State	244	244		244A	244			
Octal Bus Transceiver, Noninverting, 3-State	245	245		245A	245			
Hex Buffer, Common Enable, 3-State	365A	365		365				
Hex Inverter, Common Enable, 3-State	366A	366		366				

Table 4. Cross-Functional Table (continued)

Function	TTL LS	TTL FAST	CMOS STD	CMOS High Speed	CMOS FACT	MECL 10K	MECL 10H	MECL ECLinPS E-Lite
Bus-Oriented 3-State Circuits (continued)								
Hex Buffer, 4-Bit and 2-Bit, 3-State	367A	367	503	367				
Hex Inverter. 4-Bit and 2-Bit, 3-State	368A	368		368				
Octal Buffer (81LS95), 3-State	795							
Octal Buffer (81LS96), 3-State	796							
Octal Buffer (81LS97), 3-State	797							
Octal Buffer (81LS98), 3-State	798							
Octal Buffer/Line Driver, 3-State	540			540	540			
Octal Buffer/Line Driver, 3-State	541			541	541			
Octal Bus Transceiver, Inverting, 3-State	640	640		640A	640			
Octal Bus Transceiver, Noninverting, 3-State	645							
Octal Transceiver With Storage, 3-State	623	623						
Octal Transceiver/Latch/Multiplexer. Noninverting, 3-State		646		646	646			
Octal Transceiver/Latch/Multiplexer. Inverting, 3-State		648			648			
Dual Latching Bus Driver						128		
Octal Bidirectional Transceiver With 3-State Outputs					620 623 643			
Octal Bus Transceiver/Register Non-Inverting With 3-State Outputs					652			
Octal Registered Transceiver Non-Inverting, With 3-State Outputs		543						
Octal Registered Transceiver Inverting, With 3-State Outputs		544						
Octal Bus Transceiver/Inverting, With 3-State Outputs		620						
Octal Bus Transceiver With Parity Generator Checker, With 3-State Outputs		657A 657B						
Octal Bus Transceiver, Lite Load F245, With 3-State Outputs		1245						
10-Bit Buffer/Line Driver (Non-Inverting), With 3-State Outputs		827						
10-Bit Buffer/Line Driver (Inverting), With 3-State Outputs		828						
Bus Drivers (25Ω Outputs)								
Triple 4-3-3 Input						123	123	
Quad Driver/Receiver With 2-1 Output Multiplexer							330	
Dual Driver/Receiver With 4-to-1 Output Multiplexers							332	
Quad Driver/Receiver With Transmit and Receiver Latches							334	
Triple 3-Input Driver With Enable							423	
3-Bit Registered Transceiver								E336
3-Bit Scannable Registered Transceiver								E337

Table 4. Cross-Functional Table (continued)

Function	TTL		CMOS			MECL		
	LS	FAST	STD	High Speed	FACT	10K	10H	ECLinPS E-Lite
Transceivers								
Octal Bus, Noninverting, Open-Collector	641							
Octal Bus, Inverting, Open-Collector	642							
Quad Futurebus Backplane, 3-State, Open-Collector		3893A						
Quad TTL-ECL 25Ω Bus Transceiver							680	
6-Bit 50Ω ECL-TTL Transceiver							681	
Schmitt Triggers								
Quad 2-Input NAND	132	132	093	132A	132			
Dual			583					
Dual 4-Input	13	13						
Hex	14	14	584 106	14A	14			
Latches								
4-Bit Bi-Stable Latch With Q and $\overline{Q}$	75		042	75				
4-Bit Bi-Stable Latch	77							
Octal Transparent Latch, 3-State, Noninverting	373	373		373A	373			
Quad Latch	375					168		
Quad NAND R-S Latch	279		044					
8-Bit Addressable Latch (9334)	259	259	099	259	259			
Dual 4-Bit Addressable Latch	256	256			256			
Octal Transparent Latch, 3-State				573 563	573 563			
Octal Transparent Latch, 3-State, Inverting		533			533			
Dual Latch						130	130	
Quad (Negative Transition) Latch						133		
Quad (Positive Transition) Latch						153		
Quint Latch						175	175	
Quad NOR R-S Latch			043					
Dual 4-Bit Latch			508					
8-Bit, Bus-Compatible, 3-State Latches, Binary Address			598					
8-Bit Addressable Latch With Bidirectional Port			599					
6-Bit D								E150
9-Bit With Parity								E175
3-Bit, 4:1 MUX								E256
3-Bit, 4:1 MUX								E156
5-Bit, 2:1 MUX								E154
6-Bit, 2:1 MUX								E155

Table 4. Cross-Functional Table (continued)

Function	TTL		CMOS			MECL		
	LS	FAST	STD	High Speed	FACT	10K	10H	ECLinPS E-Lite
Flip-Flops/Registers								
Dual J-K	73A		027	73				
Dual D	74A	74	013	74A	74	131	131	
Dual J-K With Set and Reset	76A					135	135	
Dual J-K With Preset	109A	109		109	109			
Dual J-K With Clear	107A			107				
Dual J-K Edge-Triggered	112A	112		112				
Dual J-K Edge-Triggered	113A							
Dual J-K Edge-Triggered	114A							
4-Bit D Register, 3-State	173		076	173				
Hex D With Clear	174	174	174	174A	174			
Hex D With Enable	378	378			378			
Quad D With Clear	175	175	175	175				
Octal D With Clear	273			273A	273			
Octal D, 3-State	374	374		374A	374			
Octal D With Enable	377	377			377			
4-Bit D With Enable	379	379						
Hex D						176	176	
Hex D Master-Slave With Reset						186	186	
Octal D, Inverting, 3-State				564	564			
Octal D, 3-State		574		574A	574			
High-Speed Dual Type D Master-Slave						231		
Octal D Flip-Flop, 3-State		534		534A	534			
3-Bit Differential D Flip-Flop								E431
4-Bit D Flip-Flop								E131 EL31
6-Bit D Register								E151 EL51
6-Bit D Register, Differential Data and Clock								E451
6-Bit, 2:1 MUX Register								E167
5-Bit Differential D Register								E452 EL52
9-Bit Hold Register								E143
J-K Flip-Flop								EL35
Counters								
Decade	90							
Divide-By-12	92							
4-Bit Binary	93					154		
Decade, Asynchronously Presettable	196							
4-Bit Binary, Asynchronously Presettable	197							
BCD Decade, Asynchronously Reset	160A	160A	160	160	160			

Table 4. Cross-Functional Table (continued)

Function	TTL		CMOS			MECL		
	LS	FAST	STD	High Speed	FACT	10K	10H	ECLinPS E-Lite
Counters (continued)								
4-Bit Binary, Asynchronous Reset	161A	161A	161	161A	161	178	016	
BCD Decade, Synchronous Reset	162A	162A	162	162	162			
4-Bit Binary, Synchronous Reset	163A	163A	163	163A	163			
Up/Down Decade, With Clear	192		510					
Up/Down Binary, With Clear	193		516					
Up/Down Decade	190				190			
Up/Down Binary	191		029			136	136	
Decade (Divide By 2 and 5)	290					138		
4-Bit Binary	293							
Dual Decade	390		518	390				
Dual 4-Bit Binary	393		520	393				
Dual Decade	490							
Decade Up/Down, 3-State		568						
Binary Up/Down, 3-State	569A	569						
Synchronous 4-Bit Up/Down Binary	669							
Up/Down Decade	168	168						
Up/Down Binary	169	169						
Programmable Decade			522					
Programmable Binary			526					
Universal Decade BCD						137		
Seven-Stage Ripple Counter			024	4024				
Decade Counter/Divider			017	4017				
Presentable Divide-by-N			018					
14-Bit Binary Counter/Divider			060	4060				
12-Bit Binary			040	4040	4040			
14-Bit Binary			020	4020	4020			
Octal Counter/Divider			022					
Dual Programmable BCD/Binary			569					
Three-Digit BCD			553					
Real Time 5-Decade			534					
8-Bit Bidirectional Binary Counter, With 3-State Outputs		579 779						
Industrial Time Base Generator			566					
8-Bit Synchronous Binary Up Counter								E016
6-Bit Universal Counter								E136
8-Bit Ripple Counter								E137
8-Bit Bidirectional Binary Counter		269						

Table 4. Cross-Functional Table (continued)

Function	TTL		CMOS			MECL		
	LS	FAST	STD	High Speed	FACT	10K	10H	ECLinPS E-Lite
Register Files								
4 x 4 Register File, Open-Collector	170							
4 x 4 Register File, 3-State	670							
16 X 4-Bit Register File						145	145	
Shift Register								
8-Bit Serial-In/Parallel-Out Shift Register	164	164		164				
8-Bit Parallel-In/Serial-Out Shift Register	165		021	165				
4-Bit Shift Register	95B							
8-Bit Parallel-In/Serial-Out Shift Register	166		014					
4-Bit Shift Register	195A	195		195				
4-Bit Universal Shift Register	194A	194	194	194	194	141	141	
8-Bit Shift/Storage Register, 3-State	299	299	094	299	299			
8-Bit Shift Register With Sign Extend, 3-State	322A							
8-Bit Shift/Storage Register, 3-State	323	323			323			
4-Bit Shift Register, 3-State	395							
4-Bit Shifter, With 3-State Outputs		350			350			
18-Bit Static Shift Register			006					
1-to-64 Bit Variable Length Shift Register			557					
Dual 64-Bit Static Shift Register			517					
4-Bit Parallel-In/Parallel-Out Shift Register			035					
Dual 4-Bit Static Shift Register			015					
128-Bit Static Shift Register			562					
8-Bit Parallel to Serial S.R. With Input Latches, 3-State				589				
8-Bit Serial to Parallel S.R. 3-State				595A				
8-Bit Parallel to Serial S.R. With Input Latches				597				
8-Bit Shift Register								E141
9-Bit Shift Register								E142
8-Bit Scannable Register								E241
3-Bit Scannable Registered Address Driver								E212
8-Bit Successive Approximation Register			549 559					
Multiplexers/Data Selectors								
Quad 2-Input Multiplexer, Noninverting	157	157A	519	157A	157	158	158	
Quad 2-Input Multiplexer, Inverting	158	158A			158	159	159	
Quad 2-Input Multiplexer, Noninverting, 3-State	257B	257A		257	257			
Quad 2-Input Multiplexer, Inverting, 3-State	258B	258A			258			
Quad 2-Multiplexer, With Output Register	298					173	173	
Dual 4-Input Multiplexer	153	153	539	153	153	174	174	
Dual 4-Input Multiplexer, 3-State	253	253		253	253			
8-Input Multiplexer	151	151		151	151	164	164	

Table 4. Cross-Functional Table (continued)

Function	TTL LS	TTL FAST	CMOS STD	CMOS High Speed	CMOS FACT	MECL 10K	MECL 10H	MECL ECLinPS E-Lite
Multiplexers/Data Selectors (continued)								
8-Input Multiplexer, 3-State	251	251	512	251	251			
Dual 4-Input Multiplexer (Inverting LS153)	352	352			352			
Dual 4-Input Multiplexer (3-State LS352)	353	353			353			
QUAD 2-Input Multiplexer With Output Register	398	398						
Quad 2-Input Multiplexer With Output Register	399	399						
Dual Multiplexer With Latch and Common Reset						132		
Dual Multiplexer With Latch						134		
Quad Analog Switch/Quad Multiplexer			016	4016 4316				
Quad Analog Switch/Quad Multiplexer			066	4066				
Triple 2-Channel Analog Multiplexer/Demultiplexer			053	4053 4353				
Dual 4-Channel Analog Multiplexer/Demultiplexer			052	4052				
Dual 4-Channel Analog Data Selector			529					
Quad 2-Input Analog Multiplexer/Demultiplexer			551					
8-Channel Analog Multiplexer/Demultiplexer			051	4051 4351				
16-Channel Analog Multiplexer/Demultiplexer			067					
4-to-16 Decoder				154				
Quad 2:1 Multiplexer								E157 EL57
5-Bit 2:1 Multiplexer								E158 EL58
3-Bit 4:1 Multiplexer								E171
2-Bit 8:1 Multiplexer								E163
16:1 Multiplexer								E164
Triple Differential 2:1 Multiplexer								E457
Decoders/Demultiplexers								
Dual 1-of-4 Decoder/Demultiplexer	139	139		139A	139			
Dual 1-of-4 Decoder (Low)	155		556			171	171	
Dual 1-of-4 Decoder, Open-Collector	156							
1-of-10 Decoder	42			42				
1-of-10 Decoder/Driver, Open-Collector	145							
1-of-8 Decoder/Demultiplexer (Low)	138	138		138A	138	161	161	
3-Line to 8-Line Decoder/Demultiplexer	137			137				
1-of-10 Decoder, 3-State		537						
1-of-8 Decoder, 3-State		538						
Dual 1-of-4 Decoder, 3-State		539						
Binary to 1-8 (High)						162	162	
Dual Binary 1-4 (High)			555			172	172	

Table 4. Cross-Functional Table (continued)

Function	TTL LS	TTL FAST	CMOS STD	CMOS High Speed	CMOS FACT	MECL 10K	MECL 10H	MECL ECLinPS E-Lite
Decoders/Demultiplexers (continued)								
BCD-to-Decimal/Binary-to-Octal Decoder			028					
4-Bit Latch/4-to-16 Line Decoder (High)			514	4514				
4-Bit Latch/4-to-16 Line Decoder (Low)			515					
1-of-8 Decoder/Demultiplexer With Latched Inputs				237				
Display Decode Drivers								
BCD-to-Seven Segment Decoder/Driver, Open-Collector	47							
BCD-to-Seven Segment Decoder/Driver With Pull-Ups	48		558					
BCD-to-Seven Segment Decoder/Driver, Open-Collector	247							
BCD-to-Seven Segment Decoder/Driver With Pull-Ups	248 249							
BCD-to-Seven Segment Latch/Decoder/Driver			511	4511				
BCD-to-Seven Segment Latch/Decoder/Driver Ripple Blanking			513					
BCD-to-Seven Segment Latch/Decoder/Driver			543					
BCD-to-Seven Segment Latch/Decoder/Driver Ripple Blanking			544					
BCD-to-Seven Segment Decoder/Driver, High Current			547					
Priority Encoders								
10-Line Decimal to 4-Line Priority Encoder	147			147				
8-Input to 3-Line Priority Encoder	148	148	532			165	165	
8-Input to 3-Line Priority Encoder	748							
8-Input to 3-Line Priority Encoder, 3-State	348							
8-Input to 3-Line Priority Encoder, 3-State	848							
Multivibrators								
Retriggerable Monostable Multivibrator	122					198		
Dual Retriggerable Monostable Multivibrator	123			4538A				
Dual One-Shot (Very Stable)	221							
Dual Precision Retriggerable/Resettable Monostable Multivibrator			538					
Oscillators/Timers								
24-Stage Frequency Divider			521B					
Programmable Timer			536B					
Programmable Oscillator Timer			541B					
Quad Precision Timer/Driver			415					
Receivers								
Triple Line						114		
Quad Line						115	115	
Triple Line						116	116	

Table 4. Cross-Functional Table (continued)

Function	TTL		CMOS			MECL		
	LS	FAST	STD	High Speed	FACT	10K	10H	ECLinPS E-Lite
Receivers (continued)								
High-Speed Triple Line						216		
Quad Bus						129		
Quint Differential Line								E116 EL16
Quint High-Frequency Differential Line								E416
Comparators								
4-Bit Magnitude Comparator	85	85	585	85				
5-Bit Magnitude Comparator						166	166	
8-Bit Magnitude Comparator		521			521			
8-Bit Magnitude Comparator, 3-State	682							
8-Bit Magnitude Comparator, 3-State	684							
8-Bit Magnitude Comparator	688			688				
9-Bit Magnitude Comparator								E166
Arithmetic Operators								
4-Bit Full Adder	83A		008					
4-Bit Full Adder (Rotated LS83A)	283	283						
4-Bit ALU	181	181 381 382				181	181	
4-Bit Barrel Shifter		350			350			
Look Ahead Carry Generator		182					179	
Dual High-Speed Adder/Subtractor							180	
BCD Rate Multiplier			527					
Triple Serial Adder (Negative Logic)			038					
NBCD Adder			560					
9's Complementer			561					
Parity Generator/Checkers								
9-Bit Odd/Even Parity Generator/Checker	280	280		280		170		
12-Bit Parity Generator/Checker			531			160	160	

Special Logic Circuits

Table 5. ALExIS

Advance Low-Power Expandable Interface Solutions

MC	Function	Pins	DIP	SM
20LX244	20-Bit Buffer (3-State, Non-Inverting)	64		A
20LX245	20-Bit Transceiver (3-State, Non-Inverting)	64		A
20LX373	20-Bit Transparent Latch (3-State, Non-Inverting)	64		A
20LX374	20-Bit D-Type Flip-Flop (3-State, Non-Inverting)	64		A

Table 6. Timing Solutions

MC	Function	Pins	DIP	SM
Clock Drivers				
10/100E111	1:9 Differential Clock Driver With Low Skew, Enable, Vbb	28		FN
10/100E211	1:6 Differential Clock Distribution Chip	28		FN
10/100EL11	1:2 Differential Clock Driver	8		D
74F803	Clock Driver, Quad D-Type Flip-Flop, With Matched Propagation Delays	14	N	D
74F1803	Clock Driver, Quad D-Type Flip-Flop	14	N	D
10/100H640	PECL/TTL-TTL Clock Driver (Single @ 5.0V)	28		FN
10/100H641	1-9 PECL-TTL Clock Distribution Chip (Single P.S. @ 5.0V)	28		FN
10/100H642	PECL/TTL-TTL Clock Driver (Similar to H640)	28		FN
10/100H643	1:8 ECL-TTL Clock Dist Chip (Dual Supply, H641)	28		FN
10/100H644	PECL/TTL-TTL Clock Driver	28		FN
10H645	1:9 TTL-TTL Clock Distribution Chip	28		FN
88913	Low Skew CMOS Clock Driver	14	N	D
88914	Low Skew CMOS Clock Driver With Reset	14	N	D
88915*55	Low Skew CMOS PLL Clock Driver	28		FN
88915*70	Low Skew CMOS PLL Clock Driver	28		FN
Programmable Delay Chips				
10/100E195	Programmable Delay Chip (Digitally Selectable 20ps Res)	28		FN
10/100E196	Programmable Delay Chip (Dig 20ps Anal. < lps)	28		FN

Table 7. Translators

MC	Function	Pins	DIP	SM
10124	Quad TTL-to-MECL Translator	16	P,L	FN
10125	Quad MECL-to-TTL Translator	16	P,L	FN
10177	Triple MECL-to-NMOS Translator	16	L	
10190	Quad MST-to-MECL 10K Translator	16	P,L	FN
14504B	Hex TTL OR CMOS to CMOS Hex Level Shifter	16	P,L	D
10H124	Quad TTL-to-MECL Translator	16	P,L	FN
10H125	Quad MECL-to-TTL Translator	16	P,L	FN
10H350	PECL-to-TTL Translator (Single P.S. @+ 5.0V)	16	P,L	FN
10H351	Quad TTL/NMOS-to-PECL Translator (Single P.S. @+ 5.0V)	20	P,L	FN

*≤ 20-Pin DIP = 20-Pin PLCC; > 20-Pin DIP = 28-Pin PLCC; See Conversion Table on page 3.1-58

Table 7. Translators (continued)

MC	Function	Pins	DIP	SM
10H352	Quad CMOS-to-PECL Translator (Single P.S. @+ 5.0V)	20	P,L	FN
10H424	Quad TTL-to-ECL Translator (ECL Strobe)	16	P,L	FN
10/100H600	9-Bit TTL-ECL Translator	28		FN
10/100H601	9-Bit ECL-TTL Translator	28		FN
10/100H602	9-Bit Latch/TTL-ECL Translator	28		FN
10/100H603	9-Bit Latch/ECL-TTL Translator	28		FN
10/100H605	Registered Hex ECL-TTL Translator	28		FN
10/100H606	Registered Hex TTL-PECL Translator	28		FN
10/100H607	Registered Hex PECL-TTL Translator			

*≤ 20-Pin DIP = 20-Pin PLCC; > 20-Pin DIP = 28-Pin PLCC; See Conversion Table on page 3.1-58

Table 8. CBM

Device	Function	Pins	DIP	SM
MC68194	CBM – Carrier Band Modem	52		FJ**

**FJ = Ceramic Leadless Chip Carrier (CLCC)

Table 9. SCSI Bus Terminator

Device	Function	Pins	DIP	SM
MCCS142233	9-Bit Switchable Passive SCSI Bus Term (220Ω & 330Ω)	20		FN
MCCS142234	9-Bit Switchable Active SCSI Bus Term (110Ω)	16		D
MCCS142235	18-Bit Active SCSI Bus Terminator (Also Available in 32-Pin QFP Package)	24		DW, F, A

Table 10. Memory Support

MC	Function	Pins	DIP	SM
10/100H660	Quad Dual Output ECL-TTL DRAM Driver With Latch	28		FN

Table 11. Industrial Control Unit

Device	Function	Pins	DIP	SM
MC14500B	Industrial Control Unit	16	P,L	DW

Table 12. Bounce Eliminator

Device	Function	Pins	DIP	SM
MC14490	Hex Contact Bounce Eliminator	16	P,L	DW

Table 13. Phase-Locked Loop

MC	Function	Pins	DIP	SM
4016	Programmable Modulo-N Counters (N=0-9)	16	P,L	
4018	Programmable Modulo-N Counters (N=0-9)	16	P,L	
4024	Dual Voltage-Controlled Multivibrator	14	P,L	
4044	Phase-Frequency Detector	14	P,L	
4316	Programmable Modulo-N Counters (N=0-9)	16	P,L	
4324	Dual Voltage-Controlled Multivibrator	14	P,L	

Table 13. Phase-Locked Loop (continued)

MC	Function	Pins	DIP	SM
4344	Phase-Frequency Detector	14	P,L	
12002	Analog Mixer	14	P,L	
12009	480MHz ÷5/6 Dual Modulus Prescaler	16	P,L	
12011	550MHz ÷8/9 Dual Modulus Prescaler	16	P,L	
12013	550MHz ÷10/11 Dual Modulus Prescaler	16	P,L	
12014	Counter Control Logic	16	P,L	
12015	225MHz ÷32/33 Dual Modulus Prescaler	8	P,L	D
12016	225MHz ÷40/41 Dual Modulus Prescaler	8	P,L	D
12017	225MHz ÷64/65 Dual Modulus Prescaler	8	P,L	D
12018	520MHz ÷128/129 Dual Modulus Prescaler	8	P,L	D
12019	225MHz ÷20/21 Dual Modulus Prescaler	8	P,L	D
12022A	1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	8	P	D
12022B	1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	8	P	D
12022LVA	1.1GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	8	P	D
12022LVB	1.1GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	8	P	D
12022SLA	1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	8	P	D
12022SLB	1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	8	P	D
12022TSA	1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	8	P	D
12022TSB	1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	8	P	D
12022TVB	1.1GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	8	P	D
12022TVA	1.1GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	8	P	D
12023	225MHz ÷64 Prescaler	8	P	D
12025	520MHz ÷64/65 Dual Modulus Prescaler	8	P	D
12026A	1.1GHz ÷8/9, ÷16/17 Dual Modulus Prescaler	8		
12026B	1.1GHz ÷8/9, ÷16/17 Dual Modulus Prescaler	8		
12028A	1.1GHz ÷32/33, ÷64/65 Dual Modulus Prescaler	8	P	D
12028B	1.1GHz ÷32/33, ÷64/65 Dual Modulus Prescaler	8	P	D
12031A	2.0GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	8	P	D
12031B	2.0GHz ÷64/65, ÷128/129 Low Voltage Dual Modulus Prescaler	8	P	D
12032A	2.0GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	8	P	D
12032B	2.0GHz ÷64/65, ÷128/129 Dual Modulus Prescaler	8	P	D
12033A	2.0GHz ÷32/33, ÷64/65 Low Voltage Dual Modulus Prescaler	8	P	D
12033B	2.0GHz ÷32/33, ÷64/65 Low Voltage Dual Modulus Prescaler	8	P	D
12034A	2.0GHz ÷32/33, ÷64/65 Dual Modulus Prescaler	8	P	D
12034B	2.0GHz ÷32/33, ÷64/65 Dual Modulus Prescaler	8	P	D
12036A	1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler with Stand-By Mode	8	P	D
12036B	1.1GHz ÷64/65, ÷128/129 Dual Modulus Prescaler with Stand-By Mode	8	P	D
12040	Phase-Frequency Detector	14	P,L	FN
12061	Crystal Oscillator	16	P,L	
12073	1.1GHz ÷64 Prescaler	8	P	D
12074	1.1GHz ÷256 Prescaler	8	P	D

Table 13. Phase-Locked Loop (continued)

MC	Function	Pins	DIP	SM
12076	1.3GHz ÷256 Prescaler	8	P	D
12078	1.3GHz ÷256 Prescaler	8	P	D
12079	2.8GHz ÷64/128/256 Prescaler	8		
12080	1.1GHz ÷10/20/40/80 Prescaler	8		
12083	1.1GHz ÷2 Low Power Prescaler with Stand-By Mode	8	P	D
12090	750MHz ÷2 UHF Prescaler	16	P,L	
12100	200 MHz Voltage Controlled Multivibrator	20	P	FN
12101	130MHz Voltage Controlled Multivibrator	20	P	FN
H12140	Phase-Frequency Detector	8		D
K12140	Phase-Frequency Detector	8		D
12148	Low Power Voltage Controlled Oscillator	8	P	D

Numeric Listings

TTL

Since its introduction, TTL has become the most popular form of digital logic. It has evolved from the original gold-doped saturated 7400 logic, to Schottky-Clamped logic, and finally to the modern advanced families of TTL logic. The popularity of these TTL families stems from their ease of use, low cost, medium-to-high speed operation, and good output drive capability.

Motorola offers two modern TTL logic families — LS and FAST. They are pin and functionally compatible and can easily be combined in a system to achieve maximum performance at minimum cost.

LS (Low Power Schottky) is currently the more popular and commands by far the largest share of the total TTL logic market. It is low-cost and provides moderate performance at low power.

FAST, the state-of-the-art, high-performance TTL family, is growing rapidly and gaining a significant share of the total TTL logic market. FAST offers a 20–30 percent improvement in performance over the older Standard Schottky family (74S) with a 75–80 percent reduction in power. When compared with the Advanced Schottky family (74AS), FAST offers nearly equal performance at a 25–50 percent savings in power.

FAST is manufactured on Motorola's MOSAIC (oxide-isolated) process. This process provides FAST with inherent speed/power advantages over the older junction-isolated 74S and 74LS families. This allows the FAST family to be designed and specified with improved noise margins, reduced input currents, and superior line driving capabilities in comparison to these earlier families. Additionally, FAST designs incorporate power-down circuitry on all three-state outputs, and buffered outputs on all storage devices.

Two further advantages of FAST are the load specifications and power supply specifications. FAST ac characteristics are specified at a heavier capacitive load than the earlier families (50 pF versus 15 pF) to more accurately reflect actual in-circuit performance. Motorola's DC and AC characteristics for FAST are specified over a full 10% supply voltage range — a significant improvement over the industry standard specifications for the earlier families (5% for DC, 0% for AC).

These design and specification improvements offered by the Motorola FAST family provide the user with better system performance, enhanced design flexibility, and more reliable system operation.

TTL Family Comparisons

General Characteristics for Schottky TTL Logic (All Maximum Ratings)

Characteristic	Symbol	LS		FAST		Unit
		54LSxxx	74LSxxx	54Fxxx	74Fxxx	
Operating Voltage Range	V_{CC}	5 ± 10%	5 ± 5%	5 ± 10%	5 ± 10%	Vdc
Operating Temperature Range	T_A	–55 to 125	0 to 70	–55 to 125	0 to 70	°C
Input Current	I_{IN}	20 –400	20 –400	20 –600	20 –600	µA
Output Drive	I_{OH}	–0.4	–0.4	–1.0	–1.0	mA
Standard Output	I_{OL}	4.0	8.0	20	20	mA
	I_{SC}	–20 to –100	–20 to –100	–60 to –150	–60 to –150	mA
	I_{OH}	–12	–15	–12	–15	mA
Buffer Output	I_{OL}	12	24	48	64	mA
	I_{SC}	–40 to –225	–40 to –225	–100 to –225	–100 to –225	mA

Speed/Power Characteristics for Schottky TTL Logic(1) (All Typical Ratings)

Characteristic	Symbol	LS	FAST	Unit		Characteristic	Symbol	LS	FAST	Unit
Quiescent Supply Current/Gate	I_G	0.4	1.1	mA		Speed Power Product	—	18	19.2	pJ
Power/Gate (Quiescent)	P_G	2.0	5.5	mW		Clock Frequency (D-F/F)	f_{max}	33	125	MHz
Propagation Delay	t_p	9.0	3.7	ns		Clock Frequency (Counter)	f_{max}	40	125	MHz

(1) Specifications are shown for the following conditions: a) V_{CC} = 5.0 Vdc; b) T_A = 25°C and c) C_L = 50 pF for FAST; 15 pF for LS.

TTL (continued)

Table 14. LS — Low Power Schottky

SN54LS/ SN74LS	Function	Pins	DIP	SM
00	Quad 2-Input NAND Gate	14	N,J	D
01	Quad 2-Input NAND Gate	14	N,J	D
02	Quad 2-Input NOR Gate	14	N,J	D
03	Quad 2-Input NAND Gate	14	N,J	D
04	Hex Inverter	14	N,J	D
05	Hex Inverter	14	N,J	D
08	Quad 2-Input AND Gate	14	N,J	D
09	Quad 2-Input AND Gate	14	N,J	D
10	Triple 3-Input NAND Gate	14	N,J	D
11	Triple 3-Input AND Gate	14	N,J	D
12	Triple 3-Input NAND Gate	14	N,J	D
13	Dual 4-Input NAND Schmitt Trigger	14	N,J	D
14	Hex Inverter Schmitt Trigger	14	N,J	D
15	Triple 3-Input AND Gate	14	N,J	D
20	Dual 4-Input NAND Gate	14	N,J	D
21	Dual 4-Input AND Gate	14	N,J	D
22	Dual 4-Input NAND Gate	14	N,J	D
26	Quad 2-Input NAND Buffer	14	N,J	D
27	Triple 3-Input NOR Gate	14	N,J	D
28	Quad 2-Input NOR Buffer	14	N,J	D
30	8-Input NAND Gate	14	N,J	D
32	Quad 2-Input OR Gate	14	N,J	D
33	Quad 2-Input NOR Buffer	14	N,J	D
37	Quad 2-Input NAND Buffer	14	N,J	D
38	Quad 2-Input NAND Buffer Open-Collector	14	N,J	D
40	Dual 4-Input NAND Buffer	14	N,J	D
42	One-of-Ten Decoder	16	N,J	D
47	Binary-Coded-Decimal to 7 Segment Decoder/Driver	16	N,J	D
48	Binary-Coded-Decimal to 7 Segment Decoder	16	N,J	D
51	Dual 2 Wide 2-Input/3-Input AND/OR Invert Gate	14	N,J	D
54	3-2-2-3-Input AND/OR Invert Gate	14	N,J	D
55	2-wide, 4-Input AND/OR Invert Gate	14	N,J	D
73A	Dual J-K Negative Edge-triggered Flip-Flop	14	N,J	D
74A	Dual D-Type Positive Edge-triggered Flip-Flop	16	N,J	D
75	4-Bit D Latch	16	N,J	D
76A	Dual J-K Flip-Flop With Set and Clear	16	N,J	D
77	4-Bit D Latch	14	N,J	D

* Available in 74LS only

Table 14. LS — Low Power Schottky (continued)

SN54LS/ SN74LS	Function	Pins	DIP	SM
83A	4-Bit Binary Full Adder With Fast Carry	14	N,J	D
85	4-Bit Magnitude Comparator	16	N,J	D
86	Quad Exclusive OR Gate	14	N,J	D
90	Decade Counter	14	N,J	D
92	Divide By 12 Counter	14	N,J	D
93	4-Bit Binary Counter	14	N,J	D
95B	4-Bit Shift Register	14	N,J	D
107A	Dual J-K Flip-Flop	14	N,J	D
109A	Dual J-K Positive Edge Triggered Flip-Flop	16	N,J	D
112A	Dual J-K Negative Edge Triggered Flip-Flop	16	N,J	D
113A	Dual J-K Negative Edge Triggered Flip-Flop	14	N,J	D
114A	Dual J-K Negative Edge Triggered Flip-Flop	14	N,J	D
122	Retriggerable Monostable Multivibrators	14	N,J	D
123	Retriggerable Monostable Multivibrators	14	N,J	D
125A	Quad Buffers With 3-State Outputs	14	N,J	D
126A	Quad Buffers With 3-State Outputs	14	N,J	D
132	Quad 2-Input Schmitt Trigger NAND Gate	14	N,J	D
133	13-Input NAND Gate	16	N,J	D
136*	Quad 2-Input Exclusive OR Gate	14	N,J	D
137	3-Line to 8-Line Decoders/Demultiplexers With Address Latches	16	N,J	D
138	1-of-8 Decoder/Demultiplexer	16	N,J	D
139	Dual 1-of-4 Decoder/Demultiplexer	16	N,J	D
145	1-of-10 Decoder/Driver Open-Collector	16	N,J	D
147	10-Line to 4-Line Priority Encoder	16	N,J	D
148	8-Line to 3-Line Priority Encoder	16	N,J	D
151	8-Input Multiplexer	16	N,J	D
153	Dual 4-Input Multiplexer	16	N,J	D
155	Dual 1-of-4 Decoder	16	N,J	D
156	Dual 1-of-4 Decoder Open-Collector	16	N,J	D
157	Quad 2-Input Multiplexer	16	N,J	D
158	Quad 2-Input Multiplexer	16	N,J	D
160A	4-Bit BCD Decade Counter, Asynchronous Reset	16	N,J	D
161A	4-Bit Binary Counter, Synchronous Reset	16	N,J	D
162A	4-Bit BCD Decade Counter, Asynchronous Reset	16	N,J	D
163A	4-Bit Binary Counter, Synchronous Reset	16	N,J	D
164	8-Bit Serial-In Parallel-Out Shift Register	14	N,J	D
165	8-Bit Parallel-to-serial Converter	16	N,J	D
166	8-Bit Shift Registers	16	N,J	D
168	BCD Decade Synchronous Bidirectional Counter	16	N,J	D
169	Modulo 16 Binary Synchronous Bidirectional Counter	16	N,J	D

* Available in 74LS only

Table 14. LS — Low Power Schottky (continued)

SN54LS/ SN74LS	Function	Pins	DIP	SM
170	4 X 4 Register File Open Collector	16	N,J	D
173A	4-Bit D-Type Register With With 3-State Outputs	16	N,J	D
174	Hex D Flip-Flop	16	N,J	D
175	Quad D Flip-Flop	16	N,J	D
181	4-Bit Arithmetic Logic Unit	24	N,J	DW
190	Presettable BCD/Decade Up/Down Counter	16	N,J	D
191	Presettable 4-Bit Binary Up/Down Counter	16	N,J	D
192	Presettable BCD/Decade Up/Down Counter	16	N,J	D
193	Presettable 4-Bit Binary Up/Down Counter	16	N,J	D
194A	4-Bit Bidirectional Universal Shift Register	16	N,J	D
195A	Universal 4-Bit Shift Register	16	N,J	D
196	4-Stage Presettable Ripple Counters	14	N,J	D
197	4-Stage Presettable Ripple Counters	14	N,J	D
221	Dual Monostable Multivibrators With Schmitt Trigger Inputs	16	N,J	D
240	Octal Buffer/Line Driver With 3-State Outputs	20	N,J	DW
241	Octal Buffer/Line Driver With 3-State Outputs	20	N,J	DW
242	Quad Bus Transceiver/Inverting With 3-State Outputs	14	N,J	D
243	Quad Bus Transceiver/noninverting With 3-State Outputs	14	N,J	D
244	Octal Buffer/Line Driver With 3-State	20	N,J	DW
245	Octal Bus Transceiver	20	N,J	DW
247	BCD-to-Seven-Segment Decoders/Drivers	16	N,J	D
248	BCD-to-Seven-Segment Decoders/Drivers	16	N,J	D
249	BCD-to-Seven-Segment Decoders/Drivers	16	N,J	D
251	8-Input Multiplexer With 3-State Outputs	16	N,J	D
253	Dual 4-Input Multiplexer With 3-State Outputs	16	N,J	D
256	Dual 4-Bit Addressable Latch	16	N,J	D
257B	Quad 2-Input Multiplexer With 3-State Outputs	16	N,J	D
258B	Quad 2-Input Multiplexer, Inverting, With 3-State Outputs	16	N,J	D
259	8-Bit Addressable Latch	16	N,J	D
260	Dual 5-Input NOR Gate	14	N,J	D
266	Quad 2-Input Exclusive NOR Gate	14	N,J	D
273	Octal D Flip-Flop With Clear	20	N,J	DW
279	Quad Set/Reset Latch	16	N,J	D
280	9-Bit Odd/Even Parity Generator/Checker	14	N,J	D
283	4-Bit Binary Full Adder With Fast Carry	16	N,J	D
290	Decade Counter	14	N,J	D
293	4-Bit Binary Counter	14	N,J	D
298	Quad 2-Input Multiplexer With Storage	16	N,J	D
299	8-Bit Shift/Storage Register With 3-State Outputs	20	N,J	DW
322A	8-Bit Shift Registers With Sign Extend	20	N,J	DW

* Available in 74LS only

Table 14. LS — Low Power Schottky (continued)

SN54LS/ SN74LS	Function	Pins	DIP	SM
323	8-Bit Shift/Storage Register With 3-State Outputs	20	N,J	DW
348	8-Input Priority Encoder	16	N,J	D
352	Dual 4-Input Multiplexer	16	N,J	D
353	Dual 4-Input Multiplexer With 3-State Outputs	16	N,J	D
365A	Hex Buffer Gated Enable Noninverting With 3-State Outputs	16	N,J	D
366A	Hex Buffer Gated Enable Inverting With 3-State Outputs	16	N,J	D
367A	Hex Buffer 4/2-Bit/Non-Inverting With 3-State Outputs	16	N,J	D
368A	Hex Buffer 4/2-Bit/Inverting With 3-State Outputs	16	N,J	D
373	Octal Transparent Latch With 3-State Outputs	20	N,J	DW
374	Octal D-Type Flip-Flop With 3-State Outputs	20	N,J	DW
375	4-Bit D Latch	16	N,J	D
377	Octal D Flip-Flop With Enable/ Noninverting	20	N,J	DW
378	Hex D Flip-Flop With Enable	16	N,J	D
379	4-Bit D Flip-Flop With Enable	16	N,J	D
386	Quad 2-Input Exclusive OR Gate	14	N,J	D
390	Dual Decade Counter	16	N,J	D
393	Dual 4-stage Binary Counter	16	N,J	D
395*	4-Bit Shift Register With 3-State Outputs	16	N,J	D
398	Quad 2-Port Register	20	N,J	DW
399	Quad 2-Port Register	20	N,J	DW
490	Dual Decade Counter	16	N,J	D
540	Octal Buffer/Line Driver With 3-State Outputs	20	N,J	DW
541	Octal Buffer/Line Driver With 3-State Outputs	20	N,J	DW
569A	4-Bit Up/Down Counter With 3-State Outputs	20	N,J	DW
623	Octal Bus Transceiver	20	N,J	DW
640	Octal Bus Transceiver/Inverting With 3-State Outputs	20	N,J	DW
641	Octal Bus Transceiver/Noninverting With Open Collector	20	N,J	DW
642	Octal Bus Transceiver/Inverting With Open Collector	20	N,J	DW
645	Octal Bus Transceiver/Noninverting With 3-State Outputs	20	N,J	DW
669	Synchronous 4-Bit Up/Down Counter	16	N,J	D
670	4 X 4 Register File With 3-State Outputs	16	N,J	D
682	8-Bit Magnitude Comparators	20	N,J	DW
684	8-Bit Magnitude Comparators	20	N,J	DW
688	8-Bit Magnitude Comparators	20	N,J	DW
748	8-Line to 3-Line Priority Encoder	16	N,J	D
795	Octal Buffer (81LS95), With 3-State Outputs	20	N,J	DW
796	Octal Buffer (81LS96), With 3-State Outputs	20	N,J	DW
797	Octal Buffer (81LS97), With 3-State Outputs	20	N,J	DW
798	Octal Buffer (81LS98), With 3-State Outputs	20	N,J	DW
848	8-Input Priority Encoder (Glitchless)	16	N,J	D

* Available in 74LS only

TTL (continued)

Table 15. FAST

MC54F/ MC74F	Function	Pins	DIP	SM
00	Quad 2-Input NAND Gate	14	N,J	D
02	Quad 2-Input NOR Gate	14	N,J	D
04	Hex Inverter	14	N,J	D
08	Quad 2-Input AND Gate	14	N,J	D
10	Triple 3-Input NAND Gate	14	N,J	D
11	Triple 3-Input AND Gate	14	N,J	D
13	Dual 4-Input NAND Schmitt Trigger	14	N,J	D
14	Hex Inverter Schmitt Trigger	14	N,J	D
20	Dual 4-Input NAND Gate	14	N,J	D
21	Dual 4-Input AND Gate	14	N,J	D
32	Quad 2-Input OR Gate	14	N,J	D
37*	Quad 2-Input NAND Buffer	14	N,J	D
38*	Quad 2-Input NAND Buffer Open-Collector	14	N,J	D
40*	Dual 4-Input NAND Buffer	14	N,J	D
51	Dual 2-Wide 2-Input, 2-Wide 3-Input AND-OR-Invert Gate	14	N,J	D
64	4-2-3-2 Input AND-OR-Invert Gate	14	N,J	D
74	Dual D-Type Positive Edge-Triggered Flip-Flop	14	N,J	D
85	4-Bit Magnitude Comparator	16	N,J	D
86	Quad 2-Input Exclusive OR Gate	14	N,J	D
109	Dual JK(bar) Positive Edge-Triggered Flip-Flop	16	N,J	D
112*	Dual J-K Negative Edge-Triggered Flip-Flop	16	N,J	D
125	Quad Buffer, With 3-State Outputs	14	N,J	D
126	Quad Buffer, With 3-State Outputs	14	N,J	D
132	Quad 2-Input NAND Schmitt Trigger	14	N,J	D
138	1-of-8 Decoder/Demultiplexer	16	N,J	D
139	Dual 1-of-4 Decoder/Demultiplexer	16	N,J	D
148	8-Line to 3-Line Priority Encoder	16	N,J	D
151	8-Input Multiplexer	16	N,J	D
153	Dual 4-Input Multiplexer	16	N,J	D
157A*	Quad 2-Input Multiplexer	16	N,J	D
158A*	Quad 2-Input Multiplexer	16	N,J	D
160A*	BCD Decade Counter, Synchronous Presettable	16	N,J	D
161A*	Binary Counter, Synchronous Presettable, 4-Bit	16	N,J	D
162A*	BCD Decade Counter, Synchronous Presettable	16	N,J	D
163A*	Binary Counter, Synchronous Presettable, 4-Bit	16	N,J	D
164	8-Bit Serial In-Serial Out Shift Register	14	N,J	D
168	4-Stage Synchronous Bidirectional Counter	16	N,J	D

* Available in 74F only

Table 15. FAST (continued)

MC54F/ MC74F	Function	Pins	DIP	SM
169	4-Stage Synchronous Bidirectional Counter	16	N,J	D
174	Hex D Flip-Flop With Master Reset	16	N,J	D
175	Quad D Flip-Flop	16	N,J	D
181	4-Bit Arithmetic Logic Unit	24	N	DW
182	Carry Lookahead Generator	16	N,J	D
194*	4-Bit Bidirectional Universal Shift Register	16	N,J	D
195*	4-Bit Shift Register	16	N,J	D
240	Octal Buffer/Line Driver With 3-State Outputs	20	N,J	DW
241	Octal Buffer/Line Driver With 3-State Outputs	20	N,J	DW
242	Quad Bus Transceivers With 3-State Outputs	14	N,J	D
243	Quad Bus Transceivers With 3-State Outputs	14	N,J	D
244	Octal Buffer/Line Driver With 3-State Outputs	20	N,J	DW
245	Octal Bidirectional Transceiver With 3-State Outputs	20	N,J	DW
251	8-Input Multiplexer, With 3-State Outputs	16	N,J	D
253	Dual 4-Input Multiplexer, With 3-State Outputs	16	N,J	D
256	Dual 4-Bit Addressable Latch	16	N,J	D
257A*	Quad 2-Input Multiplexer, With 3-State Outputs	16	N,J	D
258A*	Quad 2-Input Multiplexer, With 3-State Outputs	16	N,J	D
259	8-Bit Addressable Latch	16	N,J	D
269*	8-Bit Bidirectional Binary Counter	24	N,J	DW
280	9-Bit Parity Generator/Checker	14	N,J	D
283	4-Bit Binary Full Adder (With Fast Carry)	16	N,J	D
299*	8-Input Universal Shift/Storage Register, W/Common Parallel I/O Pins	20	N,J	DW
323*	8-Input Shift/Storage Register W/Synchronous Reset and Common I/O Pins	20	N,J	DW
350	4-Bit Shifter, With 3-State Outputs	16	N,J	D
352	Dual 4-Input Multiplexer	16	N,J	D
353	Dual 4-Input Multiplexer, With 3-State Outputs	16	N,J	D
366	Hex Buffer/Driver Gated Enable Inverting, With 3-State Outputs	16	N,J	D
367	Hex Buffer/Driver, 4+2-Bit, Noninverting, With 3-State Outputs	16	N,J	D
368	Hex Buffer Driver, 4+2-Bit, Inverting, With 3-State Outputs	16	N,J	D
373	Octal Transparent Latch, With 3-State Outputs	20	N,J	DW
374	Octal D Flip Flop, With 3-State Outputs	20	N,J	DW
377*	Octal D Flip-Flop With Enable	20	N,J	DW
378	Hex Parallel D Register With Enable	16	N,J	D
379	Quad Parallel Register With Enable	16	N,J	D
381	4-Bit Arithmetic Logic Unit	20	N,J	DW
382	4-Bit Arithmetic Logic Unit	20	N,J	DW
398	Quad 2-Port Register	20	N,J	DW
399	Quad 2-Port Register	16	N,J	D
521	8-Bit Identity Comparator	20	N,J	DW

* Available in 74F only

Table 15. FAST (continued)

MC54F/ MC74F	Function	Pins	DIP	SM
533	Octal Transparent Latch, With 3-State Outputs	20	N,J	DW
534	Octal D-Type Flip Flop, With 3-State Outputs	20	N,J	DW
537	1-of-10 Decoder, With 3-State Outputs	20	N,J	DW
538	1-of-8 Decoder, With 3-State Outputs	20	N,J	DW
539	1-of-4 Decoder, With 3-State Outputs	20	N,J	DW
543*	Octal Registered Transceiver Noninverting, With 3-State Outputs	24	N	DW
544*	Octal Registered Transceiver Inverting, With 3-State Outputs	24	N	DW
568	4-Bit Bidirectional Decade Counter, With 3-State Outputs	20	N,J	DW
569	4-Bit Bidirectional Binary Counter, With 3-State Outputs	20	N,J	DW
574*	Octal D Flip-Flop With 3-State Outputs/Broadside Pinout, F374	20	N,J	DW
579*	8-Bit Bidirectional Binary Counter, With 3-State Outputs	20	N,J	DW
620*	Octal Bus Transceiver/Inverting, With 3-State Outputs	20	N,J	DW
623*	Octal Bus Transceiver, With 3-State Outputs	20	N,J	DW
640*	Octal Bus Transceiver/Inverting, With 3-State Outputs	20	N,J	DW
646*	Octal Transceiver/Register, With 3-State Outputs	24	N	DW
657A*	Octal Bidirectional Transceiver With 8-Bit Parity Generator Checker, With 3-State Outputs	24	N	DW
657B*	Octal Bidirectional Transceiver With 8-Bit Parity Generator Checker, With 3-State Outputs	24	N,J	DW
779*	8-Bit Bidirectional Binary Counter, With 3-State Outputs	16	N,J	D
803*	Clock Driver, Quad D-Type Flip-Flop, With Matched Propagation Delays	14	N,J	D
823*	9-Bit Bus Interface, NINV, 3 State Outputs	24	N	DW
827	10-Bit Buffer/Line Driver (Noninverting), With 3-State Outputs	24	N,J	DW
828	10-Bit Buffer/Line Driver (Inverting), With 3-State Outputs	24	N,J	DW
1245*	Octal Bidirectional Transceiver, With 3-State Inputs/Outputs	20	N,J	DW
1803*	Clock Driver (Quad D-Type Flip-flop) With Matched Propagation Delays	14	N	D
3893A*	Quad Futurebus Backplane Transceiver, With 3-State Outputs and Open Collector	20		FN

* Available in 74F only

MECL

Motorola's Emitter Coupled Logic (MECL) is a nonsaturated form of digital logic which eliminates transistor storage time as a speed limiting characteristic, permitting very high speed operation.

Motorola offers four versions of MECL: MECL 10K, MECL 10H, MECL III and the recently introduced ECLinPS (ECL in picoseconds) family.

The *MECL 10K* series was the first generation of Motorola's ECL logic families. In order to make the circuits comparatively easy to use, edge speed was slowed to 2.0 ns while the important propagation delay was held to 2.0 ns. The slow edge speed permits use of wire-wrap and standard printed circuit lines, however, the circuits are specified to drive transmission lines for optimum performance.

The *MECL 10H* family is a higher performance, pin compatible upgrade to the MECL 10K family. MECL 10H features 100% improvement in propagation delay and clock speeds while maintaining power supply current equal to MECL 10K. MECL 10H is voltage compensated which allows guaranteed DC and switching parameters over a ±5% power supply range. MECL 10H is compatible with MECL 10K, MECL III, and ECLinPS 10E devices. The MECL 10H family includes a number of translators that allow designers to move between ECL and TTL technologies. The new H600 additions to the MECL 10H family provide wide fanout translators and translating clock drivers in a 28-lead PLCC package.

ECLinPS is the latest ECL family and represents a major advance in high-speed logic capabilities. With a gate propagation delay of only 0.33 ns and a flip-flop toggle frequency of at least 1100 MHz it literally eclipses the performance of the earlier ECL lines while maintaining signal and power-supply compatibility with MECL 10H/100H. ECLinPS functions include both 10E (10H Equivalent) and full voltage and temperature compensated 100E (100H Equivalent) versions.

In addition to the 28-lead PLCC ECLinPS family, an 8-lead SOIC *ECLinPS Lite* family is also available. The ECLinPS Lite family is made up of single basic logic building blocks, i.e., gates, flip-flops, line receivers and multiplexers, in both 10E and 100E varieties. The ECLinPS Lite family also includes translators to move between ECL and TTL technologies.

MECL III has 1.0 ns gate propagation delays and greater than 500 MHz flip-flop toggle rates. MECL III is used mostly in high-speed test and communications equipment.

Speed/power comparisons for Motorola ECL families are as follows:

Speed/Power Characteristics for MECL (All Typical Ratings)

Characteristic	Symbol	MECL 10K		MECL 10H	ECLinPS & ECLinPS Lite		MECL III	Unit
		MC101xx	MC102xx	MC10H1xx	MC10E/100E	MC10EL/100EL	MC16xx	
Quiescent Supply Current/Gate	I_G	5.0	5.0	5.0	3.5	7.0	10	mA
Power/Gate (Quiescent)	P_G	26	26	26	18	36	54	mW
Propagation Delay	t_p	2.0	1.5	1.0	0.33	0.23	1.1	ns
Rise/Fall Time	t_r, t_f	2.0	1.5	1.0	0.35	0.25	0.4	ns
Speed Power Product	—	52	39	26	5.9	8.3	59	pJ
Clock Frequency (D-F/F)	f_{max}	125	200	250	1100	2200	550	MHz

MECL (continued)

Table 16. MECL 10K

MC10	Function	Pins	DIP	SM*
100	Quad 2-Input NOR Gate With strobe	16	P,L	FN
101	Quad OR/NOR Gate	16	P,L	FN
102	Quad 2-Input NOR Gate	16	P,L	FN
103	Quad 2-Input OR Gate	16	P,L	FN
104	Quad 2-Input AND Gate	16	P,L	FN
105	Triple 2-3-2 Input OR/NOR Gate	16	P,L	FN
106	Triple 4-3-3 Input NOR Gate	16	P,L	FN
107	Triple 2-Input Exclusive Or/Exclusive NOR Gate	16	P,L	FN
109	Dual 4-5 Input OR/NOR Gate	16	P,L	FN
110	Dual 3-Input 3-Output OR Gate	16	P,L	FN
111	Dual 3-Input 3-Output NOR Gate	16	P,L	FN
113	Quad Exclusive OR Gate	16	P,L	FN
114	Triple Line Receiver	16	P,L	FN
115	Quad Line Receiver	16	P,L	FN
116	Triple Line Receiver	16	P,L	FN
117	Dual 2-wide 2-3-Input OR-AND/OR-AND-Invert Gate	16	P,L	FN
118	Dual 2-wide 3-Input OR-AND Gate	16	P,L	FN
119	4-wide 4-3-3-3 Input OR-AND Gate	16	P,L	FN
121	4-wide OR-AND/OR-AND-Invert Gate	16	P,L	FN
123	Triple 4-3-3 Input Bus Driver (25Ω)	16	P,L	FN
124	Quad TTL-to-MECL Translator	16	P,L	FN
125	Quad MECL-to-TTL Translator	16	P,L	FN
128	Bus Driver	16	L	
129	Quad Bus Receiver	16	L	
130	Dual Latch	16	P,L	FN
131	Dual Type D Master-slave Flip-Flop	16	P,L	FN
132	Dual Multiplexer With Latch and Common Reset	16	P,L	
133	Quad Latch	16	P,L	FN
134	Dual Multiplexer With Latch	16	P,L	FN
135	Dual J-K Master-Slave Flip-Flop	16	P,L	FN
136	Universal Hexadecimal Counter	16	P,L	FN
137	Universal Decade Counter	16	P,L	
138	Bi-Quinary Counter	16	P,L	FN
141	4-Bit Universal Shift Register	16	P,L	FN
153	Quad Latch	16	P,L	FN
154	Binary Counter	16	P,L	
158	Quad 2-Input Multiplexer (Noninverting)	16	P,L	FN
159	Quad 2-Input Multiplexer (Inverting)	16	P,L	FN

*≤ 20-Pin DIP = 20-Pin PLCC; > 20-Pin DIP = 28-Pin PLCC; See Conversion Table on Page 3.1-58

Table 16. MECL 10K (continued)

MC10	Function	Pins	DIP	SM*
160	12-Bit Parity Generator/Checker	16	P,L	FN
161	Binary to 1-8 Decoder, (Low)	16	P,L	FN
162	Binary to 1-8 Decoder, (High)	16	P,L	FN
164	8-Line Multiplexer	16	P,L	FN
165	8-Input Priority Encoder	16	P,L	FN
166	5-Bit Magnitude Comparator	16	P,L	FN
168	Quad Latch	16	P,L	FN
170	9 + 2-Bit Parity Generator-Checker	16	P,L	FN
171	Binary to 1-4 Decoder (Low)	16	P,L	FN
172	Dual Binary to 1-4 Decoder (High)	16	P,L	FN
173	Quad 2-Input Multiplexer/Latch	16	P,L	FN
174	Dual 4-to-1 Multiplexer	16	P,L	FN
175	Quint Latch	16	P,L	FN
176	Hex D Master-Slave Flip-Flop	16	P,L	FN
178	Binary Counter	16	P,L	FN
181	4-Bit Arithmetic Logic Unit/Function Generator	24	P,L	
186	Hex D Master Slave Flip-Flop With Reset	16	P,L	FN
188	Hex Buffer With Enable	16	P,L	FN
189	Hex Inverter With Enable	16	P,L	FN
190	Quad MST-to-MECL 10K Translator	16	P,L	FN
192	Quad Bus Driver	16	P,L	FN
193	Error Detection-Correction Circuit (Motorola Code)	16	P,L	
195	Hex Inverter/Buffer	16	P,L	FN
197	Hex AND Gate	16	P,L	FN
198	Monostable Multivibrator	16	P,L	FN
210	Dual 3-Input, 3-Output OR Gate	16	P,L	FN
211	Dual 3-Input, 3-Output NOR Gate	16	P,L	FN
212	High Speed Dual 3-Input 3-Output OR/NOR Gate	16	P,L	FN
216	High Speed Triple Line Receiver	16	P,L	FN
231	High Speed Dual D Master-Slave Flip-Flop	16	P,L	FN
804	ECL/TTL Inverting Bidirectional Transceivers With Latch(4-Bit)	16	L	
805	ECL/TTL Inverting Bidirectional Transceivers With Latch(5-Bit)	20	L	

*≤ 20-Pin DIP = 20-Pin PLCC; > 20-Pin DIP = 28-Pin PLCC; See Conversion Table on Page 3.1-58

MECL (continued)

Table 17. MECL 10H

MC10H	Function	Pins	DIP	SM
016	4-Bit Binary Counter	16	P,L	FN
100	Quad 2-Input NOR Gate With strobe	16	P,L	FN
101	Quad OR/NOR Gate	16	P,L	FN
102	Quad 2-Input NOR Gate	16	P,L	FN
103	Quad 2-Input OR Gate	16	P,L	FN
104	Quad 2-Input AND Gate	16	P,L	FN
105	Triple 2-3-2 Input OR/NOR Gate	16	P,L	FN
106	Triple 4-3-3 Input NOR Gate	16	P,L	FN
107	Triple 2-Input Exclusive OR/Exclusive NOR Gate	16	P,L	FN
109	Dual 4-5 Input OR/NOR Gate	16	P,L	FN
113	Quad Exclusive OR Gate	16	P,L	FN
115	Quad Line Receiver	16	P,L	FN
116	Triple Line Receiver	16	P,L	D,FN
117	Dual 2-wide 2-3-Input OR-AND/OR-AND-invert Gate	16	P,L	FN
118	Dual 2-wide 3-Input OR-AND Gate	16	P,L	FN
119	4-wide 4-3-3-3 Input OR-AND Gate	16	P,L	FN
121	4-wide OR-AND/OR-AND-Invert Gate	16	P,L	FN
123	Triple 4-3-3 Input Bus Driver (25Ω)	16	P,L	FN
124	Quad TTL-to-MECL Translator, With TTL Strobe Input	16	P,L	FN
125	Quad MECL-to-TTL Translator	16	P,L	FN
130	Dual Latch	16	P,L	FN
131	Dual Type-D Master-slave Flip-Flop	16	P,L	FN
135	Dual J-K Master-slave Flip-Flop	16	P,L	FN
136	Universal Hexadecimal Counter	16	P,L	FN
141	4-Bit Universal Shift Register	16	P,L	FN
145	16 X 4-Bit Register File (RAM)	16	P,L	FN
158	Quad 2-Input Multiplexer, Noninverting Output	16	P,L	FN
159	Quad 2-Input Multiplexer, Inverting Output	16	P,L	FN
160	12-Bit Parity Generator/Checker	16	P,L	FN
161	Binary to 1-8 Decoder, (Low)	16	P,L	FN
162	Binary to 1-8 Decoder, (High)	16	P,L	FN
164	8-Line Multiplexer	16	P,L	FN
165	8-Input Priority Encoder	16	P,L	FN
166	5-Bit Magnitude Comparator	16	P,L	FN
171	Dual Binary to 1-4 Decoder (Low)	16	P,L	FN
172	Dual Binary to 1-4 Decoder (High)	16	P,L	FN
173	Quad 2 Input Multiplexer With latch	16	P,L	FN

*≤ 20-Pin DIP = 20-Pin PLCC; > 20-Pin DIP = 28-Pin PLCC; See Conversion Table on Page 3.1-58
**Also Available in 100H

Table 17. MECL 10H (continued)

MC10H	Function	Pins	DIP	SM
174	Dual 4-to-1 Multiplexer	16	P,L	FN
175	Quint Latch	16	P,L	FN
176	Hex D Master Slave Flip-Flop	16	P,L	FN
179	Look Ahead Carry Block	16	P,L	FN
180	Dual 2-Bit Adder/Subtractor	16	P,L	FN
181	4-Bit Arithmetic Logic Unit/Function Generator	24	P,L	FN
186	Hex D Master Slave Flip-Flop With Reset	16	P,L	FN
188	Hex Buffer With Enable	16	P,L	FN
189	Hex Inverter With Enable	16	P,L	FN
209	Dual 4-5-Input OR/NOR Gate	16	P,L	FN
210	Dual 3-Input, 3-Output OR Gate	16	P,L	FN
211	Dual 3-Input, 3-Output NOR Gate	16	P,L	FN
330	Quad Bus Driver/Receiver With 2-to-1 Output Multiplexer (25Ω)	24	P,L	FN
332	Dual Bus Driver/Receiver With 4-to-1 Output Multiplexer (25Ω)	20	P,L	FN
334	Quad Bus Driver/Receiver With Transmit & Receiver Latches (25Ω)	20	P,L	FN
350	ECL-to-TTL Translator (Single P.S. @+ 5.0V)	16	P,L	FN
351	Quad TTL/NMOS-to-PECL Translator (Single P.S. @+ 5.0V)	20	P,L	FN
352	Quad CMOS-to-ECL Translator (Single P.S. @+ 5.0V)	20	P,L	FN
423	Triple 3-Input Bus Driver With Enable (25Ω)	16	P,L	FN
424	Quad TTL-to-ECL Translator (ECL Strobe)	16	P,L	FN
600**	9-Bit TTL/ECL Translator	28		FN
601**	9-Bit ECL/TTL Translator	28		FN
602**	9-Bit Latch TTL/ECL Translator	28		FN
603**	9-Bit Latch ECL/TTL Translator	28		FN
605**	Registered Hex ECL/TTL Translator	28		FN
606**	Registered Hex TTL/PECL Translator	28		FN
607**	Registered Hex PECL/TTL Translator	28		FN
640**	68030/040 PECL/TTL Clock Driver	28		FN
641**	Single Supply PECL/TTL 1:9 Clock Distribution Chip	28		FN
642**	68030/040 PECL/TTL Clock Driver	28		FN
643**	Dual Supply ECL/TTL 1:8 Clock Driver	28		FN
644**	68030/40 PECL/TTL Clock Driver	20		FN
645	1:9 TTL-TTL Clock Distribution Chip	28		FN
660**	4-Bit ECL-TTL Load Reducing DRAM Driver	28		FN
680**	4-Bit Differential ECL Bus/TTL Bus Transceiver	28		FN
681**	Hex ECL/TTL Transceiver With Latches	28		FN

*≤ 20-Pin DIP = 20-Pin PLCC; > 20-Pin DIP = 28-Pin PLCC; See Conversion Table on Page 3.1-58
**Also Available in 100H

MECL (continued)

Table 18. ECLinPS

MC10E/ MC100E	Function	Pins	DIP	SM
016	8-Bit Synchronous Binary Up Counter	28		FN
101	Quad 4-Input OR/NOR Gate	28		FN
104	Quint 2-Input AND/NAND Gate	28		FN
107	Quint 2-Input XOR/XNOR Gate	28		FN
111	1:9 Differential Clock Driver With Low Skew, Enable, Vbb	28		FN
112	Quad Driver	28		FN
116	Quint Differential Line Receiver	28		FN
122	9-Bit Buffer	28		FN
131	4-Bit D Flip-Flop Individual Clock, Reset Differential Output	28		FN
136	6-Bit Universal Counter, (Lookahead Carry)	28		FN
137	8-Bit Ripple Counter	28		FN
141	8-Bit Shift Register	28		FN
142	9-Bit Shift Register, 700mhz, With Asynchronous Master Reset	28		FN
143	9-Bit Shift Register, 700mhz, With Asynchronous Master Reset	28		FN
150	6-Bit D Latch	28		FN
151	6-Bit D Register With Common Clock, Asynchronous Master Reset, Differential Outputs	28		FN
154	5-Bit 2:1 Mux-Latch, With Common Enable, Asynchronous Master Reset Differential Output	28		FN
155	6-Bit 2:1 Mux-Latch, With Common Enable, Asynchronous Master Reset Single Ended	28		FN
156	3-Bit 4:1 Mux-Latch, With Common Enable, Asynchronous Master Reset, Differential Output	28		FN
157	Quad 2:1 Mux, Individual-Select	28		FN
158	5-Bit 2:1 Multiplexer, With Differential Output	28		FN
160	12-Bit Parity Generator/Checker, Register-Shiftable, Differential Output	28		FN
163	2-Bit 8:1 Multiplexer	28		FN
164	16:1 Multiplexer	28		FN
166	9-Bit Magnitude Comparator	28		FN
167	6-Bit 2:1 Mux-Register With Common Clock, Asynchronous Master Reset Single Ended	28		FN
171	3-Bit 4:1 Multiplexer, With split Select Differential Output	28		FN
175	9-Bit Latch, With Parity	28		FN
193	Error Detection and Correction Circuit	28		FN
195	Programmable Delay Chip (Digitally Selectable 20ps Res)	28		FN
196	Programmable Delay Chip (Dig 80ps Anal. 1.6 Ps/mv)	28		FN
197*	Data Separator	28		FN
211	1:6 Differential Clock Distribution Chip	28		FN
212	3-Bit Scannable Registered Address Driver, ECL	28		FN
241	8-Bit Scannable Register	28		FN
256	3-Bit 4:1 Mux-Latch (Integrated E156 & E171)	28		FN
336	3-Bit Registered Bus Transceiver, 25Ω Cutoff Outputs	28		FN

* Available in 10E only

Table 18. ECLinPS (continued)

MC10E/ MC100E	Function	Pins	DIP	SM
337	3-Bit Scannable Registered Bus Transceiver	28		FN
404	Quad Differential AND/NAND Gate	28		FN
416	Quint Differential Line Receiver	28		FN
431	3-Bit Differential Flip-Flop	28		FN
445	4-Bit Serial/Parallel Converter	28		FN
446	4-Bit Parallel/Serial Converter	28		FN
451	6-Bit D Register, With Differential Inputs, (Data & Clock) , VBB, Common Reset	28		FN
452	5-Bit Differential Register	28		FN
457	Triple Differential 2:1 Multiplexer	28		FN
1651*	Dual Analog Comparator With Latch	16		FN
1652*	Dual Analog Comparator With Latch (High Performance Version of MC10E1651)	16		FN

* Available in 10E only

Table 19. ECLinPS *Lite*

MC10EL/ MC100EL	Function	Pins	DIP	SM*
01	4-Input OR/NOR Gate	8		D
04	2-Input AND/NAND Gate	8		D
05	2-Input Differential AND/NAND Gate	8		D
07	2-Input XOR/NOR Gate	8		D
11	1:2 Differential Clock Driver	8		D
12	Driver	8		D
16	Differential Receiver	8		D
31	D Flip-Flop With Set & Reset	8		D
32	P 2 Divider	8		D
33	P 4 Divider	8		D
35	J-K Flip-Flop	8		D
51	Differential Clock D Flip-Flop	8		D
52	Differential Data & Clock D Flip-Flop	8		D
58	2:1 Multiplexer	8		D
89*	Coaxial Cable Driver	8		D

* Available in 10EL only

CMOS

Motorola offers three complete CMOS families, each enhanced for different design applications. Metal Gate CMOS, for low power and wide ranging voltage applications; High-Speed CMOS for compatibility with LSTTL; and FACT (Advanced CMOS) combining the best of both families with high speed, low power and high output drive characteristics.

Metal Gate CMOS

Motorola's Standard 14000 Series Metal Gate CMOS logic family consists of a full line of products which are pinout compatible with many LSTTL and High-Speed CMOS series devices. These Metal Gate CMOS devices meet or exceed the industry-standardized family specifications. Some additional features are:

- Very Low Power Dissipation
- Available Packages: Dual-in-Line Ceramic, Dual-in-Line Plastic and SOIC
- Electrical Parameters Specified –55°C to +125°C on all packages
- 3–18 Volt Operational Limits
- Parameters Specified at 5.0V, 10V and 15V Supply
- Capable of Driving Two Low-Power TTL Loads or One Low-Power Schottky TTL Load Over the Rated Temperature Range
- Direct Interface to High-Speed CMOS and Many LSTTL Devices
- Maximum Input Current of ±1.0μA at 15V Power Supply Over the Temperature Range
- Noise Margins:
  - B Series (Buffered)
    - 1.0V Min @ 5.0V Supply
    - 2.0V Min @ 10V Supply
    - 2.5V Min @ 15V Supply
  - UB Series (Unbuffered)
    - 0.5V Min @ 5.0V Supply
    - 1.0V Min @ 10V Supply
    - 1.0V Min @ 15V Supply
- UB Devices Have Single Inverting Stage Between Input and Output

  Can Be Used in a Linear Mode to Form Oscillators, Monostables or Amplifiers

  Decreased Gain Results in Increased Stability and a Cleaner Output Waveform

  Increases Speed Since Only a Single Stage Is Involved

High-Speed CMOS

Motorola's High-Speed CMOS logic family consists of a full line of products that are pinout compatible with many LSTTL and MC14000B Standard CMOS series devices. Use of silicon-gate processing technology allows the High-Speed CMOS family to combine the switching speeds and operating frequencies of LSTTL with the lower power consumption and high noise immunity advantages of CMOS.

- Wide Operating Voltage Range
  - HC/HCU: 2.0–6.0V Recommended
  - HCT: 5.0V ±10% Recommended
- High Noise Immunity
- High Fanout
  - Standard Outputs Drive 10 LSTTL Loads (4mA)
  - Bus Outputs Drive 15 LSTTL Loads (6mA)
- Wide Operating Temperature Range: –55°C to +125°C
- Low Input Current
- Low Power Dissipation
- Improved ESD and Latch-Up Performance
- Direct Pin Compatibility:
  - HCXXX or HCTXXX With LSTTL
  - HC4XXX With CMOS
- Input Logic Compatible:
  - HCXXX or HC4XXX With CMOS
  - HCTXXX With LSTTL
- Available Packages: Dual-in-Line Ceramic, Dual-in-Line Plastic and SOIC
- Proven Reliability and Process:
  - Reliability Report Available From Your Local Motorola Sales Office

FACT CMOS

Motorola FACT is the latest advanced family of CMOS logic devices which offer system designers a solution to the problem of high speed and low power in a standard product. Until now, designers had to choose between either high speed with large power consumption, or low power with low speed.

Motorola FACT is fabricated using a sub-two micron, silicon gate process. This process has been proven in the past few years in high performance gate arrays and is the basis of the product family for future logic systems.

FACT is faster than any previous CMOS technology and approaches the speed of advanced bipolar devices. This superior speed allow direct replacement of slower speed CMOS or bipolar products with the inherent capabilities of advanced CMOS.

Low power consumption is a major advantage of CMOS. During standby operating mode, power consumption is near zero.

- High Output Drive: Sink or Source 24mA
- Providing Wide Logic Fanout and Will Drive a 50Ω Transmission Line
- Noise Immunity: Consistent, Predictable, Wide Margin Input Switching Level
- Standardized Packages/Pinouts: Available in Either Dual-in-Line or SOIC Packages
- Function Pinouts Adhere to Industry Standards for Interchangeability and Circuit Layout
- Motorola FACT Is Directly Interchangeable and Has Identical Performance Specifications With FACT From National Semiconductor Corporation

Logic Family Comparisons

General Characteristics (All Maximum Ratings)

Characteristics	Symbol	LS	ALS	HCMOS	FACT	Unit
Operating Voltage Range	$V_{CC/EE/DD}$	5 ± 5%	5 ± 10%	2.0 to 6.0	2.0 to 6.0	V
Operating Temperature	t_A 74 Series	0 to +70	0 to +70	–55 to +125	–40 to +85	°C
Input Voltage (limits)	V_{IH} (min)	2.0	2.0	3.15	3.15	V
	V_{IL} (max)	0.8	0.8	0.9	1.35	V
Output Voltage (limits)	V_{OH} (min)	2.7	2.7	V_{CC} – 0.1	V_{CC} – 0.1	V
	V_{OL} (max)	0.5	0.5	0.1	0.1	V
Input Current	I_{IH}	20	20	+1.0	+1.0	µA
	I_{IL}	–400	–200	–1.0	–1.0	µA
Output Current @ V_O (limit)	I_{OH}	–0.4	–0.4	–4.0 @ V_{CC} –0.8	–24 @ V_{CC} – 0.8	mA
	I_{OL}	8.0	8.0	4.0 @ 0.4 V	24 @ 0.4 V	mA
DC Noise Margin LOW/HIGH	DCM	0.3/0.7	0.4/0.7	0.8/1.25	1.25/1.25	V
DC Fanout (LSTTL Unit Loads)		20	20	10	60	Unit Loads

Speed/Power Characteristics (All Typical Ratings)

Characteristics	Symbol	LS	ALS	HCMOS	FACT	Unit
Quiescent Supply Current/Gate	I_G	0.4	0.2	0.0005	0.0005	mA
Power/Gate (Quiescent)	P_G	2.0	1.2	0.0025	0.0025	mW
Propagation Delay	t_P	7.0	5.0	8.0	4.8	ns
Speed Power Product	—	14	6.0	0.02	0.01	pJ
Clock Frequency D/FF	f_{max}	33	50	50	160	MHz

CMOS (continued)

Table 20. Standard 14000 Series

MC	Function	Pins	DIP	SM
14000UB	Dual 3-Input NOR Gate + Inverter (Unbuffered)	14	P,L	D
14001B	Quad 2-Input NOR Gate	14	P,L	D
14001UB	Quad 2-Input NOR Gate (Unbuffered)	14	P,L	D
14002B	Dual 4-Input NOR Gate	14	P,L	D
14002UB	Dual 4-Input NOR Gate (Unbuffered)	14	P,L	D
14006B	18-Bit Static Shift Register	14	P,L	D
14007UB	Dual Complementary Pair Plus Inverter (Unbuffered)	14	P,L	D
14008B	4-Bit Full Adder	16	P,L	D
14011B	Quad 2-Input NAND Gate	14	P,L	D
14011UB	Quad 2-Input NAND Gate (Unbuffered)	14	P,L	D
14012B	Dual 4-Input NAND Gate	14	P,L	D
14012UB	Dual 4-Input NAND Gate (Unbuffered)	14	P,L	D
14013B	Dual D Flip/Flop	14	P,L	D
14014B	8-Bit Static Shift Register	16	P,L	D
14015B	Dual 5-Bit Shift Register	16	P,L	D
14016B	Quad Analog Switch/Multiplexer	14	P,L	D
14017B	Decade Counter	16	P,L	D
14018B	Presettable Divide-by-N Counter	16	P,L	D
14020B	14-Bit Binary Counter	16	P,L	D
14021B	8-Bit Static Shift Register	16	P,L	D
14022B	Octal Counter	16	P,L	D
14023B	Triple 3-Input NAND Gate	14	P,L	D
14023UB	Triple 3-Input NAND Gate (Unbuffered)	14	P,L	D
14024B	7-stage Ripple Counter	14	P,L	D
14025B	Triple 3-Input NOR Gate	14	P,L	D
14025UB	Triple 3-Input NOR Gate (Unbuffered)	14	P,L	D
14027B	Dual J-K Flip/Flop	16	P,L	D
14028B	BCD-to-decimal Decoder	16	P,L	D
14029B	Presettable Binary/BCD Up/Down Counter	16	P,L	D
14035B	4-Bit Shift Register	16	P,L	D
14038B	Triple Serial Adder(Negative Logic)	16	P,L	D
14040B	12-Bit Binary Counter	16	P,L	D
14042B	Quad Transparent Latch	16	P,L	D
14043B	Quad NOR R-S Latch	16	P,L	D
14044B	Quad NAND R-S Latch	16	P,L	D
14046B	Phase-Locked Loop	16	P,L	DW
14049B	Hex Inverter/buffer	16	P,L	D
14049UB	Hex Inverter/buffer (Unbuffered)	16	P,L	D
14050B	Hex Buffer/Non Inverting	16	P,L	D

Table 20. Standard 14000 Series (continued)

MC	Function	Pins	DIP	SM
14051B	8-Channel Analog Multiplexer/Demultiplexer	16	P,L	D
14052B	Dual 4-Channel Analog Multiplexer/Demultiplexer	16	P,L	D
14053B	Triple 2-Channel Analog Multiplexer/Demultiplexer	16	P,L	D
14060B	14-Bit Binary Counter and Oscillator	16	P,L	D
14066B	Quad Analog Switch/Multiplexer	14	P,L	D
14067B	16-Channel Analog Multiplexer/Demultiplexer	24	P,L	DW
14068B	8-Input NAND Gate	14	P,L	D
14069UB	Hex Inverter (Unbuffered)	14	P,L	D
14070B	Quad Exclusive OR Gate	14	P,L	D
14071B	Quad 2-Input OR Gate	14	P,L	D
14072B	Dual 4-Input OR Gate	14	P,L	D
14073B	Triple 3-Input AND Gate	14	P,L	D
14075B	Triple 3-Input OR Gate	14	P,L	D
14076B	Quad D-Type Register With 3-State Outputs	16	P,L	D
14077B	Quad Exclusive NOR Gate	14	P,L	D
14078B	8-Input NOR Gate	14	P,L	D
14081B	Quad 2-Input AND Gate	14	P,L	D
14082B	Dual 4-Input AND Gate	14	P,L	D
14093B	Quad 2-Input NAND Schmitt Trigger	14	P,L	D
14094B	8-Stage Shift/Store Register With 3-State Outputs	16	P,L	D
14099B	8-Bit Addressable Latch	16	P,L	DW
14106B	Hex Schmitt Trigger	14	P,L	D
14161B	4-Bit Binary Counter, Synchronous Presettable	16	P,L	D
14163B	4-Bit Binary Counter, Synchronous Presettable	16	P,L	D
14174B	Hex D Flip/Flop	16	P,L	D
14175B	Quad D Flip/Flop	16	P,L	D
14194B	4-Bit Universal Shift Register	16	P,L	D
14415	Quad Precision Timer/Driver	16	P,L	DW
14490	Hex Contact Bounce Eliminator	16	P,L	DW
14500B	Industrial Control Unit	16	P,L	DW
14501UB	Dual 4-Input NAND, 2-Input NOR/OR, 8-Input AND/NAND Gate (Unbuffered)	16	P,L	D
14502B	Strobed Hex Inverter/Buffer	16	P,L	DW
14503B	Hex With 3-State Outputs Buffer (Noninverting)	16	P,L	D
14504B	Hex TTL OR CMOS to CMOS Hex Level Shifter	16	P,L	D
14506UB	Dual Expandable AND OR Invert Gate (Unbuffered)	16	P,L	D
14508B	Dual 4-Bit Latch	24	P,L	DW
14510B	Presettable BCD Up/Down Counter	16	P,L	D
14511B	BCD-to-7-segment Latch/Decoder/Driver	16	P,L	D,DW
14512B	8-channel Data Selector	16	P,L	D
14513B	BCD-to-7-segment Latch/Decoder/Driver With Ripple Blanking	18	P,L	
14514B	4-Bit Transparent Latch/4-to-16 Line Decoder(High)	24	P,L	DW

Table 20. Standard 14000 Series (continued)

MC	Function	Pins	DIP	SM
14515B	4-Bit Transparent Latch/4-to-16 Line Decoder(Low)	24	P,L	DW
14516B	Presettable Binary Up/Down Counter	16	P,L	D
14517B	Dual 64-Bit Static Shift Register	16	P,L	DW
14518B	Dual BCD Up Counter	16	P,L	DW
14519B	4-Bit AND/OR Selector	16	P,L	D
14520B	Dual Binary Up Counter	16	P,L	DW
14521B	24-Stage Frequency Divider	16	P,L	D
14522B	Presettable 4-Bit BCD Down Counter	16	P,L	DW
14526B	Presettable 4-Bit Binary Down Counter	16	P,L	DW
14527B	BCD Rate Multiplier	16	P,L	DW
14528B	Dual Monostable Multivibrator	16	P,L	D
14529B	Dual 4-Channel Analog Data Selector	16	P,L	D
14530B	Dual 5-Input Majority Logic Gate	16	P,L	D
14531B	12-Bit Parity Tree	16	P,L	D
14532B	8-Bit Priority Encoder	16	P,L	D
14534B	5 Cascaded BCD Counters	24	P,L	DW
14536B	Programmable Timer	16	P,L	DW
14538B	Dual Precision Monostable Multivibrator	16	P,L	D, DW
14539B	Dual 4-channel Data Selector/Multiplexer	16	P,L	D
14541B	Programmable Oscillator Timer	14	P,L	D
14543B	BCD-to-7-Segment Latch/Decoder/Driver for Liquid Crystals	16	P,L	D
14544B	BCD-to-7-Segment Latch/Decoder/Driver With Ripple Blanking	18	P,L	
14547B	High Current BCD-to-7-Segment Decoder/Driver	16	P,L	DW
14549B	Successive Approximation Register	16	P,L	DW
14551B	Quad 2-Channel Analog Multiplexer/Demultiplexer	16	P,L	D
14553B	3-Digit BCD Counter	16	P,L	DW
14555B	Dual Binary to 1-of-4 Decoder (Active High Outputs)	16	P,L	D
14556B	Dual Binary to 1-of-4 Decoder (Active Low Outputs)	16	P,L	D
14557B	1-to-64-Bit Variable Length Shift Register	16	P,L	DW
14558B	BCD-to-7-Segment Decoder	16	P,L	D
14559B	Successive Approximation Register	16	P,L	DW
14560B	NBCD Adder	16	P,L	D
14561B	9's Complementer	14	P,L	D
14562B	128-Bit Static Shift Register	14	P,L	
14566B	Industrial Time Base Generator	16	P,L	D
14568B	Phase Comparator and Programmable Counter	16	P,L	D
14569B	Programmable Dual Binary/BCD Counter	16	P,L	DW
14572UB	Hex NAND/NOR/Invert Gate (Unbuffered)	16	P,L	D
14583B	Dual Schmitt Trigger	16	P,L	D
14584B	Hex Schmitt Trigger	14	P,L	D
14585B	4-Bit Magnitude Comparator	16	P,L	D

Table 20. Standard 14000 Series (continued)

MC	Function	Pins	DIP	SM
14598B	8-Bit Bus Compatible Addressable Latch	18	P,L	
14599B	8-Bit Addressable Latch	18	P,L	

Table 21. High-Speed

MC54HC/ MC74HC	Function	Pins	DIP	SM
HC00A	Quad 2-Input NAND Gate	14	N,J	D
HC02A	Quad 2-Input NOR Gate	14	N,J	D
HC03A	Quad 2-Input NAND Gate With Open-Drain Outputs	14	N,J	D
HC04A	Hex Inverter	14	N,J	D
HCU04	Hex Unbuffered Inverter	14	N,J	D
HC08A	Quad 2-Input AND Gate	14	N,J	D
HC10	Triple 3-Input NAND Gate	14	N,J	D
HC11	Triple 3-Input AND Gate	14	N,J	D
HC14A	Hex Schmitt Trigger Inverter	14	N,J	D
HC20	Dual 4-Input NAND Gate	14	N,J	D
HC27	Triple 3-Input NOR Gate	14	N,J	D
HC30	8-Input NAND Gate	14	N,J	D
HC32A	Quad 2-Input OR Gate	14	N,J	D
HC42	1-of-10 Decoder	16	N,J	D
HC51	2-Wide, 2-Input/2-Wide, 3-Input AND-NOR Gate	14	N,J	D
HC58	2-Wide, 2-Input/2-Wide, 3-Input AND-OR Gate	14	N,J	D
HC73	Dual J-K Flip/Flop With Reset	14	N,J	D
HC74A	Dual D Flip/Flop With Set and Reset	14	N,J	D
HC75	Dual 2-Bit Transparent Latch	16	N,J	D
HC85	4-Bit Magnitude Comparator	16	N,J	
HC86	Quad 2-Input Exclusive OR Gate	14	N,J	D
HC107	Dual J-K Flip/Flop With Reset	14	N,J	D
HC109	Dual J-K(bar) Flip/Flop With Set and Reset	16	N,J	D
HC112	Dual J-K Flip/Flop With Set and Reset	16	N,J	D
HC125A	Quad With 3-State Outputs Noninverting Buffer	14	N,J	D
HC126A	Quad With 3-State Outputs Noninverting Buffer	14	N,J	D
HC132A	Quad 2-Input NAND Gate With Schmitt Trigger Inputs	14	N,J	D
HC133	13-Input NAND Gate	16	N,J	D
HC137	1-of-8 Decoder/Demultiplexer With Address Latch	16	N,J	D
HC138A	1-of-8 Decoder/Demultiplexer	16	N,J	D
HC139A	Dual 1-of-4 Decoder/Demultiplexer	16	N,J	D
HC147	Decimal-to-BCD Encoder	16	N,J	D
HC151	8-Input Data Selector/Multiplexer	16	N,J	D
HC153	Dual 4-Input Data Selector/Multiplexer	16	N,J	D
HC154	1-of-16 Decoder/Demultiplexer	24	N,J	DW
HC157A	Quad 2-Input Data Selector/Multiplexer	16	N,J	D

Table 21. High-Speed (continued)

MC54HC/ MC74HC	Function	Pins	DIP	SM
HC160	Presettable Counter	16	N,J	D
HC161A	Presettable Counter	16	N,J	D
HC162	Presettable Counter	16	N,J	D
HC163A	Presettable Counter	16	N,J	D
HC164	8-Bit Serial-Input/Parallel-Output Shift Register	14	N,J	
HC165	8-Bit Serial or Parallel-Input/Serial-Output Shift Register	16	N,J	D
HC173	Quad With 3-State Outputs D Flip/Flop With Common Clock & Reset	16	N,J	D
HC174A	Hex D Flip/Flop With Common Clock & Reset	16	N,J	D
HC175	Quad D Flip/Flop With Common Clock & Reset	16	N,J	D
HC194	4-Bit Bidirectional Universal Shift Register	16	N,J	
HC195	4-Bit Universal Shift Register	16	N,J	
HC237	1-of-8 Decoder/Demultiplexer With Address Latch	16	N,J	D
HC240A	Octal With 3-State Outputs Inverting Buffer/Line Driver/line Receiver	20	N,J	DW
HC241A	Octal With 3-State Outputs Noninverting Buffer/Line Driver/Line Receiver	20	N,J	DW
HC242	Quad With 3-State Outputs Inverting Bus Transceiver	14	N,J	
HC244A	Octal With 3-State Outputs Noninverting Buffer/Line Driver/Line Receiver	20	N,J	DW
HC245A	Octal With 3-State Outputs Noninverting Bus Transceiver	20	N,J	DW
HC251	8-Input Data Selector/Multiplexer With 3-State Outputs	16	N,J	D
HC253	Dual 4-Input Data Selector/Multiplexer With 3-State Outputs	16	N,J	D
HC257	Quad 2-Input Data Selector/Multiplexer With 3-State Outputs	16	N,J	D
HC259	8-Bit Addressable Latch/1-of-8 Decoder	16	N,J	D
HC273A	Octal D Flip/Flop With Common Clock & Reset	20	N,J	DW
HC280	9-Bit Odd/Even Parity Generator/Checker	14	N,J	D
HC299	8-Bit Bidirectional Universal Shift Register With parallel I/O	20	N,J	DW
HC365	Hex With 3-State Outputs Noninverting Buffer With separate 2-Bit/4-Bit Sections	16	N,J	
HC366	Hex With 3-State Outputs Inverting Buffer With Common Enables	16	N,J	
HC367	Hex With 3-State Outputs Noninverting Buffer With separate 2-Bit and 4-Bit Sections	16	N,J	
HC368	Hex With 3-State Outputs Inverting Buffer With separate 2-Bit and 4-Bit Sections	16	N,J	
HC373A	Octal With 3-State Outputs Noninverting Transparent Latch	20	N,J	DW
HC374A	Octal With 3-State Outputs Noninverting D Flip/Flop	20	N,J	DW
HC390	Dual 4-Stage Binary Ripple Counter W ÷2, ÷5 Sections	16	N,J	D
HC393	Dual 4-Stage Binary Ripple Counter	14	N,J	D
HC534A	Octal With 3-State Outputs Inverting D Flip/Flop	20	N,J	DW
HC540	Octal With 3-State Outputs Inverting Buffer/Line Driver/Line Receiver	20	N,J	DW
HC541	Octal With 3-State Outputs Noninverting Buffer/Line Driver/Line Receiver	20	N,J	DW
HC563	Octal With 3-State Outputs Inverting Transparent Latch	20	N,J	DW
HC564	Octal With 3-State Outputs Inverting D Flip/Flop	20	N,J	DW
HC573A	Octal With 3-State Outputs Noninverting Transparent Latch	20	N,J	DW
HC574A	Octal With 3-State Outputs Noninverting D Flip/Flop	20	N,J	DW
HC589	8-Bit Serial or Parallel-Input/Serial-Output Shift Register With 3-State Outputs	16	N,J	D
HC595A	8-Bit Serial-Input/Serial or Parallel-Output Shift Register With Latched 3-State Outputs	16	N,J	D

Table 21. High-Speed (continued)

MC54HC/ MC74HC	Function	Pins	DIP	SM
HC597	8-Bit Serial or Parallel-Input/Serial-Output Shift Register With Input Latch	16	N,J	D
HC640A	Octal With 3-State Outputs Inverting Bus Transceiver	20	N,J	DW
HC646	Octal With 3-State Outputs Noninverting Bus Transceiver & D Flip/Flop	24	N,J	DW
HC688	8-Bit Equality Comparator	20	N,J	DW
HC4002	Dual 4-Input NOR Gate	14	N,J	D
HC4016	Quad Analog Switch/Multiplexer/Demultiplexer	14	N,J	D
HC4017	Decade Counter	16	N,J	D
HC4020	14-Stage Binary Ripple Counter	16	N,J	
HC4024	7-Stage Binary Ripple Counter	14	N,J	D
HC4040	12-Stage Binary Ripple Counter	16	N,J	
HC4046A	Phase-Locked-Loop With VCO	16	N,J	D
HC4049	Hex Inverting Buffer/logic-level Down Converter	16	N,J	D
HC4050	Hex Noninverting Buffer/Logic-Level Down Converter	16	N,J	D
HC4051	8-Channel Analog Multiplexer/Demultiplexer	16	N,J	D
HC4052	Dual 4-Channel Analog Multiplexer/Demultiplexer	16	N,J	D
HC4053	Triple 2-Channel Analog Multiplexer/Demultiplexer	16	N,J	DW
HC4060	14-Stage Binary Ripple Counter With Oscillator	16	N,J	
HC4066	Quad Analog Switch/Multiplexer/Demultiplexer	14	N,J	D
HC4075	Triple 3-Input OR Gate	14	N,J	D
HC4078	8-Input NOR/OR Gate	14	N,J	D
HC4316	Quad Analog Switch/Multiplexer/Demultiplexer With Separate Analog/Digital Power Supplies	16	N,J	D
HC4351	8-ch Analog Multiplexer/Demultiplexer With Address Latch	20	N,J	DW
HC4353	Triple 2-Channel Analog Multiplexer/Demultiplexer With Address Latch	20	N,J	DW
HC4511	BCD-to-7 Segment Latch/Decoder/Display Driver	16	N,J	D
HC4514	1-of-16 Decoder/Demultiplexer With Address Latch	24	N,J	DW
HC4538A	Dual Precision Monostable Multivibrator Retriggerable, Resettable)	16	N,J	D
HC7266	Quad 2-Input Exclusive NOR Gate	14	N,J	D

Table 22. High-Speed — TTL Compatible Devices

MC54/ MC74	Function	Pins	DIP	SM
HCT00A	Quad 2-Input NAND Gate	14	N,J	D
HCT04A	Hex Inverter	14	N,J	D
HCT08A	Quad 2-Input AND Gate	14	N,J	D
HCT14A	Hex Schmitt Trigger Inverter	14	N,J	D
HCT32A	Quad 2-Input OR Gate	14	N,J	D
HCT74A	Dual D Flip/Flop With Set and Reset	14	N,J	D
HCT138A	1-of-8 Decoder/Demultiplexer	16	N,J	D
HCT157A	Quad 2-Input Data Selector/Multiplexer	16	N,J	D
HCT174A	Hex D Flip/Flop With Common Clock & Reset	16	N,J	D
HCT240A	Octal With 3-State Outputs Inverting Buffer/Line Driver/line Receiver	20	N,J	DW

Table 22. High-Speed — TTL Compatible Devices (continued)

MC54/ MC74	Function	Pins	DIP	SM
HCT241A	Octal With 3-State Outputs Noninverting Buffer/Line Driver/Line Receiver	20	N,J	DW
HCT244A	Octal With 3-State Outputs Noninverting Buffer/Line Driver/Line Receiver	20	N,J	DW
HCT245A	Octal With 3-State Outputs Noninverting Bus Transceiver	20	N,J	DW
HCT273A	Octal D Flip/Flop With Common Clock & Reset	20	N,J	DW
HCT373A	Octal With 3-State Outputs Noninverting Transparent Latch	20	N,J	DW
HCT374A	Octal With 3-State Outputs Noninverting D Flip/Flop	20	N,J	DW
HCT541	Octal With 3-State Outputs Noninverting Buffer/Line Driver/Line Receiver	20	N,J	DW
HCT573A	Octal With 3-State Outputs Noninverting Transparent Latch	20	N,J	DW
HCT574A	Octal With 3-State Outputs Noninverting D Flip/Flop	20	N,J	DW
HCT640A	Octal With 3-State Outputs Inverting Bus Transceiver	20	N,J	DW

Table 23. FACT

MC74	Function	Pins	DIP	SM
AC00	Quad 2-Input NAND Gate	14	N	D
AC02	Quad 2-Input NOR Gate	14	N	D
AC04	Hex Inverter	14	N	D
AC05	Hex Inverter With open Drain Outputs	14	N	D
AC08	Quad 2-Input AND Gate	14	N	D
AC10	Triple 3-Input NAND Gate	14	N	D
AC11	Triple 3-Input AND Gate	14	N	D
AC14	Hex Inverter Schmitt Trigger	14	N	D
AC20	Dual 4-Input NAND Gate	14	N	D
AC32	Quad 2-Input OR Gate	14	N	D
AC74	Dual D Flip-Flop	14	N	D
AC86	Quad 2-Input Exclusive OR Gate	14	N	D
AC109	Dual J-K Positive Edge Triggered Flip-Flop With Set & Clear	16	N	D
AC125	Quad Buffer With 3-State Outputs	14	N	D
AC126	Quad Buffer With 3-State Outputs	14	N	D
AC132	Quad 2-Input NAND Schmitt Trigger	14	N	D
AC138	1-of-8 Decoder/Demultiplexer	16	N	D
AC139	Dual 1-of-4 Decoder/Demultiplexer	16	N	D
AC151	1-of-8 Decoder/Multiplexer	16	N	D
AC153	Dual 4-Input Multiplexer	16	N	D
AC157	Quad 2-Input Multiplexer: Noninverting	16	N	D
AC158	Quad 2-Input Multiplexer: Inverting	16	N	D
AC160	Synchronous Presettable Binary-Coded-Decimal Decade Counter	16	N	D
AC161	Synchronous Presettable Binary Counter	16	N	D
AC162	Synchronous Presettable Binary-Coded-Decimal Decade Counter	16	N	D
AC163	Synchronous Presettable Binary Counter	16	N	D
AC174	Hex D Flip-Flop With Master Reset	16	N	D
AC175	Quad D Flip-Flop	16	N	D

Table 23. FACT (continued)

MC74	Function	Pins	DIP	SM
AC190	Up/Down Counter With Preset and Ripple Clock	16	N	D
AC194	4-Bit Bidirectional Universal Shift Register	16	N	D
AC240	Octal Buffer/Line Driver: With 3-State Outputs	20	N	DW
AC241	Octal Buffer/Line Driver: With 3-State Outputs	20	N	DW
AC244	Octal Buffer/Line Driver: With 3-State Outputs	20	N	DW
AC245	Octal Bidirectional Transceiver With 3-State Inputs/Outputs	20	N	DW
AC251	8-Input Multiplexer: With 3-State Outputs	16	N	D
AC253	Dual 4-Input Multiplexer With 3-State Outputs	16	N	DW
AC256	Dual 4-Bit Addressable Latch	16	N	DW
AC257	Quad 2-Input Multiplexer Noninverting With 3-State Outputs	16	N	D
AC258	Quad 2-Input Multiplexer Inverting With 3-State Outputs	16	N	DW
AC259	8-Bit Addressable Latch	16	N	D
AC273	Octal D Flip-Flop	20	N	DW
AC299	8-Input Universal Shift/Storage Register With Common Parallel I/O Pins: With 3-State Outputs	20	N	DW
AC323	8-Input Universal Shift/Storage Register With Syn Reset/Common Parallel I/O Pins: With 3-State Outputs	20	N	DW
AC350	4-Bit Shifter With 3-State	16	N	D
AC352	Dual 4-Input Multiplexer	16	N	DW
AC353	Dual 4-Input Multiplexer With 3-State Outputs	16	N	D
AC373	Octal Transparent Latch With 3-State Outputs	20	N	DW
AC374	Octal D Type Flip-Flop With 3-State Outputs	20	N	DW
AC377	Octal D Flip-Flop With Clock Enable	20	N	DW
AC378	6-Bit Parallel D Register With Enable	16	N	D
AC533	Octal Transparent Latch/ With 3-State Outputs	20	N	DW
AC534	Octal D Flip-flop/ With 3-State Outputs	20	N	DW
AC540	Octal Buffer/Line Driver: With 3-State Outputs	20	N	DW
AC541	Octal Buffer/Line Driver: With 3-State Outputs	20	N	DW
AC563	Octal D Latch With 3-State Outputs	20	N	DW
AC564	Octal D Latch With 3-State Outputs	20	N	DW
AC573	Octal D-Type Latch With 3-State Outputs	20	N	DW
AC574	Octal D-Type Latch With 3-State Outputs	20	N	DW
AC620	Octal Bidirectional Transceiver With 3-State Outputs	20	N	DW
AC623	Octal Bidirectional Transceiver With 3-State Outputs	20	N	DW
AC640	Octal Bidirectional Transceiver With 3-State Outputs	20	N	DW
AC643	Octal Bidirectional Transceiver With 3-State Outputs	20	N	DW
AC646	Octal Transceiver/Register With 3-State Outputs Noninverting	24	N	DW
AC648	Octal Transceiver/Register With 3-State Outputs Inverting	24	N	DW
AC652	Octal Bus Transceiver/Register With 3-State Outputs Noninverting	24	N	DW
AC810	Quad 2-Input Exclusive NOR Gate	14	N	DW
AC4020	14-stage Binary Ripple Counter	16	N	D
AC4040	12-stage Binary Ripple Counter	16	N	D

Table 24. FACT — TTL Compatible Devices

MC74	Function	Pins	DIP	SM
ACT00	Quad 2-Input NAND Gate	14	N	D
ACT02	Quad 2-Input NOR Gate	14	N	D
ACT04	Hex Inverter	14	N	D
ACT05	Hex Inverter With Open Drainput Output	14	N	D
ACT08	Quad 2-Input AND Gate	14	N	D
ACT10	Triple 3-Input NAND Gate	14	N	D
ACT11	Triple 3-Input AND Gate	14	N	D
ACT14	Hex Inverter Schmitt Trigger	14	N	D
ACT20	Dual 4-Input NAND Gate	14	N	D
ACT32	Quad 2-Input OR Gate	14	N	D
ACT74	Dual D Flip-Flop	14	N	D
ACT86	Quad 2-Input Exclusive OR Gate	14	N	D
ACT125	Quad Buffer 3-State	14	N	D
ACT126	Quad Buffer 3-State	14	N	D
ACT132	Quad 2-Input NAND Schmitt Trigger	14	N	D
ACT138	1-of-8 Decoder/Demux	16	N	D
ACT139	Dual 1-of-4 Decoder/Demux	16	N	D
ACT151	1-of-8 Decoder/Multiplexer	16	N	D
ACT153	Dual 4-Input Multiplexer	16	N	D
ACT157	Quad 2-Input Multiplexer: Non-Inverting	16	N	D
ACT160	Synchronous Presettable Binary-Coded-Decimal Decade Counter	16	N	D
ACT161	Synchronous Presettable Binary Counter	16	N	D
ACT162	Synchronous Presettable Binary-Coded-Decimal Decade Counter	16	N	D
ACT163	Synchronous Presettable Binary Counter	16	N	D
ACT174	Hex D Flip-Flop With Master Reset	16	N	D
ACT175	Quad D Flip-Flop	16	N	D
ACT194	4-Bit Bidirectional Universal Shift Register	16	N	D
ACT240	Octal Buffer/Line Driver: 3-State	20	N	DW
ACT241	Octal Buffer/Line Driver: 3-State	20	N	DW
ACT244	Octal Buffer/Line Driver: 3-State	20	N	DW
ACT245	Octal Bidirectional Transceiver With 3-State Inputs/Outputs	20	N	DW
ACT251	8-Input Multiplexer: 3-State	16	N	D
ACT253	Dual 4-Input Multiplexer With 3-State Outputs	16	N	DW
ACT256	Dual 4-Bit Addressable Latch	16	N	DW
ACT258	Quad 2-Input Multiplexer Inverting 3-State	16	N	DW
ACT259	8-Bit Addressable Latch	16	N	D
ACT273	Octal D Flip-Flop	20	N	DW
ACT299	8-Input Universal Shift/Storage Register With Common Parallel I/O Pins: 3-State	20	N	DW
ACT323	8-Input Universal Shift/Storage Register With Syn Reset/Common Parallel I/O Pins: 3-State	20	N	DW
ACT350	4-Bit Shifter With 3-State	16	N	D
ACT352	Dual 4-Input Multiplexer	16	N	DW

Table 24. FACT — TTL Compatible Devices (continued)

MC74	Function	Pins	DIP	SM
ACT353	Dual 4-Input Multiplexer With 3-State Outputs	16	N	D
ACT373	Octal Transparent Latch With 3-State Outputs	20	N	DW
ACT374	Octal D-Type Flip-Flop With 3-State Outputs	20	N	DW
ACT377	Octal D Flip-Flop With clock Enable	20	N	DW
ACT378	6-Bit Parallel D Register With Enable	16	N	D
ACT521	8-Bit Identity Comparator	20	N	DW
ACT533	Octal Transparent Latch With 3-State Outputs	20	N	DW
ACT534	Octal D Flip-Flop With 3-State Outputs	20	N	DW
ACT540	Octal Buffer/Line Driver: 3-State Outputs	20	N	DW
ACT541	Octal Buffer/Line Driver: 3-State Outputs	20	N	DW
ACT563	Octal D Latch With 3-State Outputs	20	N	DW
ACT564	Octal D Latch With 3-State Outputs	20	N	DW
ACT573	Octal D-Type Latch With 3-State Outputs	20	N	DW
ACT574	Octal D-Type Latch With 3-State Outputs	20	N	DW
ACT620	Octal Bidirectional Transceiver With 3-State Outputs	20	N	DW
ACT623	Octal Bidirectional Transceiver With 3-State Outputs	20	N	DW
ACT640	Octal Bidirectional Transceiver With 3-State Outputs	20	N	DW
ACT643	Octal Bidirectional Transceiver With 3-State Outputs	20	N	DW
ACT646	Octal Transceiver/Register With 3-State Outputs, Non-Inverting	24	N	DW
ACT648	Octal Transceiver/Register With 3-State Outputs, Inverting	24	N	DW
ACT652	Octal Bus Transceiver/Register, Non-Inverting 3-State	24	N	DW
ACT810	Quad 2-Input Exclusive NOR Gate	14	N	DW

MECL III

Table 25. MECL III

MC	Function	Pins	DIP	SM
1648**	Voltage Controlled Oscillator	14	P,L	D, FN
1650	Dual A/D Converter	16	L	
1651	Dual A/D Converter	16	L	
1658	Voltage Controlled Multivibrator	16	P,L	D, FN
1660	Dual 4-Input OR/NOR Gate	16	L	
1662	Quad 2-Input NOR Gate	16	L	
1670	Master-Slave Flip-Flop	16	L	
1672	Triple 2-Input Exclusive-OR Gate	16	L	
1692	Quad Line Receiver	16	L	

*≤ 20-Pin DIP = 20-Pin PLCC; > 20-Pin DIP = 28-Pin PLCC; See Conversion Table on page 3.1-58
**The MC1648 has a Non-Standard Conversion Table. For more information, refer to the Motorola MECL Data Book, DL122/D, REV 5.

HTL/DTL Circuits

Motorola still supplies a large selection of HTL (High-Threshold Logic) and DTL (Diode-Transistor Logic) circuits. These are recommended primarily for replacement purposes. A list of available type numbers is given below.

Table 26. DTL Circuits

Device Number	Function
MC830	Expandable NAND Gate
MC832	Expandable Buffer
MC836	Hex Inverter
MC837	Hex Inverter
MC840	Hex Inverter (without input diodes)
MC844	Expandable Dual Power Gate
MC845	Clocked Flip-Flop
MC846	Quad 2-Input NAND Gate
MC849	Quad 2-Input NAND Gate
MC936	Hex Inverter
MC937	Hex Inverter
MC944	Expandable Dual Power Gate
MC945	Clocked Flip-Flop
MC946	Quad 2-Input NAND Gate
MC951	Monostable Multivibrator
MC952	Dual J-K Flip-Flop (common clock and CD Separate SD)
MC953	Dual J-K Flip-Flop (separate clock and SD, No CD)

Table 27. HTL Circuits

Device Number	Function
MC660	Expandable Dual 4-Input Gate (active pullup)
MC661	Expandable Dual 4-Input Gate (passive pullup)
MC662	Expandable Dual 4-Input Line Driver
MC663	Dual J-K Flip-Flop
MC664	Master-Slave R-S Flip-Flop
MC667	Dual Monostable Multivibrator
MC668	Quad 2-Input Gate (passive pullup)
MC669	Dual 4-Input Expander
MC670	Triple 3-Input Gate (passive pullup)
MC671	Triple 3-Input Gate (active pullup)
MC672	Quad 2-Input Gate (active pullup)
MC677	Hex Inverter With Strobe (active pullup)
MC678	Hex Inverter With Strobe (without output resistors)

Ordering Information

Device Nomenclatures

LS — Low Power Schottky

SN VV WW XXXX Y

Standard Prefix — SN

Temperature Range — VV
- 74 Series (0 to +70°C)
- 54 Series (–55 to +125°C)

Family — WW
- LS = Low Power Schottky

Function Type — XXXX

Package Type — Y
- N for Plastic (74 Series Only)
- J for Ceramic
- D for 150 mil Plastic SOIC (74 Series Only)
- DW for 300 mil Plastic SOIC (74 Series Only)

FAST

MC VV W XXXX Y

Motorola Circuit Identifier — MC

Temperature Range — VV
- 74 Series (0 to +70°C)
- 54 Series (–55 to +125°C)

Family — W
- F = FAST

Function Type — XXXX

Package Type — Y
- N for Plastic (74 Series Only)
- J for Ceramic (54 Series Only)
- D for 150 mil Plastic SOIC (74 Series Only)
- DW for 300 mil Plastic SOIC (74 Series Only)

MECL 10K/MECL 10H

MC WWW XXX YY

Motorola Circuit Identifier — MC

Temperature Range — WWW
- 10 = 10K (–30 to +85°C)
- 10H = 10H (0 to +75°C)
- 100H = 100K Compatible (0 to +85°C)

Function Type — XXX

Package Type — YY
- P for Plastic
- L for Ceramic
- FN for PLCC

Device Nomenclatures (continued)

ECLinPS/ECLinPS Lite

MC WWW XX YYY ZZ

Motorola Circuit Identifier

Compatability Identifier
- 10 = 10H Compatible (0 to +85°C)
- 100 = 100K Compatible (0 to +85°C)

Package Type
- FN for PLCC

Function Type
- YYY = 3-Digits for ELCinPS
- YY = 2-Digits for ELCinPS Lite

ECLinPS Family Identifier
- E = ELCinPS
- EL = ELCinPS Lite

High-Speed CMOS

MC VV WWW XXXX Y

Motorola Circuit Identifier

Temperature Range
- 74 Series (–55 to +125°C)
- 54 Series (–55 to +125°C)

High-Speed CMOS Specification Identifier
- HC = Buffered High-Speed CMOS
- HCU = Unbuffered High-Speed CMOS*
- HCT = High-Speed CMOS TTL Compatible

*Not Available On All Devices

Package Type
- N for Plastic (74 Series Only)
- J for Ceramic (54 Series Only)
- D for 150 mil Plastic SOIC (74 Series Only)
- DW for 300 mil Plastic SOIC (74 Series Only)

Function Type
- XX(X) Same Function and Pin Configuration as LSTTL
- 4XXX Same Function and Pin Configuration as CMOS 14000
- 7XX(X) Variation of LSTTL or CMOS 14000 Device

14000 Series CMOS

MC1 4xxx YY ZZ

Motorola Circuit Identifier

Function Type

Identifier (per JEDEC Standard)
- B = Buffered Outputs
- UB = Unbuffered Outputs

Package and Temperature Range
- CL for Ceramic –55 to +125°C
- CP for Plastic –55 to +125°C
- D/DW for Small Outline Package (Plastic) –55 to +125°C

FACT

MC WWWWW XXX YY

Motorola Circuit Identifier

Temperature Range Family
- 74AC = FACT (–40 to +85°C)
- 74ACT = TTL Compatible (–40 to +85°C)

Package Type
- N for Plastic
- D for Narrow SOIC
- DW for Wide SOIC

Function Type

Device Nomenclatures (continued)

Special Logic Circuits

MC/MCCS WWWWWW X YY ZZ

Motorola Circuit Identifier
- MC = Standard Circuit Identifier
- MCCS = Circuit Chip-Set Identifier

Function Type

Option Suffix Indicator

Package Type
- N for Plastic
- D for Narrow SOIC
- FN for PLCC
- FJ for CLCC

Option Type

MECL III/HTL/DTL

MC XXXX Y

Motorola Circuit Identifier

Package Type
- P for Plastic
- L for Ceramic
- D for Narrow SOIC
- FN for PLCC

Function Type

ALExIS Products

MC XX YYY ZZZ –1

Motorola Circuit Identifier

Device Bit Width
- 16-, 18-, or 20-Bits

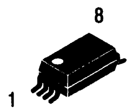
Family
- LX = Standard ALExIS Family Identifier

Package Type
- –1 = 64-Lead, 0.5mm Lead-Pitch, 10x10x2.1mm Body, Shipped in Trays, Dry Pack

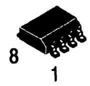
Function Type

Case Information

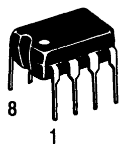
8-Pin Packages



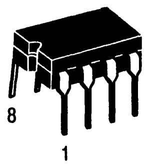
SD SUFFIX
SSOP PACKAGE
CASE 940-02



D SUFFIX
SOIC PACKAGE
CASE 751-03

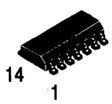


P SUFFIX
PLASTIC PACKAGE
CASE 626-04

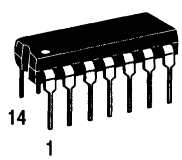


L SUFFIX
CERAMIC PACKAGE
CASE 693-03

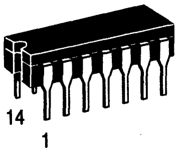
14-Pin Packages



D SUFFIX
SOIC PACKAGE
CASE 751A-02

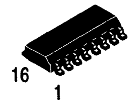


P,N SUFFIX
PLASTIC PACKAGE
CASE 646-06

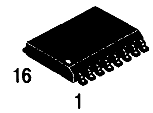


L,J SUFFIX
CERAMIC PACKAGE
CASE 632-08

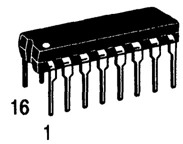
16-Pin Packages



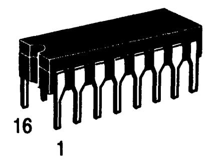
D SUFFIX
SOIC PACKAGE
CASE 751B-03



DW SUFFIX
SOIC PACKAGE
CASE 751G-01

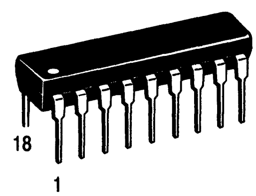


P,N SUFFIX
PLASTIC PACKAGE
CASE 648-08

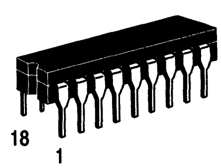


L,J SUFFIX
CERAMIC PACKAGE
CASE 620-09

18-Pin Packages

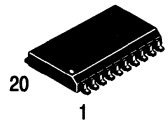


P,N SUFFIX
PLASTIC PACKAGE
CASE 707-02

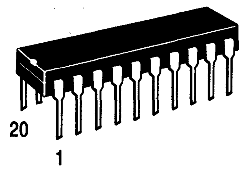


L,J SUFFIX
CERAMIC PACKAGE
CASE 726-04

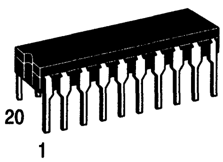
20-Pin Packages



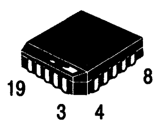
DW SUFFIX
SOIC PACKAGE
CASE 751D-03



P,N SUFFIX
PLASTIC PACKAGE
CASE 738-03

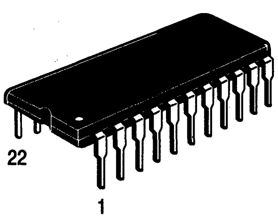


L,J SUFFIX
CERAMIC PACKAGE
CASE 732-03

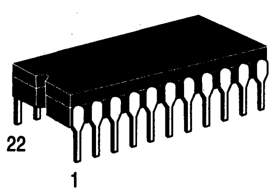


FN SUFFIX
PLASTIC LEADLESS CHIP
CARRIER (PLCC)
CASE 775-02

22-Pin Packages

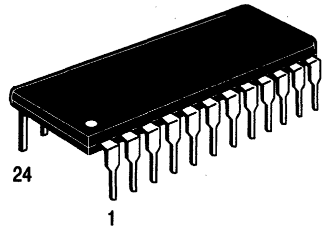


N SUFFIX
PLASTIC PACKAGE
CASE 708-04

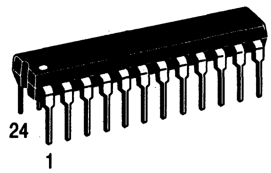


J SUFFIX
CERAMIC PACKAGE
CASE 736-05

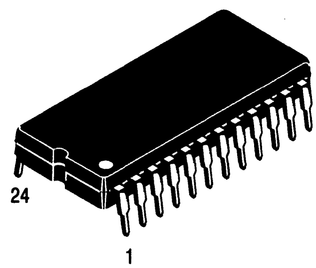
24-Pin Packages



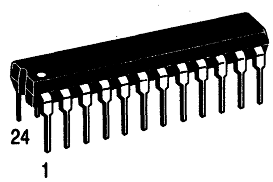
N SUFFIX
PLASTIC PACKAGE
CASE 709-02



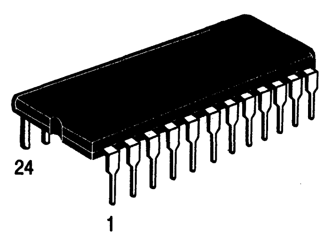
P,N SUFFIX
PLASTIC PACKAGE
CASE 724-03



P,N SUFFIX
PLASTIC PACKAGE
CASE 649-03
(PW FOR 10H181 ONLY)

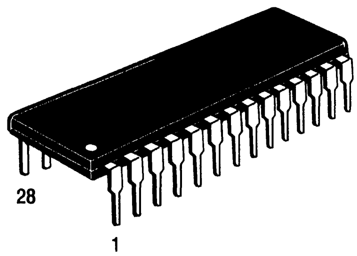


L,J SUFFIX
CERAMIC PACKAGE
CASE 758-01

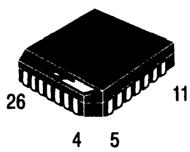


L,J SUFFIX
CERAMIC PACKAGE
CASE 623-05
(LW FOR 10H181 ONLY)

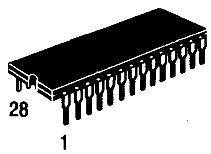
28-Pin Packages



N SUFFIX
PLASTIC PACKAGE
CASE 710-02

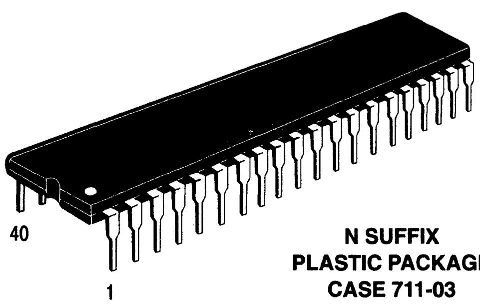


FN SUFFIX
PLASTIC LEADLESS CHIP
CARRIER (PLCC)
CASE 776-02



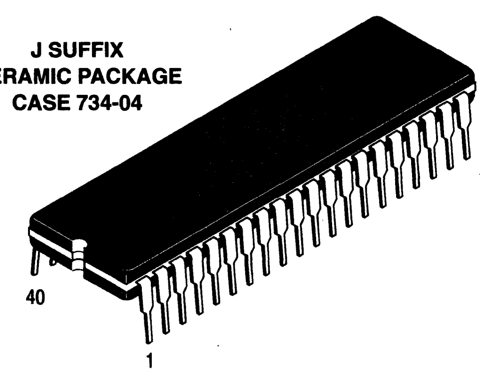
J SUFFIX
CERAMIC PACKAGE
CASE 733-04

40-Pin Packages

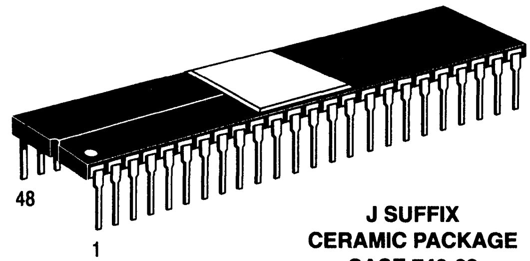


N SUFFIX
PLASTIC PACKAGE
CASE 711-03

J SUFFIX
CERAMIC PACKAGE
CASE 734-04

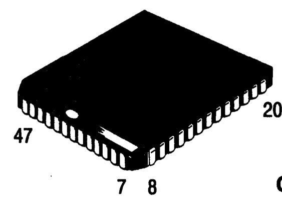


48-Pin Package



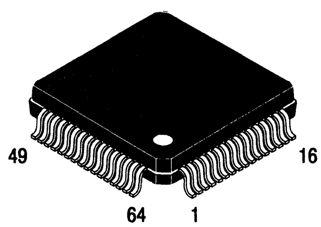
J SUFFIX
CERAMIC PACKAGE
CASE 740-03

52-Pin Package



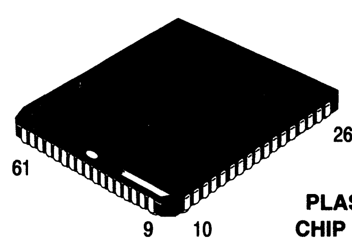
FJ SUFFIX
CERAMIC LEADLESS
CHIP CARRIER (CLCC)
CASE 778B-01

64-Pin Package



–1 SUFFIX
PLASTIC FQFP
PACKAGE
CASE 931–01

68-Pin Packages



FN SUFFIX
PLASTIC LEADLESS
CHIP CARRIER (PLCC)
CASE 779-02

Packaging Information

Surface Mount

Why Surface Mount?

Surface Mount Technology is now being utilized to offer answers to many problems that have been created in the use of insertion technology.

Limitations have been reached with insertion packages and PC board technology. Surface Mount Technology offers the opportunity to continue to advance the state-of-the-art designs that cannot be accomplished with Insertion Technology.

Surface Mount Packages allow more optimum device performance with the smaller Surface Mount configuration. Internal lead lengths, parasitic capacitance and inductance that placed limitations on chip performance have been reduced.

The lower profile of Surface Mount Packages allows more boards to be utilized in a given amount of space. They are stacked closer together and utilize less total volume than insertion populated PC boards.

Printed circuit costs are lowered with the reduction of the number of board layers required. The elimination or reduction of the number of plated through holes in the board, contributes significantly to lower PC board prices.

Automatic placement equipment is available that can place Surface Mount components at the rate of a few thousand per hour to hundreds of thousands of components per hour.

Surface Mount Technology is cost effective, allowing the manufacturer the opportunity to produce smaller units and/or offer increased functions with the same size product.

Surface Mount assembly does not require the preparation of components that are common on insertion technology lines. Surface Mount components are sent directly to the assembly line, eliminating an intermediate step.

For additional surface mount information, order Surface Mount Product Selector Guide (SG127/D)

Pin Conversion Tables

Dual-in-Line Package to PLCC Pin Conversion Data

The following table gives the equivalent I/O pinouts of Dual-In-Line Package (DIP) configuration and Plastic Leaded Chip Carrier (PLCC) packages.*

Table 28. Conversion Tables

8 PIN DIP	1	2	3	4	5	6	7	8
20 PIN PLCC	2	5	7	10	12	15	17	20

14 PIN DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14
20 PIN PLCC	2	3	4	6	8	9	10	12	13	14	16	18	19	20

16 PIN DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20 PIN PLCC	2	3	4	5	7	8	9	10	12	13	14	15	17	18	19	20

20 PIN DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
20 PIN PLCC	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

24 PIN DIP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
28 PIN PLCC	2	3	4	5	6	7	9	10	11	12	13	14	16	17	18	19	20	21	23	24	25	26	27	28

* The MC1648 has a Non-Standard Conversion Table. For more information, refer to the Motorola MECL Data Book, DL122/D, REV 5.

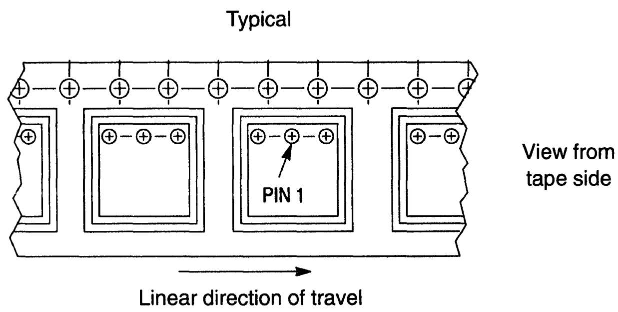
Tape and Reel

Standard Bipolar Logic Integrated Circuits

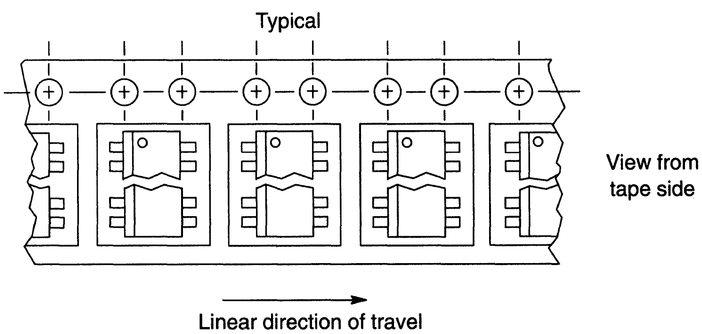
Motorola has now added the convenience of Tape and Reel packaging for Motorola's growing family of standard Integrated Circuit products. The packaging fully conforms to the latest EIA RS-481A specification. The antistatic embossed tape provides a secure cavity sealed with a peel-back cover tape.

Mechanical Polarization

PLCC Devices



SOIC Devices



General Information

— Reel Size	13 inch (330 mm) Suffix: R2	— Units/Reel	500 to 5000 (see table)
— Tape Width	12 mm to 24 mm (see table)		

Ordering Information

To order devices which are to be delivered in Tape and Reel, add the suffix R2 to the device number being ordered.

Tape and Reel Data

Device Type	Tape Width (mm)	Device/Reel	Reel Size (inch)	Min Lot Size Per Part No. Tape and Reel
PLCC-20	16	1,000	13	3,000
PLCC-28	24	500	13	500
SO-8	12	2,500	13	5,000
SO-14	16	2,500	13	5,000
SO-16	16	2,500	13	5,000
SO-16 Wide	16	1,000	13	5,000
SO-20 Wide	24	1,000	13	5,000

Logic Literature Listing

For additional information, refer to the following Motorola Logic documents, available through the Literature Distribution Center.

Logic New Product Calendar

BR1332/D	Logic New Product Calendar

Selector Guides

SG73/D	Motorola Semiconductor Master Selection Guide
SG127/D	Surface Mount Products Selector Guide
SG365/D	Timing Solutions Folder Selector Guide
SG366/D	TTL, ECL, CMOS and Special Logic Circuits Selector Guide

Data Books

DL121/D	FAST AND LS TTL DATA
DL122/D	MECL DEVICE DATA
DL129/D	HIGH-SPEED CMOS LOGIC DATA
DL131/D	CMOS LOGIC DATA
DL138/D	FACT DEVICE DATA
DL140/D	ECLinPS DATA

Design Handbooks

HB205/D	MECL Systems Design Handbook

Application Notes

AN1091/D	Low Skew Clock Drivers and Their System Design Considerations
AN1092/D	Driving High Capacitance DRAMs in an ECL System
AN1400/D	H64x Clock Driver I/O SPICE Modelling Kit
AN1401/D	Using SPICE to Analyze the Effects of Board Layout on System Skew When Designing With the MC10/100640 Family of Clock Drivers
AN1402/D	MC10/100H600 Translator Family I/O SPICE Modelling Kit
AN1403/D	FACT I/O Model Kit
AN1404/D	ECLinPS Circuit Performance at Non-Standard VIH Levels
AN1405/D	ECL Clock Distribution Techniques
AN1406/D	Designing With PECL (ECL at +5.0V)
AN1407/D	Performance Testing With the ALExIS Mini-Evaluation Boards
AN1408/D	Power Dissipation for Active SCSI Terminators
AN1503/D	ECLinPS I/O SPICE Modelling Kit
AN1504/D	Metastability and the ECLinPS Family

Other Literature

BR1330/D	ECLinPS Lite (Single Gate ECL Devices and Translators)
BR1331/D	ALExIS - Advanced Low-Power Expandable Interface Solutions Folder
BR1333/D	Motorola Timing Solutions
BR1334/D	High Performance Frequency Control Products
BR1336/D	MC22VIO PLD Folder
BR1409/D	Motorola ECL300 LogicArray

Linear and Interface Integrated Circuits

In Brief . . .

Motorola linear and interface integrated circuits cover a much broader range of products than the traditional op amps, regulators and consumer-image associated with linear suppliers. Linear circuit technology currently influences the design and architecture of equipment for all major markets. As with other integrated circuit technologies, linear circuit design techniques and processes have been continually refined and updated to meet the needs of these diversified markets.

Operational amplifiers have utilized JFET inputs for improved performance, plus innovative design and trimming concepts have evolved for improved high performance and precision characteristics. In linear power ICs, basic voltage regulators have been refined to include higher current levels and more precise three-terminal fixed and adjustable voltages. The power area continues to expand into switching regulators, power supply control and supervisory circuits, and motor controllers.

Linear designs also offer a wide array of line drivers, receivers and transceivers for many of the EIA, European, IEEE and IBM interface standards. Peripheral drivers for a variety of devices are also offered. In addition to these key interface functions, a variety of magnetic and semiconductor memory read, write, sense and RAM control circuits are also available.

In data conversion, the original A-D and D-A converters have been augmented with high performance video speed and multiplying designs. Linear circuit technology has also provided precision low-voltage references for use in data conversion and other low temperature drift applications.

A host of special purpose linear devices have also been developed. These circuits find applications in telecommunications, radio, television, automotive, RF communications, and data transmission. These products have reduced the cost of RF communications, and have provided capabilities in telecommunications which make the telephone line convenient for both voice and data communications. Linear developments have also reduced the many discrete components formerly required for consumer functions to a few IC packages, and have made significant contributions to the rapidly growing market for electronics in automotive applications.

The table of contents provides a perspective of the many markets served by linear/interface ICs and of Motorola's involvement in these areas.

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Amplifiers and Comparators

In Brief . . .

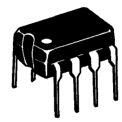
For over two decades, Motorola has continually refined and updated integrated circuit technologies, analog circuit design techniques and processes in response to the needs of the marketplace. The enhanced performance of newer operational amplifiers and comparators has come through innovative application of these technologies, designs and processes. Some early designs are still available but are giving way to the new, higher performance operational amplifier and comparator circuits. Motorola has pioneered in JFET inputs, low temperature coefficient input stages, Miller loop compensation, all NPN output stages, dual-doublet frequency compensation and analog "in-the-package" trimming of resistors to produce superior high performance operational amplifiers and comparators, operating in many cases from a single supply with low input offset, low noise, low power, high output swing, high slew rate and high gain-bandwidth product at reasonable cost to the customer.

Present day operational amplifiers and comparators find applications in all market segments including motor controls, instrumentation, aerospace, automotive, telecommunications, medical, and consumer products.

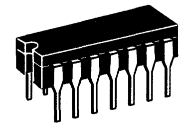
Page

Operational Amplifiers

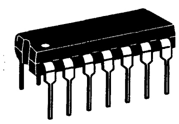
Motorola offers a broad line of bipolar operational amplifiers to meet a wide range of applications. From low-cost industry-standard types to high precision circuits, the span encompasses a large range of performance capabilities. These linear integrated circuits are available as single, dual and quad monolithic devices in a variety of temperature ranges and package styles. Most devices may be obtained in unencapsulated "chip" form as well. For price and delivery information on chips, please contact your Motorola Sales Representative or Distributor.



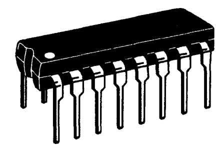
CASE 626
PLASTIC
N, P OR P1
SUFFIX



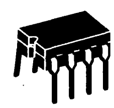
CASE 632
CERAMIC
J, L SUFFIX



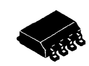
CASE 646
PLASTIC
N, N-14, P
OR P2 SUFFIX



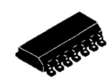
CASE 648, 648C
PLASTIC
P2 SUFFIX



CASE 693
CERAMIC
J OR J-8, U,
JG SUFFIX



CASE 751
PLASTIC
D SUFFIX



CASE 751A
PLASTIC
D SUFFIX

Table 1. Single Operational Amplifiers

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW ($A_V = 1$) (MHz) Typ	SR ($A_V = 1$) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
Noncompensated											
Commercial Temperature Range (0°C to +70°C)											
LM301A	0.25	7.5	10	50	25	1.0	0.5	± 3.0	± 18	General Purpose	N/626, J/693
LM308A	7.0	0.5	5.0	1.0	80	1.0	0.3	± 3.0	± 18	Precision	N/626
MC1748C	0.5	6.0	15	200	20	1.0	0.5	± 3.0	± 18	General Purpose	P1
Industrial Temperature Range (–25°C to +85°C)											
LM201A	0.075	2.0	10	10	50	1.0	0.5	± 3.0	± 22	General Purpose	N/626, J/693
Military Temperature Range (–55°C to +125°C)											
LM101A	0.075	2.0	10	10	50	1.0	0.5	± 3.0	± 22	General Purpose	J/693
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF351	200 pA	10	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	N/626
LF356	200 pA	10	5.0	50 pA	50	2.0	15	± 5.0	± 18	JFET Input	J/693
LF356B	100 pA	5.0	5.0	20 pA	50	5.0	12	± 5.0	± 22	JFET Input	J/693
LF357	200 pA	10	5.0	50 pA	50	3.0	75	± 5.0	± 18	Wideband FET Input	J/693
LF357B	100 pA	5.0	5.0	20 pA	50	20	50	± 5.0	± 22	JFET Input	J/693
LF411C	200 pA	2.0	10	100 pA	25	8.0	25	+ 5.0	± 22	JFET Input, Low Offset, Low Drift	N/626, D/751

Table 1. Single Operational Amplifiers (continued)

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Max	Description	Suffix/ Package
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF441C	100 pA	5.0	10	50 pA	25	2.0	6.0	± 5.0	± 18	Low Power JFET Input	N/626
LM11C	100 pA	0.6	2.0	10 pA	250	1.0	0.3	± 3.0	± 20	Precision	N/626
LM11CL	200 pA	5.0	3.0	25 pA	50	1.0	0.3	± 3.0	± 20	Precision	N/626
LM307	0.25	7.5	10	50	25	1.0	0.5	± 3.0	± 18	General Purpose	N/626
MC1436	0.04	10	12	10	70	1.0	2.0	± 15	± 34	High Voltage	U
MC1741C	0.5	6.0	15	200	20	1.0	0.5	± 3.0	± 18	General Purpose	P1, U
MC1776C	0.003	6.0	15	3.0	100	1.0	0.2	± 1.2	± 18	µPower, Programmable	P1, U
MC3476	0.05	6.0	15	25	50	1.0	0.2	± 1.5	± 18	Low Cost µPower, Programmable	P1, U
MC34001	200 pA	10	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	P/626, U
MC34001B	200 pA	5.0	10	100 pA	50	4.0	13	± 5.0	± 18	JFET Input	P/626, U
MC34071	0.5	5.0	10	75	25	4.5	10	+ 3.0	+ 44	High Performance,	P/626, U
MC34071A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	Single Supply	P/626, U
MC34080	200 pA	1.0	10	100 pA	25	16	55	± 5.0	± 22	Decompensated	P/626, U
MC34081	200 pA	1.0	10	100 pA	25	8.0	30	± 5.0	± 22	High Speed JFET Input	P/626, U
MC34181	0.1 nA	2.0	10	0.05	25	4.0	10	± 2.5	± 18	Low Power JFET Input	P/626
TL071AC	200 pA	6.0	10	50 pA	50	4.0	13	± 5.0	± 18	Low Noise JFET Input	P/626, JG
TL071C	200 pA	10	10	50 pA	25	4.0	13	± 5.0	± 18	Low Noise JFET Input	P/626, JG
TL081AC	200 pA	6.0	10	100 pA	50	4.0	13	± 5.0	± 18	JFET Input	P/626, JG
TL081C	400 pA	15	10	200 pA	25	4.0	13	± 5.0	± 18	JFET Input	P/626, JG
Automotive Temperature Range (–40°C to +85°C)											
MC33071	0.5	5.0	10	75	25	4.5	10	+ 3.0	+ 44	High Performance,	P/626, U
MC33071A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	Single Supply	P/626, U
MC33171	0.1	4.5	10	20	50	1.8	2.1	+ 3.0	+ 44	Low Power Single Supply	P/626
MC33181	0.1 nA	2.0	10	0.05	25	4.0	10	± 2.5	± 18	Low Power JFET Input	P/626
Extended Automotive Temperature Range (–40°C to +105°C)											
MC33201	200 nA	6.0	2.0	50	50	2.2	1.0	+1.8	+12	Low V Rail-to-Rail™	P/626, D/751
Military Temperature Range (–55°C to +125°C)											
MC1536	0.02	5.0	10	3.0	100	1.0	2.0	± 15	± 40	High Voltage	U
MC1741	0.5	5.0	15	200	50	1.0	0.5	± 3.0	± 22	General Purpose	U
MC1776	0.0075	5.0	15	3.0	200	1.0	0.2	± 1.2	± 18	µPower, Programmable	L
MC35001B	100 pA	5.0	10	50 pA	50	4.0	13	± 5.0	± 22	JFET Input	U
MC35071	0.5	5.0	10	75	25	4.5	10	+ 3.0	+ 44	High Performance,	U
MC35071A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	Single Supply	U
MC35080	200 pA	1.0	10	100 pA	25	16	55	± 5.0	± 22	Decompensated	U
MC35081	200 pA	1.0	10	100 pA	25	8.0	30	± 5.0	± 22	High Speed JFET Input	U
MC35171	0.1	4.5	10	20	50	1.8	2.1	+ 3.0	+ 44	Low Power Single Supply	U
TL081M	200 pA	6.0	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	JG

Table 2. Dual Operational Amplifiers

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Max	Description	Suffix/ Package
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF353	200 pA	10	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	N/626

Amplifiers and Comparators

Table 2. Dual Operational Amplifiers (continued)

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
LF412C	200 pA	3.0	10	100 pA	25	4.0	13	+ 5.0	± 18	JFET Input, Low Offset, Low Drift	N/626, D/751
LF442C	100 pA	5.0	10	50 pA	25	2.0	6.0	± 5.0	± 18	Low Power JFET Input	N/626
LM358	0.25	6.0	7.0	50	25	1.0	0.6	± 1.5	± 18	Single Supply,	N/626, J/693
								+ 3.0	+ 36	Low Power Consumption	
LM833	1.0	5.0	2.0	200	31.6	15	7.0	± 2.5	± 18	Low Noise, Audio	N/626
MC1458	0.5	6.0	10	200	20	1.1	0.8	± 3.0	± 18	Dual MC1741	P1, U
MC1458C	0.7	10	10	300	20	1.1	0.8	± 3.0	± 18	General Purpose	P1
MC1747C	0.5	6.0	10	200	25	1.0	0.5	± 3.0	± 18	Dual MC1741	L, P2
MC3458	0.5	10	7.0	50	20	1.0	0.6	± 1.5	± 18	Split Supplies	P1, U
								+ 3.0	+ 36	Single Supply	
										Low Crossover Distortion	
MC4558AC	0.5	5.0	10	200	50	2.8	1.6	± 3.0	± 22	High Frequency	P1
MC4558C	0.5	6.0	10	200	20	2.8	1.6	± 3.0	± 18	High Frequency	P1, U
MC34002	100 pA	10	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	P/626
MC34002B	100 pA	5.0	10	70 pA	25	4.0	13	± 5.0	± 18	JFET Input	P/626
MC34072	0.5	5.0	10	75	25	4.5	10	+ 3.0	+ 44	High Performance,	P/626, U
MC34072A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	Single Supply	P/626, U
MC34082	200 pA	3.0	10	100 pA	25	8.0	30	± 5.0	± 22	High Speed JFET Input	P/626
MC34083	200 pA	3.0	10	100 pA	25	16	55	± 5.0	± 22	Decompensated	P/626
MC34182	0.1 nA	3.0	10	0.05	25	4.0	10	± 2.5	± 18	Low Power JFET Input	P/626
TL062AC	200 pA	6.0	10	100 pA	4.0	2.0	6.0	± 2.5	± 18	Low Power JFET Input	P/626
TL062C	200 pA	15	10	200 pA	4.0	2.0	6.0	± 2.5	± 18	Low Power JFET Input	P/626
TL072AC	200 pA	6.0	10	50 pA	50	4.0	13	± 5.0	± 18	Low Noise JFET Input	P/626, JG/693
TL072C	200 pA	10	10	50 pA	25	4.0	13	± 5.0	± 18	Low Noise JFET Input	P/626, JG/693
TL082AC	200 pA	6.0	10	100 pA	50	4.0	13	± 5.0	± 18	JFET Input	P/626, JG/693
TL082C	400 pA	15	10	200 pA	25	4.0	13	± 5.0	± 18	JFET Input	P/626, JG/693

Industrial Temperature Range (–25°C to +85°C)

LM258	0.15	5.0	10	30	50	1.0	0.6	± 1.5	± 18	Split or Single	N/626, J/693
								+ 3.0	+ 36	Supply Op Amp	

Automotive Temperature Range (–40°C to +85°C)

LM2904	0.25	7.0	7.0	50	100 typ	1.0	0.6	± 1.5	± 13	Split Supplies	N/626, J/693
								+ 3.0	+ 26	Single Supply	
MC3358	5.0	8.0	10	75	20	1.0	0.6	± 1.5	± 18	Split Supplies	P1/626
								+ 3.0	+ 36	Single Supply	
MC33072	0.50	5.0	10	75	25	4.5	10	+ 3.0	+ 44	High Performance,	P/626, U
MC33072A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	Single Supply	P/626, U
MC33076	0.5	4.0	2.0	70	25	7.4	2.6	± 2.0	± 18	High Output Current	P1/626 P2/648C
MC33077	1.0	1.0	2.0	180	150	37	11	± 2.5	± 18	Low Noise	P/626
MC33078	750 nA	2.0	2.0	150	31.6	16	7.0	± 5.0	± 18	Low Noise	N/626
MC33102											
(Awake)	500 nA	2.0	1.0	6.0	50	4.0	1.0	± 2.5	± 18	Sleepmode™	P/626,
(Sleep)	50 nA	2.0	1.0	6.0	25	0.3	0.1	± 2.5	± 18	Micropower	D/751
MC33172	0.10	4.5	10	20	50	1.8	2.1	+ 3.0	+ 44	Low Power Single Supply	P/626
MC33178	0.5	3.0	2.0	50	50	5.0	2.0	± 2.0	± 18	High Output Current	P/626
MC33182	0.1 nA	3.0	10	0.05	25	4.0	10	± 2.5	± 18	Low Power JFET Input	P/626
MC33272	650 nA	1.0	0.56	25 nA	31.6	5.5	11.5	± 1.5	± 18	High Performance	P/626
MC33282	100 pA	200 µV	5.0	50 pA	50	30	12	± 2.5	± 18	Low Input Offset JFET	P/646
TL062V	200 pA	6.0	10	100 pA	4.0	2.0	6.0	± 2.5	± 18	Low Power JFET Input	P/626

Table 2. Dual Operational Amplifiers (continued)

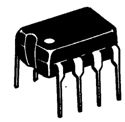
Device	I_{IB} (μA) Max	V_{IO} (mV) Max	TC_{VIO} (μV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW ($A_V = 1$) (MHz) Typ	SR ($A_V = 1$) (V/μs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
Extended Automotive Temperature Range (–40°C to +105°C)											
MC33202	200 nA	6.0	2.0	50	50	2.2	1.0	+1.8	+12	Low V Rail-to-Rail™	P/626, D/751
Extended Automotive Temperature Range (–40°C to +125°C)											
TCA0372	500 nA	15	20	50	30	1.1	1.4	+ 5.0	+ 36	Power Op Amp Single Supply	DP1/626 DP2/648
Military Temperature Range (–55°C to +125°C)											
LM158	0.15	5.0	10	30	50	1.0	0.6	± 1.5 + 3.0	± 18 + 36	Split Supplies Single Supply Low Power Consumption	J/693
MC1558	0.5	5.0	10	200	50	1.1	0.8	± 3.0	± 22	Dual MC1741	U
MC1747	0.5	5.0	10	200	50	1.0	0.5	± 3.0	± 22	Dual MC1741	L
MC3558	0.5	5.0	10	50	50	1.0	0.6	± 1.5 + 3.0	± 18 + 36	Split Supplies Single Supply	U
MC4558	0.5	5.0	10	200	50	2.8	1.6	± 3.0	± 22	High Frequency	U
MC35002	100 pA	10	10	100 pA	25	4.0	13	± 5.0	± 22	JFET Input	U
MC35002B	100 pA	5.0	10	50 pA	50	4.0	13	± 5.0	± 22	JFET Input	U
MC35072	0.5	5.0	10	75	25	4.5	10	+ 3.0	+ 44	High Performance,	U
MC35072A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	Single Supply	U
MC35172	0.1	4.5	10	20	50	1.8	2.1	+ 3.0	+ 44	Low Power Single Supply	U
TL062M	200 pA	6.0	10	100 pA	4.0	2.0	6.0	± 2.5	± 18	Low Power JFET Input	JG
TL072M	200 pA	6.0	10	50 pA	35	4.0	13	± 5.0	± 18	Low Noise JFET Input	JG
TL082M	200 pA	6.0	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	JG

Table 3. Quad Operational Amplifiers

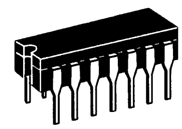
Device	I_{IB} (μA) Max	V_{IO} (mV) Max	TC_{VIO} (μV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW ($A_V = 1$) (MHz) Typ	SR ($A_V = 1$) (V/μs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
Internally Compensated											
Commercial Temperature Range (0°C to +70°C)											
LF347	200 pA	10	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	N/646
LF347B	200 pA	5.0	10	100 pA	50	4.0	13	± 5.0	± 18	JFET Input	N/646
LF444C	100 pA	10	10	50 pA	25	2.0	6.0	± 5.0	± 18	Low Power JFET Input	N/646
LM324	0.25	6.0	7.0	50	25	1.0	0.6	± 1.5 + 3.0	± 16 + 32	Low Power Consumption	J/632, N/646
LM348	0.2	6.0	—	50	25	1.0	0.5	± 3.0	± 18	Quad MC1741	J/632, N/646
MC3401/ LM3900	0.3	—	—	—	1.0	5.0	0.6	± 1.5 + 3.0	± 18 + 36	Norton Input	J/632, N/646
MC3403	0.5	10	7.0	50	20	1.0	0.6	± 1.5 + 3.0	± 18 + 36	No Crossover Distortion	L, P/646
MC4741C	0.5	6.0	15	200	20	1.0	0.5	± 3.0	± 18	Quad MC1741	L, P/646
MC34004	200 pA	10	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	L, P/646
MC34004B	200 pA	5.0	10	100 pA	50	4.0	13	± 5.0	± 18	JFET Input	L, P/646
MC34074	0.5	5.0	10	75	25	4.5	10	+ 3.0	+ 44	High Performance,	L, P/646
MC34074A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	Single Supply	L, P/646
MC34084	200 pA	12	10	100 pA	25	8.0	30	± 5.0	± 22	High Speed JFET Input	P/646
MC34085	200 pA	12	10	100 pA	25	16	55	± 5.0	± 22	Decompensated	P/646
MC34184	0.1 nA	10	10	0.05	25	4.0	10	± 2.5	± 18	Low Power JFET Input	P/646
TL064AC	200 pA	6.0	10	100 pA	4.0	2.0	6.0	± 2.5	± 18	Low Power JFET Input	N/646
TL064C	200 pA	15	10	200 pA	4.0	2.0	6.0	± 2.5	± 18	Low Power JFET Input	N/646

Table 3. Quad Operational Amplifiers (continued)

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	TC_{VIO} (µV/°C) Typ	I_{IO} (nA) Max	A_{vol} (V/mV) Min	BW (A_V = 1) (MHz) Typ	SR (A_V = 1) (V/µs) Typ	Supply Voltage (V) Min	Supply Voltage (V) Max	Description	Suffix/ Package
TL074AC	200 pA	6.0	10	50 pA	50	4.0	13	± 5.0	± 18	Low Noise JFET Input	J/632, N/646
TL074C	200 pA	10	10	50 pA	25	4.0	13	± 5.0	± 18	Low Noise JFET Input	J/632, N/646
TL084AC	200 pA	6.0	10	100 pA	50	4.0	13	± 5.0	± 18	JFET Input	J/632, N/646
TL084C	400 pA	15	10	200 pA	25	4.0	13	± 5.0	± 18	JFET Input	J/632, N/646
Industrial Temperature Range (–25°C to +85°C)											
LM224	0.15	5.0	7.0	30	50	1.0	0.6	± 1.5 + 3.0	± 16 + 32	Split Supplies Single Supply	J/632, N/646
LM248	0.2	6.0	—	50	25	1.0	0.5	± 3.0	± 18	Quad MC1741	J/632, N/646
Automotive Temperature Range (–40°C to +85°C)											
MC3301/ LM2900	0.3	—	—	—	1.0	4.0	0.6	± 2.0 + 4.0	± 15 + 28	Norton Input	P/646 N/646
LM2902	0.5	10	—	50	—	1.0	0.6	± 1.5 + 3.0	± 13 + 26	Differential Low Power	J/632, N/646
MC3303	0.5	8.0	10	75	20	1.0	0.6	± 1.5 + 3.0	± 18 + 36	Differential General Purpose	P/646
MC33074	0.5	4.5	10	75	25	4.5	10	+ 3.0	+ 44	High Performance, Single Supply	L, P/646
MC33074A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	High Performance	L, P/646
MC33079	750 nA	2.5	2.0	150	31.6	9.0	7.0	± 5.0	± 18	Low Noise	N/646
MC33174	0.1	4.5	10	20	50	1.8	2.1	+ 3.0	+ 44	Low Power Single Supply	P/646
MC33179	0.5	3.0	2.0	50	50	5.0	2.0	± 2.0	± 18	High Output Current	P/646
MC33184	0.1 nA	10	10	0.05	25	4.0	10	± 2.5	± 18	Low Power JFET Input	P/646
MC33274	650 nA	1.0	0.56	25 nA	31.6	5.5	11.5	± 1.5	± 18	High Performance	P/646
MC33284	100 pA	2.0	5.0	50 pA	50	30	12	± 2.5	± 18	Low Input Offset JFET	P/646
TL064V	200 pA	9.0	10	100 pA	4.0	2.0	6.0	± 2.5	±18	Low Power JFET Input	N/646
Extended Automotive Temperature Range (–40°C to +105°C)											
MC33204	200 nA	6.0	2.0	50	50	2.2	1.0	+1.8	+12	Low V Rail-to-Rail™	P/646, D/751A
Telecommunications Temperature Range (–40°C to +85°C)											
MC143403	1.0 nA	30	—	200 pA	45 dB	0.8	1.5	4.75	12.6	CMOS Low Power, Drives Low-Impedance Loads	L, P/646
MC143404	1.0 nA	30	—	200 pA	60 dB	0.8	1.0	4.75	12.6	CMOS Very Low Power	L, P/646
Military Temperature Range (–55°C to +125°C)											
LM124	0.15	5.0	7.0	30	50	1.0	0.6	± 1.5 + 3.0	± 16 + 32	Low Power Consumption	J/632, N/646
MC3503	0.5	5.0	7.0	50	50	1.0	0.6	± 1.5 + 3.0	± 18 + 36	General Purpose, Low Power	L, P/646
MC4741	0.5	5.0	15	200	50	1.0	0.5	± 3.0	± 22	Quad MC1741	L
MC35004	100 pA	10	10	100 pA	25	4.0	13	± 5.0	± 22	JFET Input	L
MC35004B	100 pA	5.0	10	50 pA	50	4.0	13	± 5.0	± 22	JFET Input	L
MC35074	0.5	5.0	10	75	25	4.5	10	+ 3.0	+ 44	High Performance, Single Supply	L
MC35074A	500 nA	3.0	10	50	50	4.5	10	+ 3.0	+ 44	High Performance	L
MC35084	200 pA	12	10	100 pA	25	8.0	30	± 5.0	± 22	High Speed JFET Input	L
MC35085	200 pA	12	10	100 pA	25	16	55	± 5.0	± 22	Decompensated	L
MC35174	0.1	4.5	10	20	50	1.8	2.1	+ 3.0	+ 44	Low Power, Single Supply	L
TL064M	200 pA	9.0	10	100 pA	4.0	2.0	6.0	± 2.5	± 18	Low Power JFET Input	J/632
TL074M	200 pA	9.0	10	50 pA	35	4.0	13	± 5.0	± 18	Low Noise JFET Input	J/632
TL084M	200 pA	9.0	10	100 pA	25	4.0	13	± 5.0	± 18	JFET Input	J/632

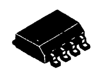


CASE 626
PLASTIC
P SUFFIX



CASE 632
CERAMIC
F, L SUFFIX

CASE 751
PLASTIC
D SUFFIX



High Frequency Amplifiers

A variety of high frequency circuits with features ranging from low cost simplicity to multi-function versatility marks Motorola's line of integrated amplifiers. Devices described here are intended for industrial and communications applications. For devices especially dedicated to consumer products, i.e., TV and entertainment radio. (See the Consumer Electronics Circuits section.)

AGC Amplifiers

MC1490P/MC1350P Family Wideband General Purpose Amplifiers

The MC1490 and MC1350 family are basic building blocks — AGC (Automatic Gain Controlled) RF/Video Amplifiers. These parts are recommended for applications up through 70 MHz. The best high frequency performance may be obtained by using the physically smaller SOIC version (shorter leads) — MC1350D. There are currently no other RF ICs like these, because other manufacturers have dropped their copies. Applications include variable gain video and instrumentation amplifiers, IF (Intermediate Frequency) amplifiers for radio and TV receivers, and transmitter power output control. Many uses will be found in medical instrumentation, remote monitoring, video/graphics processing, and a variety of communications equipment. The family of parts using the same basic die (identical circuit with slightly different test parameters) is listed in the following table.

MC1545/1445 Gated 2-Channel Input

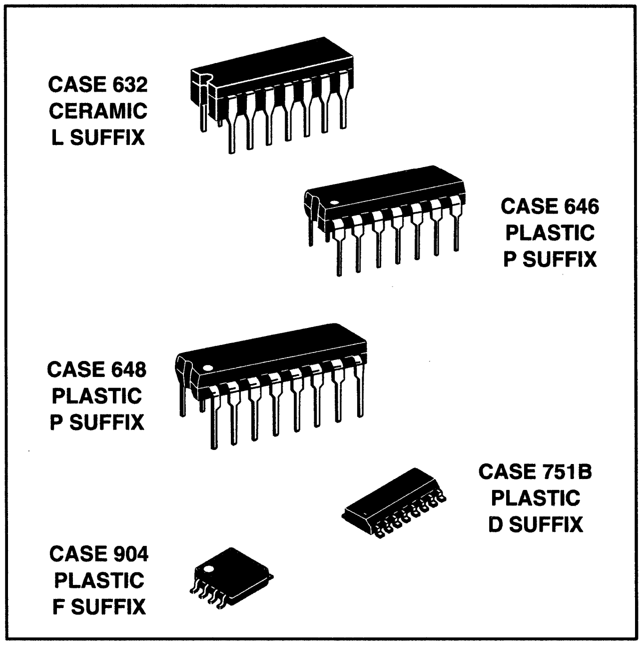
Differential input and output amplifier with gated 2-channel input provides for a wide variety of switching purposes. Typical 50 MHz bandwidth makes it suitable for high frequency applications such as video switching, FSK circuits, multiplexers, etc. Gating circuit is useful for AGC control.

Table 4. High-Frequency Amplifier Specifications

Operating Temperature Range			A_V (dB)	Bandwidth @ MHz	V_{CC}/V_{EE} (Vdc)		Suffix/ Package
–55° to +125°C	–40° to +85°C	0° to +70°C	Typ		Min	Max	
—	—	MC1350	50 50	45 45	+ 6.0	+ 18	P/626, D/751
—	MC1490	—	50 45 35	10 60 100	+ 6.0	+ 18	P/626
MC1545	—	MC1445	19	50	± 4.0	± 12	L/632

Miscellaneous Amplifiers

Motorola provides several Bipolar and CMOS special purpose amplifiers which fill specific needs. These devices range from low power CMOS programmable amplifiers and comparators to variable-gain bipolar power amplifiers.



MC3405/MC3505 Dual Operational Amplifier and Dual Voltage Comparator

This device contains two Differential Input Operational Amplifiers and two Comparators; each set capable of single supply operation. This operational amplifier-comparator circuit will find its applications as a general purpose product for automotive circuits and as an industrial "building block."

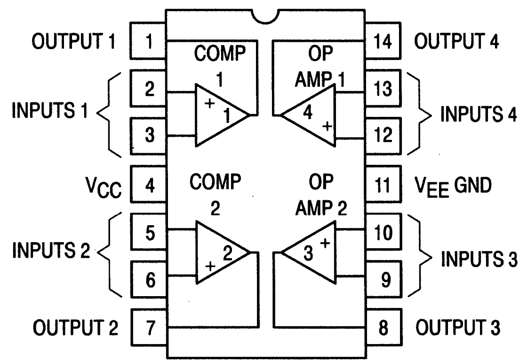


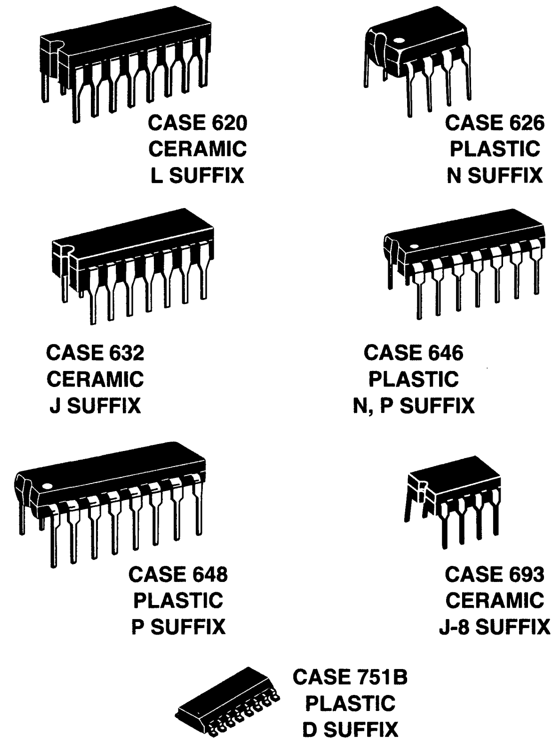
Table 5. Bipolar

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (nA) Max	A_{vol} (V/mV) Min	Response (µs) Typ	Supply Voltage Single	Supply Voltage Dual	Suffix/ Package
MC3405	0.5	10	50	20	1.3	3.0 to 36	± 1.5 to ± 18	L/632, P/646
MC3505	0.5	5.0	50	20	1.3	3.0 to 36	± 1.5 to ± 18	L/632

Table 6. CMOS
MC14573 Quad Programmable Operational Amplifier
MC14576B/MC14577B Dual Video Amplifiers
MC14575 Dual Programmable Operational Amplifier and Dual Programmable Comparator

Function	Quantity Per Package	Single Supply Voltage Range	Dual Supply Voltage Range	Frequency Range	Device Number	Suffix/ Package
Operational Amplifiers	4	3.0 to 15 V	± 1.5 to ± 7.5 V	DC to 1.0 MHz	MC14573	D/751B, P/648
Video Amplifiers	2	5 to 12 V(1)	± 2.5 to ± 6 V(2)	Up to 10 MHz	MC14576B MC14577B	P/626, F/904
Operational Amplifiers and Comparators	2 and 2	3 to 15 V	± 1.5 to ± 7.5 V	DC to 1.0 MHz	MC14575	D/751B, P/648

(1) 5.0 to 10 V for surface mount package
(2) ± 2.5 to ± 5 V for surface mount package



Comparators

Table 7. Single

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (µA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
Bipolar										
LM111	0.1	3.0	0.01	200 k	8.0	200	+ 15, – 15	With strobe, will operate from single supply	– 55 to + 125	J-8
LM211	0.1	3.0	0.01	200 k	8.0	200	+ 15, – 15		– 25 to + 85	J-8
LM311	0.25	7.5	0.05	200 k	8.0	200	+ 15, – 15		0 to + 70	N/626, J-8
CMOS										
MC14578	1.0 pA	50	—	—	1.1	—	3.5 to 14	Requires only 10 µA from single-ended supply	– 30 to + 70	P/648 D/751B

Table 8. Dual

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (µA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
Bipolar										
LM393	0.25	5.0	0.05	200 k	6.0	1300	± 1.5 to ± 18 or 3.0 to 36	Designed for single or split supply operation, input common mode includes ground (negative supply)	0 to + 70	N/626
LM393A	0.25	2.0	0.05	200 k	6.0	1300			0 to + 70	N/626
LM2903	0.25	7.0	0.05	200 k	6.0	1500			– 40 to + 85	N/626
MC3405	0.5	10	0.05	200 k	6.0	1300	± 1.5 to ± 7.5 or 3.0 to 15	This device contains 2 op amps and 2 comparators in a single package	0 to + 70	L, P/646
MC3505	0.5	5.0	0.05	200 k	6.0	1300			– 55 to + 125	L
CMOS										
MC14575	0.001	30	0.0001	2 k	3.0	1000	± 1.5 to ± 7.5 or 3.0 to 15	This device contains 2 op amps and 2 comparators in a single package	– 40 to + 85	P/648 D/751B

Comparators (continued)

Table 9. Quad

Device	I_{IB} (µA) Max	V_{IO} (mV) Max	I_{IO} (µA) Max	A_V (V/V) Typ	I_{IO} (mA) Min	Response Time (ns)	Supply Voltage (V)	Description	Temperature Range (°C)	Suffix/ Package
Bipolar										
LM139	0.1	5.0	0.025	200 k	6.0	1300	± 1.5 to ± 18 or 3.0 to 36	Designed for single or split supply operation, input common mode includes ground (negative supply)	– 55 to + 125	J
LM139A	0.1	2.0	0.025	200 k	6.0	1300			– 55 to + 125	J
LM239	0.25	5.0	0.05	200 k	6.0	1300			– 25 to + 85	J, N/646
LM239A	0.25	2.0	0.05	200 k	6.0	1300			– 25 to + 85	J, N/646
LM339	0.25	5.0	0.05	200 k	6.0	1300			0 to + 70	J, N/646
LM339A	0.25	2.0	0.05	200 k	6.0	1300			0 to + 70	J, N/646
LM2901	0.25	7.0	0.05	100 k	6.0	1300			– 40 to + 85	N/646
MC3302	0.5	20	0.5	30 k	6.0	1300			– 40 to + 85	P/646
MC3430	40	6.0	1.0 Typ	1.2 k	16	33	+ 5.0, – 5.0	High speed comparator/ sense-amplifier	0 to + 70	L, P/648
MC3431	40	10	1.0 Typ	1.2 k	16	33	+ 5.0, – 5.0		0 to + 70	L, P/648
MC3432	40	6.0	1.0 Typ	1.2 k	16	40	+ 5.0, – 5.0		0 to + 70	L, P/648
MC3433	40	10	1.0 Typ	1.2 k	16	40	+ 5.0, – 5.0		0 to + 70	L, P/648
CMOS										
MC14574	0.001	30	0.0001	2.0 k	3.0	1000	± 1.5 to ± 7.5 or 3.0 to 15	Externally programmable power dissipation with 1 or 2 resistors	– 40 to + 85	P/648 D/751B

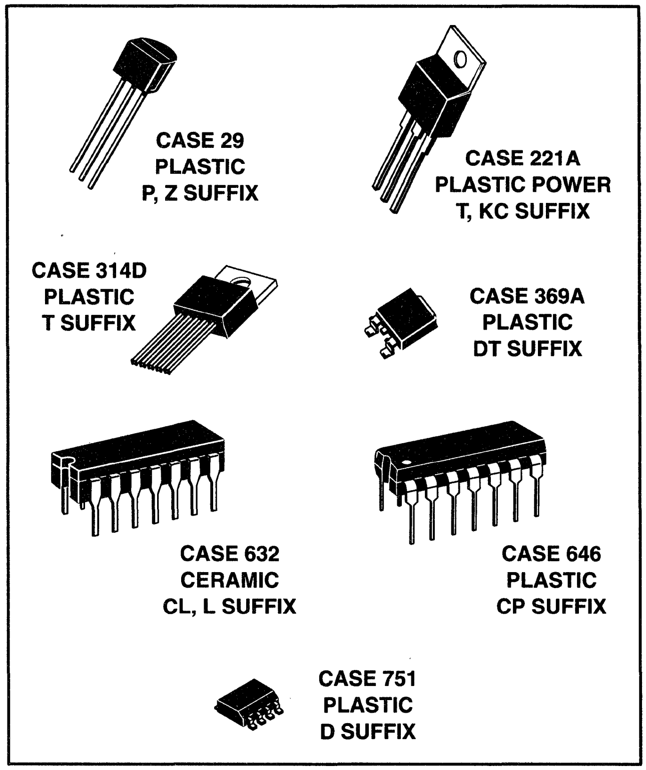
Power Supply Circuits

In Brief . . .

In most electronic systems some form of voltage regulation is required. In the past, the task of voltage regulator design was tediously accomplished with discrete devices, and the results were quite often complex and costly. Today, with bipolar monolithic regulators, this task has been significantly simplified. The designer now has a wide choice of fixed, low V_{diff}, adjustable, and tracking series-type voltage regulators. These devices incorporate many built-in protection features, making them virtually immune to the catastrophic failures encountered in older discrete designs.

The Switching Power Supply continues to increase in popularity and is one of the fastest growing markets in the world of power conversion. They offer the designer several important advantages over linear series-pass regulators. These advantages include significant advancements in the areas of size and weight reduction, improved efficiency, and the ability to perform voltage step-up, step-down, and voltage-inverting functions. Motorola offers a diverse portfolio of full featured switching regulator control circuits which meet the needs of today's modern compact electronic equipment.

Power supplies, MPU/MCU-based systems, industrial controls, computer systems and many other product applications are requiring power supervisory functions which monitor voltages to ensure proper system operation. Motorola offers a wide range of power supervisory circuits that fulfill these needs in a cost effective and efficient manner. MOSFET drivers are also provided to enhance the drive capabilities of first generation switching regulators or systems designed with CMOS/TTL logic devices. These drivers can also be used in DC-to-DC converters, motor controllers or virtually any other application requiring high speed operation of power MOSFETs.



Linear Voltage Regulators

Fixed Output

These low cost monolithic circuits provide positive and/or negative regulation at currents from 100 mA to 3.0 A. They are ideal for on-card regulation employing current limiting and thermal shutdown. Low V_{diff} devices are offered for battery powered systems.

Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

Table 10. Fixed-Voltage, 3-Terminal Regulators for Positive or Negative Polarity Power Supplies

V_{out} (V)	Tol.(1) (V)	I_O (mA) Max	Output Device		V_{in} Min/Max	Reg_{line} (mV)	Reg_{load} (mV)	$\Delta V_O/\Delta T$ (mV/°C) Typ	Suffix/ Package
			Positive	Negative					
3.3	± 0.03	800	MC33269-3.3	—	4.3/20	0.3%	0.5%	—	D, DT
5.0	± 0.5	100	LM2931-5.0	—	5.6/40	30	50	1.0	Z,T
			MC78L05C	MC79L05C	6.7/30	200	60		P
	± 0.25		LM2931A-5.0	—	5.6/40	30	50		Z, T
			MC78L05AC	MC79L05AC, AB	6.7/30	150	60		P, D
		500	MC78M05C	MC79M05C	7.0/35	100	100		DT, T
	± 0.5	750, 10	LM2935	—	5.6/26	30	50		T/314D
	± 0.25	1500	MC7805B(2)	—	8.0/35	100	100	1.0	T
			MC7805C	MC7905C	7.0/35				
	± 0.2		MC7805AC	MC7905AC	7.5/35	10		0.6	
	± 0.25		LM340-5	—	7.0/35	50	50		
	± 0.2		LM340A-5	—		10	25		
	± 0.1		TL780-05C	—		5.0		0.06	KC
	± 0.25	3000	MC78T05C	—	7.3/35	25	30	0.1	T
	± 0.2		MC78T05AC	—		10	25		
	± 0.25		LM323	—	7.5/20	25	100		
	± 0.2		LM323A	—		15	50		
	± 0.05	800	MC33269–5	—	6.0/20	0.3%	0.5%	—	D, DT
5.2	± 0.26	1500	—	MC7905.2C	7.2/35	105	105	1.0	T

(1) Output Voltage Tolerance for Worst Case
(2) T_J = –40° to +125°C

Table 10. Fixed-Voltage, 3-Terminal Regulators for Positive or Negative Polarity Power Supplies (continued)

V_{out} (V)	Tol.[1] (V)	I_O (mA) Max	Output Device		V_{in} Min/Max	Reg_{line} (mV)	Reg_{load} (mV)	$\Delta V_O/\Delta T$ (mV/°C) Typ	Suffix/ Package
			Positive	Negative					
6.0	± 0.3	500	MC78M06C	—	8.0/35	100	120	1.0	T
		1500	MC7806B[2]	—	9.0/35	120		0.7	
			MC7806C	MC7906C	8.0/35				
	± 0.24		MC7806AC	—	8.6/35	11	100		
	± 0.3		LM340-6	—	8.0/35	60	60		
8.0	± 0.8	100	MC78L08C	—	9.7/30	200	80	—	P
			MC78L08AC	—		175			
	± 0.4	500	MC78M08C	—	10/35	100	160	1.0	DT, T
		1500	MC7808B[2]	—	11.5/35	160			T
			MC7808C	MC7908C	10.5/35				
	± 0.3		MC7808AC	—	10.6/35	13	100		
	± 0.4		LM340-8	—	10.5/35	80	80		
		3000	MC78T08C	—	10.4/35	35	30	0.16	
9.0	± 0.39	1500	MC7809C	—	11.5/35	50	50	1.0	T
12	± 0.12	800	MC33269-12	—	13/20	0.3%	0.5%	—	D, DT
	± 1.2	100	MC78L12C	MC79L12C	13.7/35	250	100	—	P, D
	± 0.6		MC78L12AC	MC79L12AC, AB					
		500	MC78M12C	MC79M12C	14/35	100	240	1.0	DT, T
		1500	MC7812B[2]	—	15.5/35	240		1.5	T
			MC7812C	MC7912C	14.5/35				
	± 0.5		MC7812AC	—	14.8/35	18	100		
	± 0.6		LM340-12	—	14.5/35	120	120		
	± 0.5		LM340A-12	—		18	32		
	± 0.24		TL780-12C	—		5.0		0.15	KC
	± 0.6	3000	MC78T12C	—		45	30	0.24	T
	± 0.5		MC78T12AC	—		18	25		
15	± 1.5	100	MC78L15C	MC79L15C	16.7/35	300	150	—	P, D
	± 0.75		MC78L15AC	MC79L15AC, AB					
		500	MC78M15C	MC79M15C	17/35	100	300	1.0	DT, T
		1500	MC7815B[2]	—	18.5/35	300		1.8	T
			MC7815C	MC7915C	17.5/35				
	± 0.6		MC7815AC	—	17.9/35	22	100		
	± 0.75		LM340-15	—	17.5/35	150	150		
	± 0.6		LM340A-15	—		22	35		
	± 0.3		TL780-15C	—		15	60	0.18	KC
	± 0.75	3000	MC78T15C	—	17.5/40	55	30	0.3	T
	± 0.6		MC78T15AC	—		22	25		
18	± 1.8	100	MC78L18C	MC79L18C	19.7/35	325	170	—	P
	± 0.9		MC78L18AC	MC79L18AC					

(1) Output Voltage Tolerance for Worst Case
(2) T_J = –40° to +125°C

Table 10. Fixed-Voltage, 3-Terminal Regulators for Positive or Negative Polarity Power Supplies (continued)

V_{out} (V)	Tol.(1) (V)	I_O (mA) Max	Output Device Positive	Output Device Negative	V_{in} Min/Max	Reg_{line} (mV)	Reg_{load} (mV)	$\Delta V_O/\Delta T$ (mV/°C) Typ	Suffix/ Package
18	± 0.9	500	MC78M18C	—	20/35	100	360	1.0	T
		1500	MC7818B(2)	—	22/35	360		2.3	
	± 0.7		MC7818C	MC7918C	21/35				
			MC7818AC	—		31	100		
	± 0.9		LM340-18	—		180	180		
20	± 1.0	500	MC78M20C	—	22/40	10	400	1.1	T
24	± 2.4	100	MC78L24C	MC79L24C	25.7/40	350	200	—	P
	± 1.2		MC78L24AC	MC79L24AC		300			
		500	MC78M24C	—	26/40	100	480	1.2	T
		1500	MC7824B(2)	—	28/40	480		3.0	
			MC7824C	MC7924C	27/40				
	± 1.0		MC7824AC	—	27.3/40	36	100		
	± 1.2		LM340-24	—		240	240		

(1) Output Voltage Tolerance for Worst Case
(2) T_J = –40° to +125°C

Adjustable Output

Motorola offers a broad line of adjustable output voltage regulators with a variety of output current capabilities. Adjustable voltage regulators provide users the capability of stocking a single integrated circuit offering a wide range of output voltages for industrial and communications applications. The three-terminal devices require only two external resistors to set the output voltage.

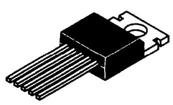
Table 11. Adjustable Positive Output Regulators

I_O (mA) Max	Device	V_{out} (V) Min	V_{out} (V) Max	V_{in} (V) Min	V_{in} (V) Max	$V_{in} - V_{out}$ Differential (V) Min	P_D (W) Max T_A = 25°C	P_D (W) Max T_C = 25°C	Regulation % V_{out} @ T_A = 25°C Max Line	Regulation % V_{out} @ T_A = 25°C Max Load	T_C V_{out} Typ (%/°C)	T_J (°C) Max	Suffix/ Package
100	LM317L	1.2	37	5.0	40	3.0	Internally Limited		0.04	0.5	0.006	125	Z
	LM2931C	3.0	24	3.16		0.6			0.15	1.0	—		T/314D
150	MC1723	2.0	37	9.5		3.0	1.25	—	0.1	0.3	0.003	150	CP
							1.5	—				175	CL
								—			0.002		L
500	LM317M	1.2		5.0			Internally Limited		0.04	0.5	0.0056	125	T
800	MC33269-ADJ	1.25	19	2.25	20	1.0			0.3		—	150	D, DT
1500	LM317	1.2	37	5.0	40	3.0			0.04		0.006	125	T
3000	LM350		33		36				0.03		0.008		

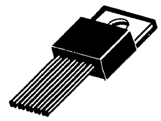
Table 12. Adjustable Negative Output Regulators

500	LM337M	–1.2	–37	5.0	4.0	3.0	Internally Limited		0.04	1.0	0.0048	125	T
1500	LM337												

Special Regulators

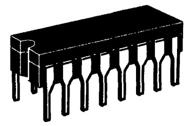


CASE 314C
PLASTIC
TV SUFFIX

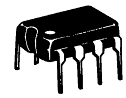


CASE 314D
PLASTIC
T SUFFIX

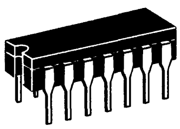
CASES 369A
PLASTIC
DT SUFFIX



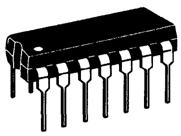
CASE 620
CERAMIC
D, J, N SUFFIX



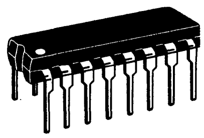
CASE 626
PLASTIC
N, P1 SUFFIX



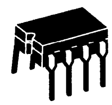
CASE 632
CERAMIC
L SUFFIX



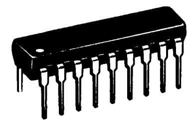
CASE 646
PLASTIC
P SUFFIX



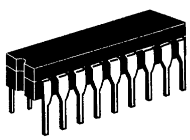
CASES 648, 648C
PLASTIC
P, N SUFFIX



CASE 693
CERAMIC
U SUFFIX



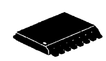
CASE 707
PLASTIC
N SUFFIX



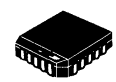
CASE 726
CERAMIC
J SUFFIX

CASE 751
PLASTIC
D, D1 SUFFIX

CASE 751A
PLASTIC
D SUFFIX



CASE 751G
PLASTIC
DW SUFFIX



CASE 775
PLASTIC
FN SUFFIX

Table 13. Microprocessor Voltage Regulator/Supervisory Circuit

A 5.0 V fixed output with monitoring functions required in microprocessor-based systems.

Device	V_{out} (V)		I_O (mA) Max	V_{in} (V)		Reg_{line} (mV) Max	Reg_{load} (mV) Max	T_A (°C)	Suffix/ Package
	Min	Max		Min	Max				
MC34160	4.75	5.25	100	7.0	40	40	50	0 to + 70	P/648C
MC33160								–40 to + 85	
MC33267	4.9	5.2	500	6.0	26	50	50	–40 to +105	T, TV

Table 14. SCSI Regulator

Device	V_{out} (V)		I_{sink} (mA)	V_{in} (V)		Reg_{line} (%)	Reg_{load} (%)	T_J (°C)	Suffix/ Package
	Min	Max		Min	Max				
MC34268	2.81	2.89	800	3.9	20	0.3	0.5	150	D/751, DT/751

Switching Regulator Control Circuits

These devices contain the primary building blocks which are required to implement a variety of switching power supplies. The product offerings fall into three major categories consisting of single-ended and double-ended controllers, plus single-ended ICs with on-chip power switch transistors. These circuits operate in voltage, current or resonant modes and are designed to drive many of the standard switching topologies. The single-ended configurations include buck, boost, flyback and forward converters. The double-ended devices control push-pull, half bridge and full bridge configurations.

Table 15. Single-Ended Controllers

These single-ended voltage and current mode controllers are designed for use in buck, boost, flyback, and forward converters. They are cost effective in applications that range from 0.1 to 200 W power output.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	Suffix	T_A (°C)	Package
500 (Uncommitted Drive Output)	7.0 to 40	Voltage	5.0 ± 1.5%	200	MC34060A	D	0 to + 70	751A
						L		632
						P		646
					MC33060A	D	–40 to + 85	751A
						P		646
1000 (Totem Pole MOSFET Drive Output)	4.2 to 12	Current	1.25 ± 2.0%	300	MC34129	D	0 to + 70	751A
						P		646
					MC33129	D	–40 to + 85	751A
						P		646
	11.5 to 30		5.0 ± 2.0%	500 (Guaranteed at 250)	UC3842A	D	0 to + 70	751A
						N		626
	11 to 30		5.0 ± 1.0%		UC2842A	D	–25 to + 85	751A
						J		693
						N		626
	11.5 to 30		5.0 ± 2.0%		UC3842BV	D	–40 to +105	751A
						D1		751
						N		626
	8.2 to 30		5.0 ± 2.0%		UC3843A	D	0 to + 70	751A
						N		626
			5.0 ± 1.0%		UC2843A	D	–25 to + 85	751A
						J		693
						N		626
			5.0 ± 2.0%		UC3843BV	D	–40 to +105	751A
						D1		751
						N		626
	11.5 to 30		5.0 ± 2.0%	500 (50% Duty Cycle Limit)	UC3844	D	0 to + 70	751A
						N		626
	11 to 30	Current	5.0 ± 1.0%		UC2844	D	–25 to + 85	751A
						J		693
						N		626

Table 15. Single-Ended Controllers (continued)

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	Suffix	T_A (°C)	Package
1000 (Totem Pole MOSFET Drive Output)	8.2 to 30	Current	5.0 ± 2.0%	500 (50% Duty Cycle Limit)	UC3845	D	0 to + 70	751A
						N		626
			5.0 ± 1.0%		UC2845	D	–25 to + 85	751A
						J		693
						N		626
	11.5 to 30		5.0 ± 2.0%	500 (Improved Oscillator Specifications with Frequency Guaranteed at 250 kHz)	UC3842B	D	0 to + 70	751A
						D1		751
						N		626
	11 to 30		5.0 ± 1.0%		UC2842B	D	–25 to + 85	751A
						D1		751
						N		626
	8.2 to 30		5.0 ± 2.0%		UC3843B	D	0 to + 70	751A
						D1		751
						N		626
			5.0 ± 1.0%		UC2843B	D	–25 to + 85	751A
						D1		751
						N		626
	11.5 to 30		5.0 ± 2.0%	500 (50% Duty Cycle Limit)	UC3844B	D	0 to + 70	751A
						D1		751
						N		626
					UC3844BV	D	–40 to +105	751A
						D1		751
						N		626
	11 to 30		5.0 ± 1.0%		UC2844B	D	–25 to + 85	751A
						D1		751
						N		626
	8.2 to 30		5.0 ± 2.0%		UC3845B	D	0 to + 70	751A
						D1		751
						N		626
					UC3845BV	D	–40 to +105	751A
						D1		751
						N		626
			5.0 ± 1.0%		UC2845B	D	–25 to + 85	751A
						D1		751
						N		626
1000 Source 1500 Sink (Split Totem Pole BIPOLAR Drive Output)	11 to 18		5.0 ± 6.0%	500 (50% Duty Cycle Limit)	MC44602	P2		648C

Table 15. Single-Ended Controllers (continued)

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	Suffix	T_A (°C)	Package
2000 (Totem Pole MOSFET Drive Output)	9.2 to 30	Current	5.1 ± 1.0%	1000	MC34023	DW	0 to + 70	751G
						FN		775
						P		648
					MC33023	DW	–40 to + 85	751G
						FN		775
						P		648

Table 16. Single-Ended Controllers With On-Chip Power Switch

These monolithic power switching regulators contain all the active functions required to implement standard DC-to-DC converter configurations with a minimum number of external components.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	Suffix	T_A (°C)	Package
1500 (Uncommitted Power Switch)	2.5 to 40	Voltage	1.25 ± 5.2%(1)	100	μA78S40	PC	0 to + 70	648
						DC		620
						PV	–40 to + 85	648
						DM	–55 to + 125	620
			1.25 ± 2.0%		MC34063A	D	0 to + 70	751
						P1		626
					MC33063A	D	–40 to + 85	751
						P1		626
					MC35063A	U	–55 to + 125	693
	3.0 to 65		1.25 ± 2.0% and 5.05 ± 3.0 %		MC34165	P	0 to + 70	648C
					MC33165		–40 to + 85	
3400 (Uncommitted Power Switch)	2.5 to 40				MC34163		0 to + 70	
					MC33163		–40 to + 85	
3400(2) (Dedicated Emitter Power Switch)	7.5 to 40		5.05 ± 2.0%	72 ± 12% Internally Fixed	MC34166	T	0 to + 70	314D
					MC33166		–40 to + 85	
5500(3) (Dedicated Emitter Power Switch)					MC34167		0 to + 70	
					MC33167		–40 to + 85	

(1) Tolerance applies over the specified operating temperature range.
(2) Guaranteed minimum, typically 4300 mA.
(3) Guaranteed minimum, typically 6500 mA.

Table 17. Double-Ended Controllers

These double-ended voltage, current and resonant mode controllers are designed for use in push-pull, half-bridge, and full-bridge converters. They are cost effective in applications that range from 100 to 2000 watts power output.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	Suffix	T_A (°C)	Package
500 (Uncommitted Drive Outputs)	7.0 to 40	Voltage	5.0 ± 5.0%(1)	200	TL494	CN	0 to + 70	648
						CJ		620
						IN	–25 to + 85	648
						IJ		620
						MJ	–55 to + 125	
			5.0 ± 1.5%	300	TL594	CN	0 to + 70	648
						IN	–25 to + 85	
						MJ	–55 to + 125	620
± 500 (Totem Pole MOSFET Drive Outputs)	8.0 to 40		5.1 ± 2.0%	400	SG3525A	N	0 to + 70	648
						J		620
					SG3527A	N		648
						J		620
± 200 (Totem Pole MOSFET Drive Outputs)			5.0 ± 2.0%		SG3526	N	0 to +125(2)	707
						J		726
±1500 (Totem Pole MOSFET Drive Outputs)	9.6 to 20	Resonant (Zero Current Switch)	5.1 ± 2.0%	1000	MC34066	DW	0 to + 70	751G
						P		648
					MC33066	DW	–40 to + 85	751G
						P		648
				2000	MC34067	DW	0 to + 70	751G
						P		648
					MC33067	DW	–40 to + 85	751G
						P		648
2000 (Totem Pole MOSFET Drive Outputs)	9.2 to 30	Current	5.1 ± 1.0%	1000	MC34025	DW	0 to + 70	751G
						FN		775
						P		648
					MC33025	DW	–40 to + 85	751G
						FN		775
						P		648

(1) Tolerance applies over the specified operating temperature range.
(2) Junction Temperature Range.

Special Switching Regulator Controllers

Table 18. Dual Channel Current Mode Controllers

These high performance dual channel controllers are optimized for off-line AC-to-DC power supplies and DC-to-DC converters in the flyback topology. The newer -H and -L versions have undervoltage lockout voltages which are optimized for off-line and lower voltage DC-to-DC converters respectively. Applications include desktop computers, peripherals, televisions, games, and various consumer appliances.

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Maximum Useful Oscillator Frequency (kHz)	Device	Suffix	T_A (°C)	Package
±1000 (Totem Pole MOSFET Drive Outputs)	11 to 15.5	Current	5.0 ± 2.0%	500	MC34065	DW	0 to + 70	751G
						P		648
					MC33065	DW	–40 to + 85	751G
						P		648
	11 to 20		5.0 ± 2.6%		MC34065	DW-H	0 to + 70	751G
						P-H		648
					MC33065	DW-H	–40 to + 85	751G
						P-H		648
	8.2 to 20				MC34065	DW-L	0 to + 70	751G
						P-L		648
					MC33065	DW-L	–40 to + 85	751G
						P-L		648

Table 19. Universal Microprocessor Power Supply Controller

A versatile power supply control circuit for microprocessor-based systems, this device is mainly intended for automotive applications and battery powered instruments. The circuit provides a power-on Reset delay and a Watchdog feature for orderly microprocessor operation.

Regulated Outputs	Output Current (mA)	V_{CC} (V) Min	V_{CC} (V) Max	Device	T_A (°C)	Reference (V)	Key Supervisory Features	Package
E^2PROM Programmable Output: 24 V (Write Mode) 5.0 V (Read Mode)	150 peak	6.0	35	TCF5600	–40 to + 85	2.5 ± 3.2%	MPU Reset and Watchdog Circuit	707
Fixed Linear Output: 5.0 V	10 to external buffer transistor			TCA5600	0 to + 75			

Special Switching Regulator Controllers (continued)

Table 20. Power Factor Controllers

I_O (mA) Max	Minimum Operating Voltage Range (V)	Operating Mode	Reference (V)	Features	Device	Suffix	T_A (°C)	Package
± 500 (Totem Pole MOSFET Drive Outputs)	9.0 to 30	Current	± 2.5	Undervoltage Lockout, Internal Start-Up Timer	MC34261	D	0 to + 70	751
						P		626
					MC33261	D	– 40 to + 85	751
						P		626
				Overvoltage Comparator, Undervoltage Lockout, Internal Start-Up Timer	MC34262	D	0 to + 70	751
						P		626
					MC33262	D	– 40 to +105	751
						P		626

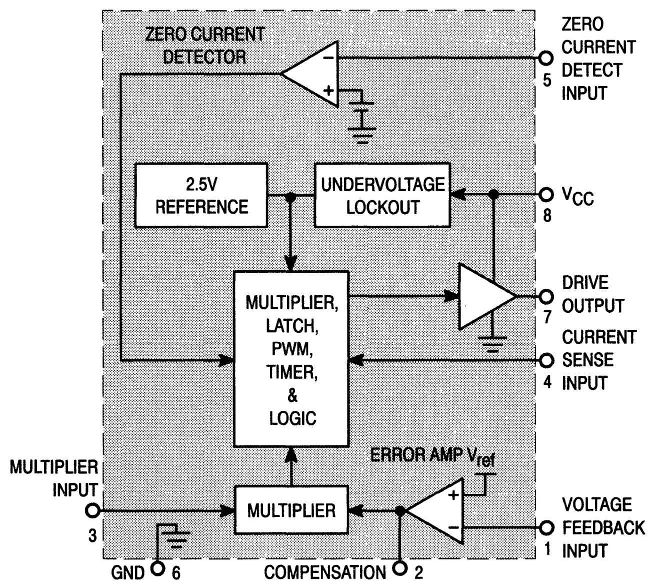
Power Factor Controllers

MC34261D, P
T_A = 0° to +70°C, Case 751, 626

MC33261D, P
T_A = – 40° to +85°C, Case 751, 626

The MC33261, MC34261 series are power factor controller circuits specifically designed for use as a preconverter in electronic ballast and in off-line converter applications. These integrated circuits feature an internal start-up timer, a one quadrant multiplier for near unit power factor, zero current detector to ensure critical conduction operation, high gain error amplifier, trimmed internal bandgap reference, current sensing comparator and a totem pole output ideally suited for driving a power MOSFET or an IGBT.

Also included are protective features consisting of input undervoltage lockout with hysteresis, cycle-by-cycle current limiting and a latch for single pulse metering.



Power Factor Controllers (continued)

MC34262D, P

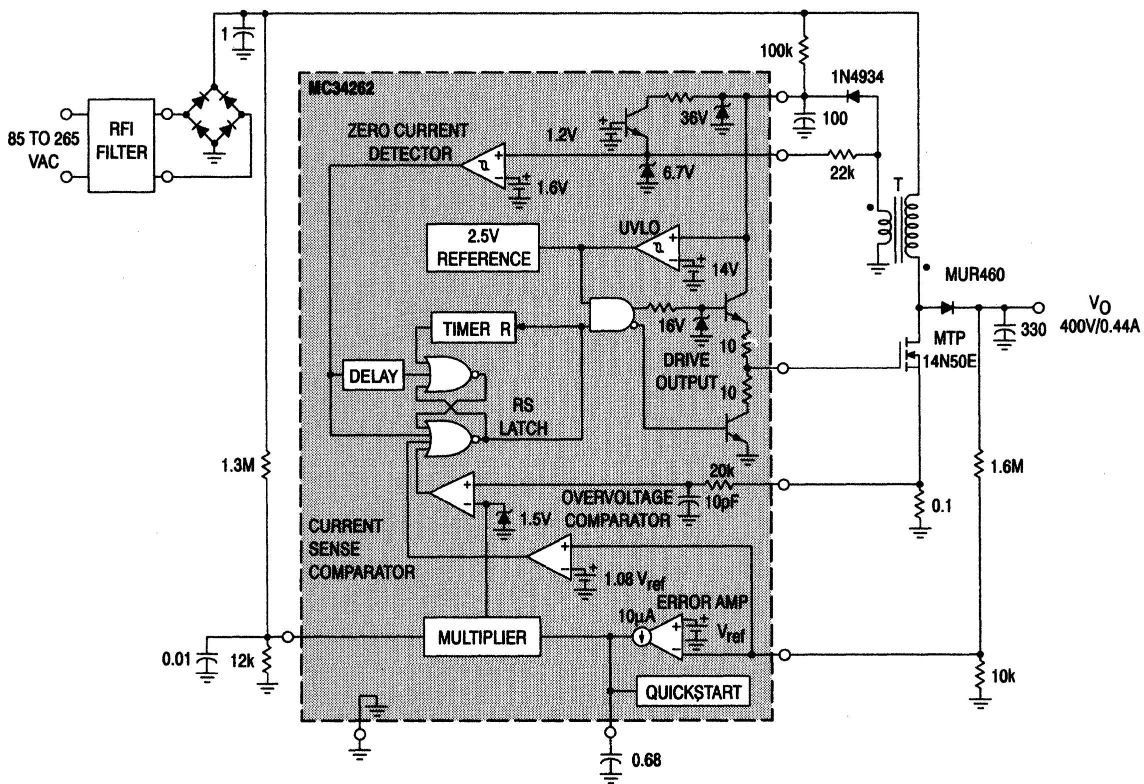
T_A = 0° to + 85°C, Case 751, 626

MC33262D, P

T_A = – 40° to +105°C, Case 751, 626

The MC34262, MC33262 series are active power factor controllers specifically designed for use as a preconverter in electronic ballast and in off-line power convertor applications. These integrated circuits feature an internal start-up timer for stand alone applications, a one quadrant multiplier for near unity power factor, zero current detector to ensure critical conduction operation, transconductance error amplifier, quickstart circuit for enhanced start-up, trimmed internal bandgap reference, current sensing comparator, and a totem pole output ideally suited for driving a power MOSFET.

Also included are protective features consisting of an overvoltage comparator to eliminate runaway output voltage due to load removal, input undervoltage lockout with hysteresis, cycle-by-cycle current limiting, multiplier output clamp that limits maximum peak switch current, an RS latch for single pulse metering, and a drive output high state clamp for MOSFET gate protection. These devices are available in dual-in-line and surface mount plastic packages.



Power Supervisory Circuits

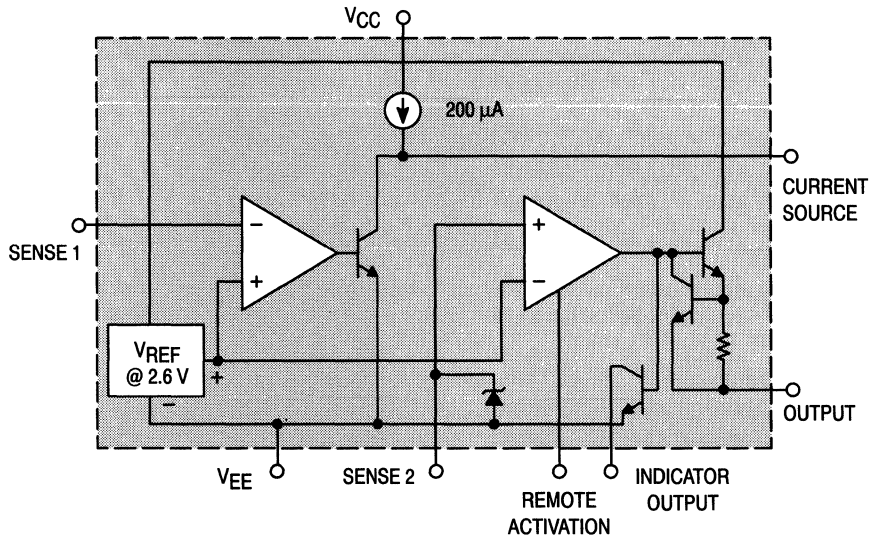
A variety of Power Supervisory Circuits are offered. Overvoltage sensing circuits which drive "Crowbar" SCRs are provided in several configurations from a low cost three-terminal version to 8-pin devices which provide pin-programmable trip voltages or additional features, such as an indicator output drive and remote activation capability. An over/undervoltage protection circuit is also offered.

Overvoltage Crowbar Sensing Circuit

MC3523U
T_A = –55° to +125°C, Case 693

MC3423P1, U
T_A = 0° to +70°C, Case 626, 693

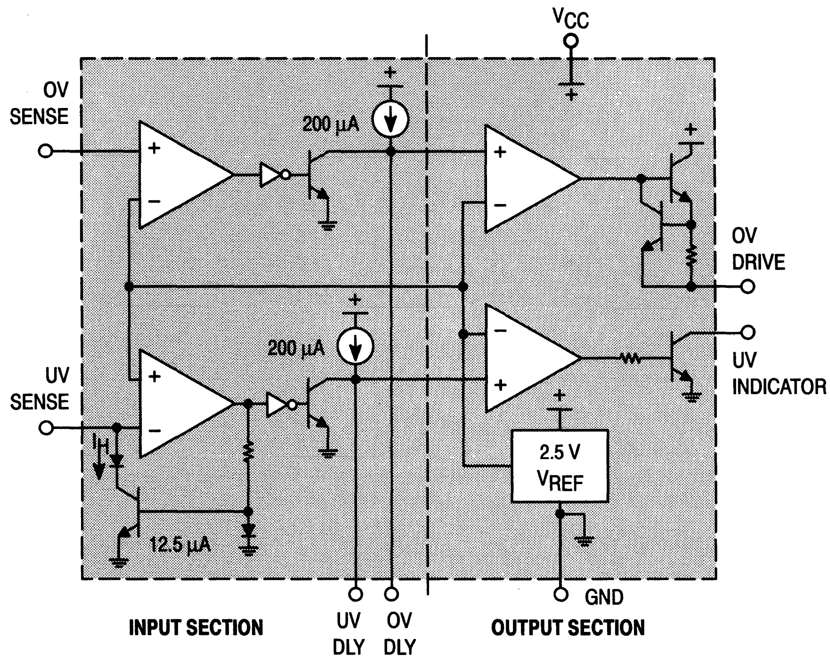
This device can protect sensitive circuitry from power supply transients or regulator failure when used with an external "Crowbar" SCR. The device senses voltage and compares it to an internal 2.6 V reference. Overvoltage trip is adjustable by means of an external resistive voltage divider. A minimum duration before trip is programmable with an external capacitor. Other features include a 300 mA high current output for driving the gate of a "Crowbar" SCR, an open-collector indicator output and remote activation capability.



Over/Undervoltage Protection Circuit

MC3425P1 T_A = 0° to +70°C, Case 626

The MC3425 is a power supply supervisory circuit containing all the necessary functions required to monitor over and undervoltage fault conditions. This device features dedicated over and undervoltage sensing channels with independently programmable time delays. The overvoltage channel has a high current Drive Output for use in conjunction with an external SCR "Crowbar" for shutdown. The undervoltage channel input comparator has hysteresis which is externally programmable, and an open-collector output for fault indication.



Power Supervisory Circuits (continued)

Undervoltage Sensing Circuit

MC34064P-5, D-5
T_A = 0° to +70°C, Case 29, 751

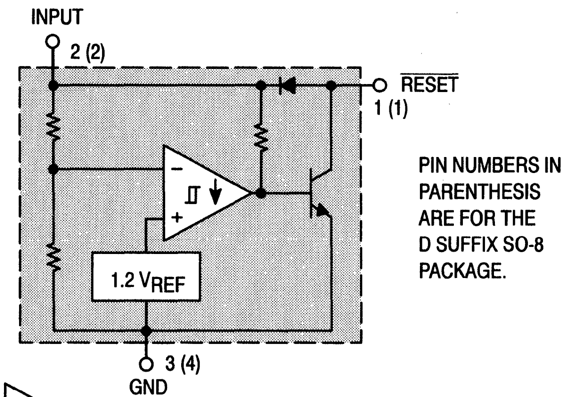
MC33064P-5, D-5
T_A = –40° to +85°C, Case 29, 751

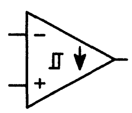
MC34164P-3, P-5, D-3, D-5
T_A = –0° to +70°C, Case 29, 751

MC33164P-3, P-5, D-3, D-5
T_A = –40° to +85°C, Case 29, 751

The MC34064 and MC34164 are two families of undervoltage sensing circuits specifically designed for use as reset controllers in microprocessor-based systems. They offer the designer an economical solution for low voltage detection with a single external resistor. Both parts feature a trimmed bandgap reference, and a comparator with precise thresholds and built-in hysteresis to prevent erratic reset operation.

The two families of undervoltage sensing circuits taken together, cover the needs of the most commonly specified power supplies used in MCU/MPU systems. Key parameter specifications of the MC34164 family were chosen to complement the MC34064 series. The table summarizes critical parameters of both families. The MC34064 fulfills the needs of a 5.0 V ± 5% system and features a tighter hysteresis specification. The MC34164 series covers 5.0 V ± 10% and 3.0 V ± 5% power supplies with significantly lower power consumption, making them ideal for applications where extended battery life is required such as consumer products or hand held equipment.





Applications include direct monitoring of the 5.0 V MPU/logic power supply used in appliance, automotive, consumer, and industrial equipment.

The MC34164 is specifically designed for battery powered applications where low bias current (1/25th of the MC34064's) is an important characteristic.

Table 21. Undervoltage Sense/Reset Controller Features

Device	Suffix	Standard Power Supply Supported	Typical Threshold Voltage (V)	Typical Hysteresis Voltage (V)	Minimum Output Sink Current (mA)	Power Supply Input Voltage Range (V)	Maximum Quiescent Input Current	Package Type
MC34064/MC33064	P-5	5.0 V ± 5%	4.6	0.02	10	1.0 to 10	500 μA @ V_{in} = 5.0 V	TO-92
	D-5							SO-8
MC34164/MC33164	P-5	5.0 V ±10%	4.3	0.09	7.0	1.0 to 12	20 μA @ V_{in} = 5.0 V	TO-92
	D-5							SO-8
	P-3	3.0 V ± 5%	2.7	0.06	6.0	1.0 to 12	15 μA @ V_{in} = 3.0 V	TO-92
	D-3							SO-8

Note: MC34X64 devices are specified to operate from 0° to +70°C, and MC33X64 devices operate from –40° to +85°C.

Power Supervisory Circuits (continued)

Microprocessor Voltage Regulator and Supervisory Circuit

MC34160P

T_A = 0° to +70°C, Case 648C

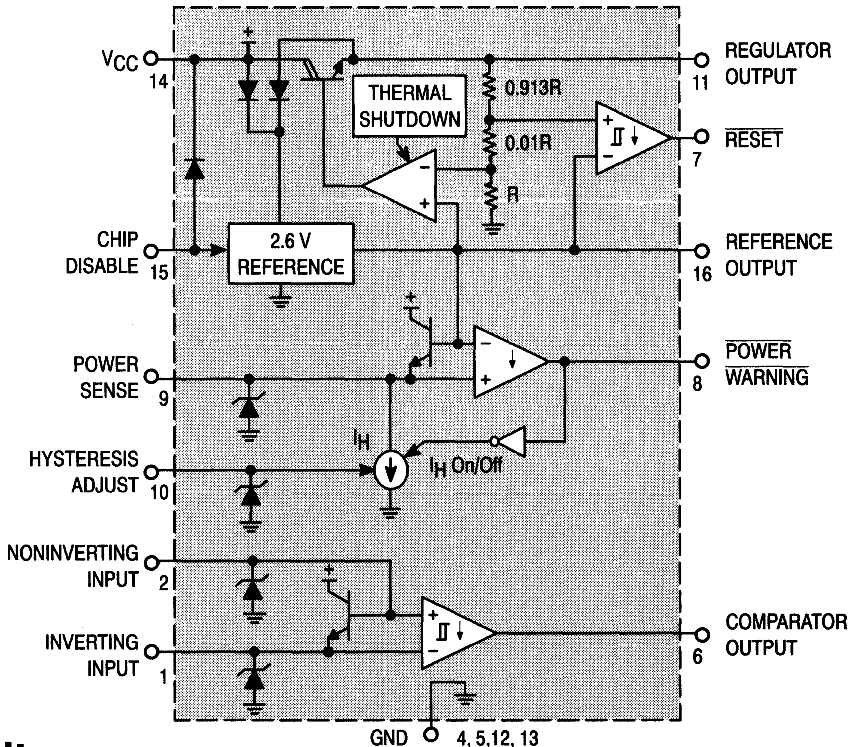
MC33160P

T_A = –40° to +85°C, Case 648C

The MC34160 Series is a voltage regulator and supervisory circuit containing many of the necessary monitoring functions required in microprocessor based systems. It is specifically designed for appliance and industrial applications offering the designer a cost effective solution with minimal external components. These integrated circuits feature a 5.0 V, 100 mA regulator with short circuit current limiting, pinned out 2.6 V bandgap reference, low voltage reset comparator, power warning comparator with programmable hysteresis, and an uncommitted comparator ideally suited for microprocessor line synchronization.

Additional features include a chip disable input for low standby current, and internal thermal shutdown for over temperature protection.

These devices are contained in a 16 pin dual-in-line heat tab plastic package for improved thermal conduction.



Universal Voltage Monitor

MC34161P, D

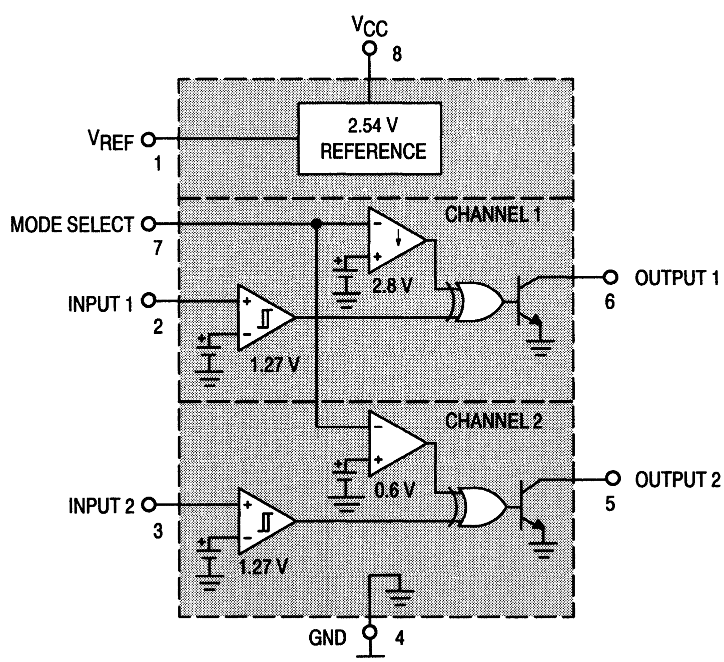
T_A = 0° to +70°C, Case 626, 751

MC33161P, D

T_A = –40° to +85°C, Case 626, 751

The MC34161 series of Universal Voltage Monitor ICs are capable of being used in a wide variety of voltage sensing applications. These versatile devices offer an economical solution for implementing over, under, and window detection of both positive and/or negative voltages.

The circuit consists of two comparator channels each with hysteresis, a pinned out 2.54 V reference, two open collector outputs capable of sinking in excess of 10 mA, and a "Mode Select" input for programming the functions of the two comparator channels. The devices are fully functional from 2.0 V to 40 V for positive voltage sensing and from 4.0 V to 40 V for negative voltage sensing.



MOSFET Drivers

High Speed Dual Drivers

Inverting
MC34151P, D
T_A = 0° to +70°C, Case 626, 751

MC33151P, D
T_A = –40° to +85°C, Case 626, 751

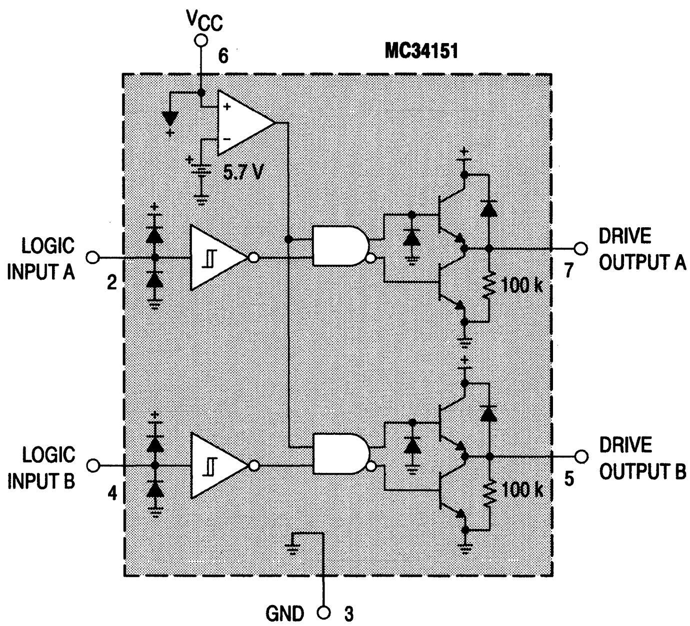
Noninverting
MC34152P, D
T_A = 0° to +70°C, Case 626, 751

MC33152P, D
T_A = –40° to +85°C, Case 626, 751

These two series of High Speed Dual MOSFET Driver ICs are specifically designed for applications requiring low current digital circuitry to drive large capacitive loads at high slew rates. Both series feature a unique undervoltage lockout function which puts the outputs in a defined low state in an undervoltage condition. In addition, the low on-state resistance of these bipolar drivers allows significantly higher output currents at lower supply voltages than with competing drivers using CMOS technology.

The MC34151 series is pin-compatible with the MMH0026 and DS0026 dual MOS clock drivers, and can be used as drop-in replacements to upgrade system performance. The MC34152 noninverting series is a mirror image of the inverting MC34151 series.

These devices can enhance the drive capabilities of first generation switching regulators or systems designed with CMOS/TTL logic devices. They can be used in DC-to-DC converters, motor controllers, capacitor charge pump converters, or virtually any other application requiring high speed operation of power MOSFETs.



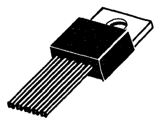
Power/Motor Control Circuits

In Brief . . .

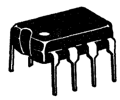
With the expansion of electronics into more and more mechanical systems there comes an increasing demand for simple but intelligent circuits that can blend these two technologies. In the past, the task of power/motor control was once accomplished with discrete devices. But today this task is being performed by bipolar IC technology due to cost, size, and reliability constraints. Motorola offers integrated circuits designed to anticipate the requirements for both simple and sophisticated control systems, while providing cost effective solutions to meet the needs of the applications.

Power Controllers

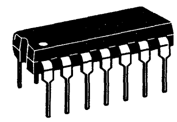
An assortment of battery and AC line-operated control ICs for specific applications is shown. They are designed to enhance system performance and reduce complexity in a wide variety of control applications.



CASE 314D
PLASTIC
S, T SUFFIX



CASE 626
PLASTIC
B SUFFIX



CASE 646
PLASTIC

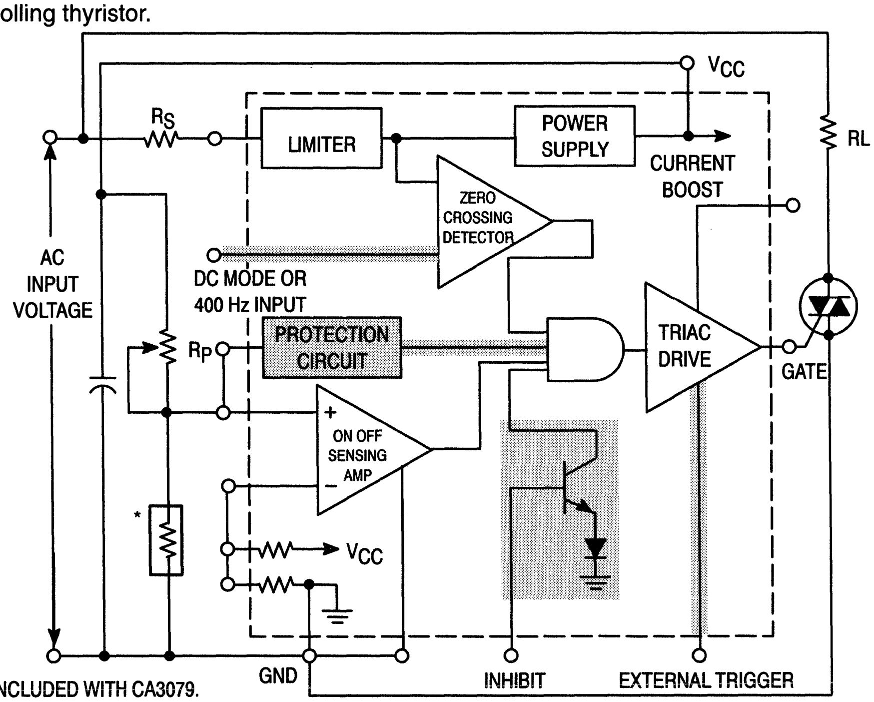
Zero Voltage Switches

CA3079/CA3059

T_A = –40° to +85°C, Case 646

These devices are designed for thyristor control in a variety of AC power switching applications for AC input voltages of 24 V, 120 V, 208/230 V, and 227 V @ 50/60 Hz.

- **Limiter-Power Supply** — Allows operation directly from an AC line.
- **Differential On/Off Sensing Amplifier** — Tests for condition of external sensors or input command signals. Proportional control capability or hysteresis may be implemented.
- **Zero-Crossing Detector** — Synchronizes the output pulses to the zero voltage point of the AC cycle. Eliminates RFI when used with resistive loads.
- **Triac Drive** — Supplies high-current pulses to the external power controlling thyristor.
- **Protection Circuit** (CA3059 only) — A built-in circuit may be actuated, if the sensor opens or shorts, to remove the drive circuit from the external triac.
- **Inhibit Capability** (CA3059 only) — Thyristor firing may be inhibited by the action of an internal diode gate.
- **High Power DC Comparator Operation** (CA3059 only) — Operation in this mode is accomplished by connecting Pin 7 to Pin 12 (thus overriding the action of the zero-crossing detector).



*NTC SENSOR
NOTE: SHADED AREA NOT INCLUDED WITH CA3079.

Power Controllers (continued)

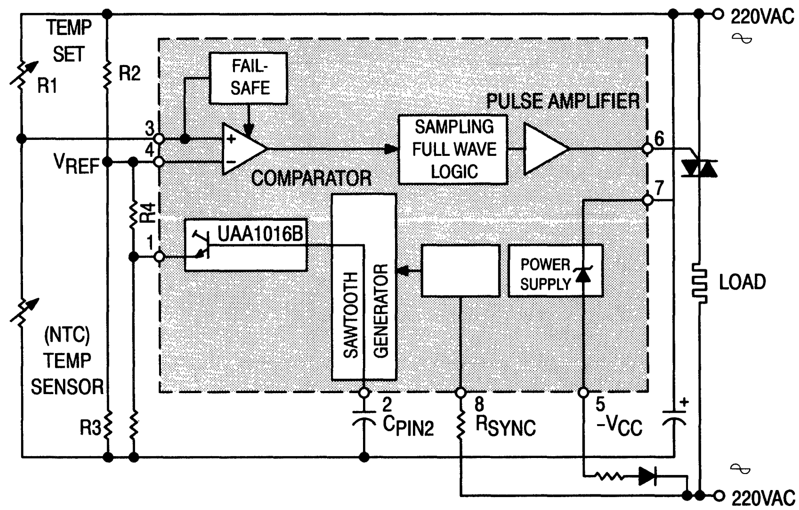
Zero Voltage Controller

UAA1016B

T_A = –20° to +100°C, Case 626

This device is designed to drive triacs with the Zero Voltage technique which allows RFI free power regulation of resistive loads. They provide the following features:

- Proportional Temperature Control Over an Adjustable Band
- Adjustable Burst Frequency (to Comply with Standards)
- Sensor Fail-Safe
- No DC Current Component Through the Main Line (to Comply with Standards)
- Negative Output Current Pulses (Triacs Quadrants 2 and 3)
- Direct AC Line Operation
- Low External Components Count



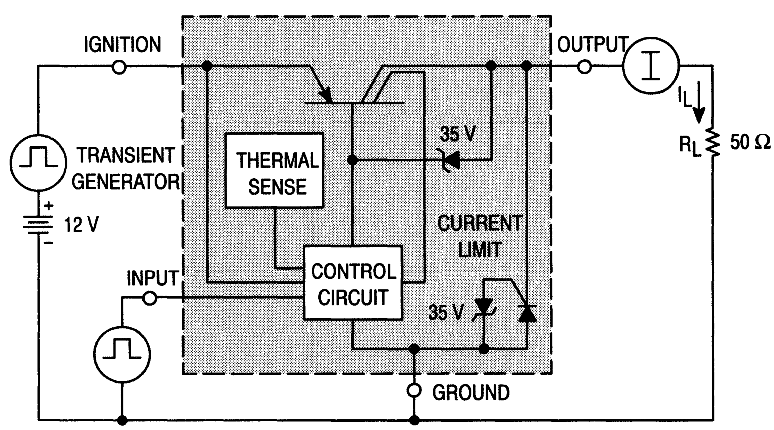
High-Side Driver Switch

MC3399T

T_J = –40° to +150°C, Case 314D

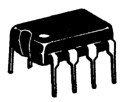
The MC3399T is a High-Side Driver Switch that is designed to drive loads from the positive side of the power supply. The output is controlled by a TTL compatible Enable pin. In the ON state, the device exhibits very low saturation voltages for load currents in excess of 750 mA. The device also protects the load from positive or negative-going high voltage transients by becoming an open circuit and isolating the transient for its duration from the load.

The MC3399T is fabricated on a power BiMOS process which combines the best features of Bipolar and MOS technologies. The mixed technology provides higher gain PNP output devices and results in Power Integrated Circuits with reduced quiescent current.

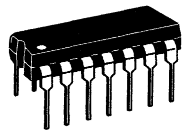


Motor Controllers

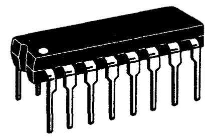
This section contains integrated circuits designed for cost effective control of specific motor families. Included are controllers for brushless, dc servo, stepper, and universal type motors.



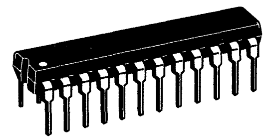
CASE 626
PLASTIC
P SUFFIX



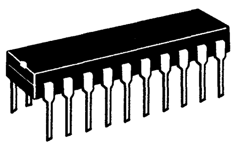
CASE 646
PLASTIC
P SUFFIX



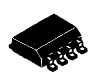
CASE 648, 648C
PLASTIC
P SUFFIX



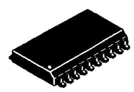
CASE 724
PLASTIC
P SUFFIX



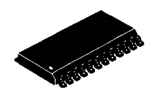
CASE 738
PLASTIC
P SUFFIX



CASE 751
PLASTIC
D SUFFIX



CASE 751D
PLASTIC
DW SUFFIX



CASE 751E
PLASTIC
DW SUFFIX

Brushless DC Motor Controllers

Advances in magnetic materials technology and integrated circuits have contributed to the unprecedented rise in popularity of brushless DC motors. Linear control ICs are making the many features and advantages of brushless motors available at a much more economical price. Motorola offers a family of monolithic integrated brushless DC motor controllers. These ICs provide a choice of control functions which allow many system features to be easily implemented at a fraction of the cost of discrete solutions. The following table summarizes and compares the features of Motorola's brushless motor controllers.

Table 22. Features Summary for Motorola Brushless DC Motor Controllers

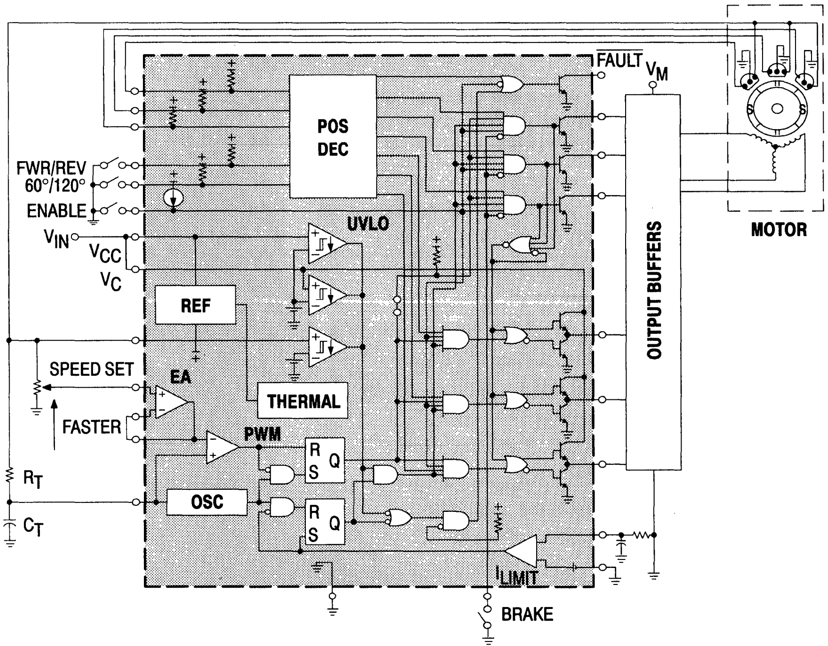
Device	Operating Voltage Range (V)		Undervoltage Lockout	Internal Thermal Shutdown	Fwd/Rev Control	Sensor Electrical Phasing	Output Enable	Output Drivers		6.25 V Reference Output	Current Sense Comparator Input(s)	Error Amplifier	FAULT Output	Separate Drive V_C	Brake Input	Suffix/ Package
	V_{CC}	V_C						Totem Pole (Bottom)	Open Collector (Top)							
MC33033	10-30		✓	✓	✓	60°/300° and 120°/240°	✓	✓	✓	✓	Noninv. Only	✓				P/738 DW/751D
MC33035	10-40	10-30	✓	✓	✓		✓	✓	✓	✓	Noninv. and Inv.	✓	✓	✓	✓	P/724 DW/751E

Motor Controllers: Brushless DC Motor Controllers (continued)

MC33035P, DW

T_A = –40° to +85°C, Case 724, 751E

The MC33035 is a second generation high performance brushless DC motor controller which contains all of the active functions required to implement a full featured open-loop motor control system. While being pin-compatible with its MC33034 predecessor, the MC33035 offers additional features at a lower price. The two additional features provided by the MC33035 are a pin which allows the user to select 60°/300° or 120°/240° sensor electrical phasings, and access to both inverting and noninverting inputs of the current sense comparator. The earlier devices had two part numbers which were needed to support the different sensor phasings, and the inverting input to the current sense comparator was internally grounded. All of the control and protection features of the MC33034 are also provided in the MC33035.

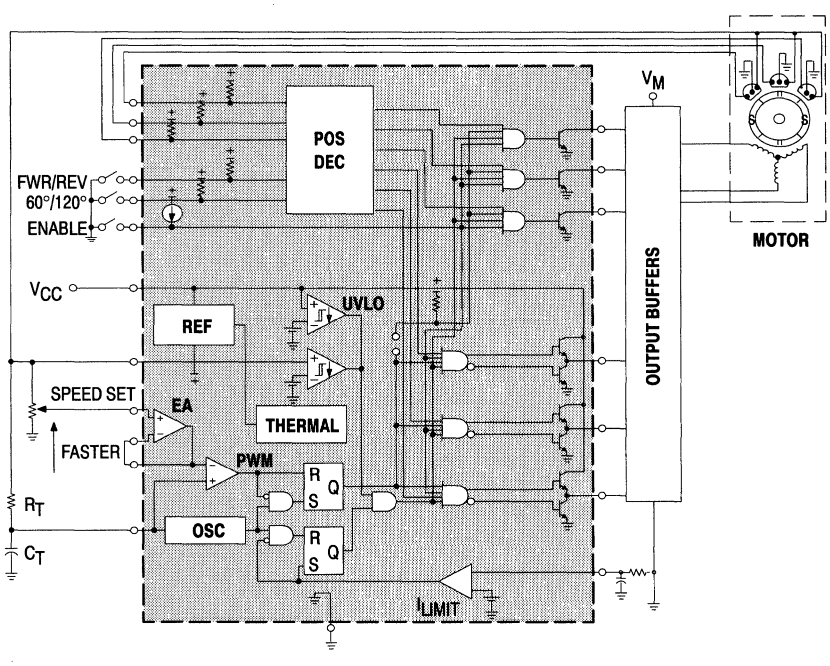


MC33033P, DW

T_A = –40° to +85°C, Case 738, 751D

The MC33033 is a lower cost second generation brushless DC motor controller which has evolved from the full featured MC33034 and MC33035 controllers. The MC33033 contains all of the active functions needed to implement a low cost open-loop motor control system. This IC has all of the key control and protection functions of the two full featured devices with the following secondary features deleted: separate drive-circuit supply and ground pins, the brake input, and the fault output signal. Like its MC33035 predecessor, the MC33033 has a control pin which allows the user to select 60°/300° or 120°/240° sensor electrical phasings.

Because of its low cost, the MC33033 can efficiently be used to control brush DC motors as well as brushless. A brush DC motor can be driven using two of the three drive output phases provided in the MC33033, while the Hall sensor input pins are selectively tied to V_{ref} or ground. Other features such as forward/reverse, output enable, speed control, current limiting, undervoltage lockout and internal thermal shutdown will still remain functional.



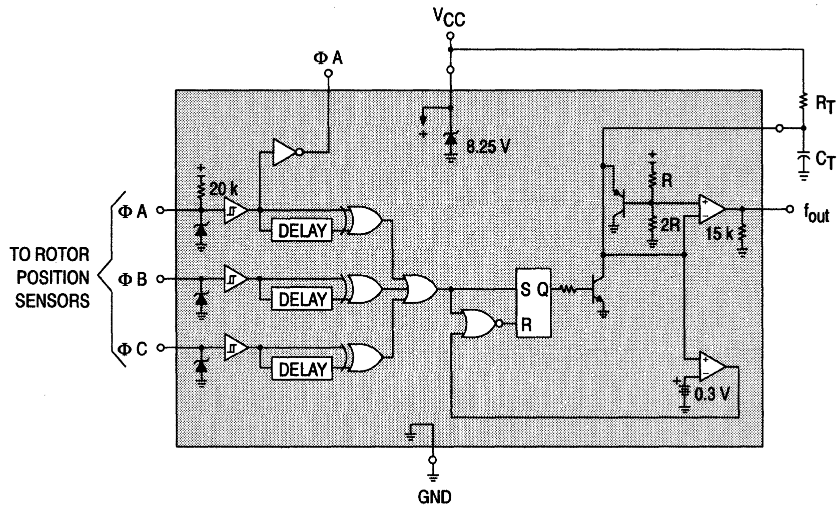
Motor Controllers (continued)

Closed-Loop Brushless Motor Adapter

MC33039P, D

T_A = –40° to +85°C, Case 626, 751

The MC33039P,D is a high performance close-loop speed control adapter specifically designed for use in brushless dc motor control systems. Implementation will allow precise speed regulation without the need for a magnetic or optical tachometer. These devices contain three input buffers each with hysteresis for noise immunity, three digital edge detectors, a programmable monostable, and an internal shunt regulator. Also included is an inverter output for use in systems that require conversion of sensor phasing. Although this device is primarily intended for use with the MC33033/35 brushless motor controllers, it can be used cost effectively in many other closed-loop speed control applications.

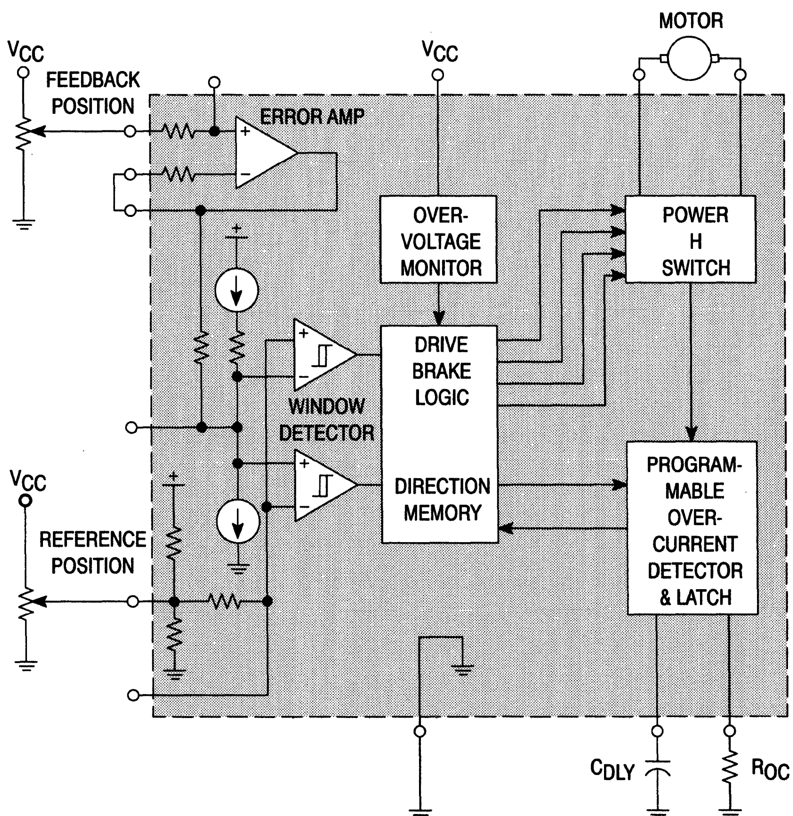


DC Servo Motor Controller/Driver

MC33030P

T_A = –40° to +85°C, Case 648C

A monolithic dc servo motor controller providing all active functions necessary for a complete closed loop system. This device consists of an on-chip op amp and window comparator with wide input common mode range, drive and brake logic with direction memory, a power H switch driver capable of 1.0 A, independently programmable over current monitor and shutdown delay, and over voltage monitor. This part is ideally suited for almost any servo positioning application that requires sensing of temperature, pressure, light, magnetic flux, or any other means that can be converted to a voltage.



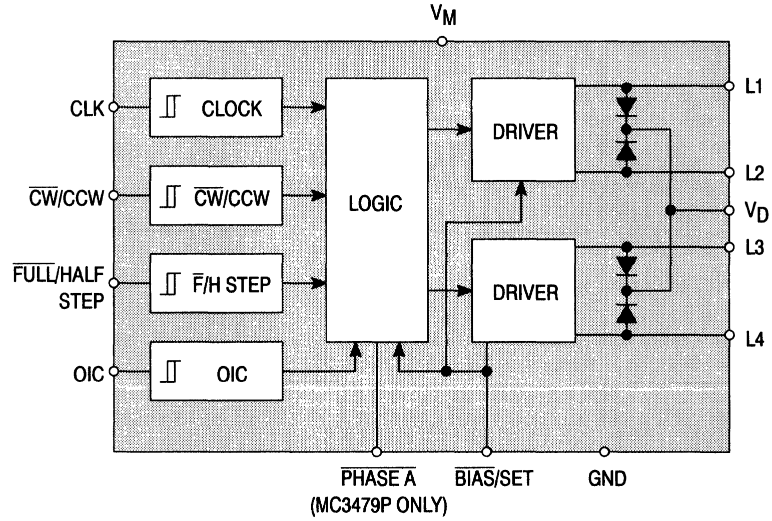
Motor Controllers (continued)

Stepper Motor Driver

MC3479P
T_A = 0° to +70°C, Case 648C

SAA1042V, AV
T_A = 0° to +70°C, Case 648C

These Stepper Motor Drivers provide up to 500 mA of drive per coil for two phase 6.0 V to 24 V stepper motors. Control logic is provided to accept commands for clockwise, counter clockwise and half or full step operation. The MC3479P has an added Output Impedance Control (OIC) and a Phase A drive state indicator (not available on SAA1042 devices).



Universal Motor Speed Controllers

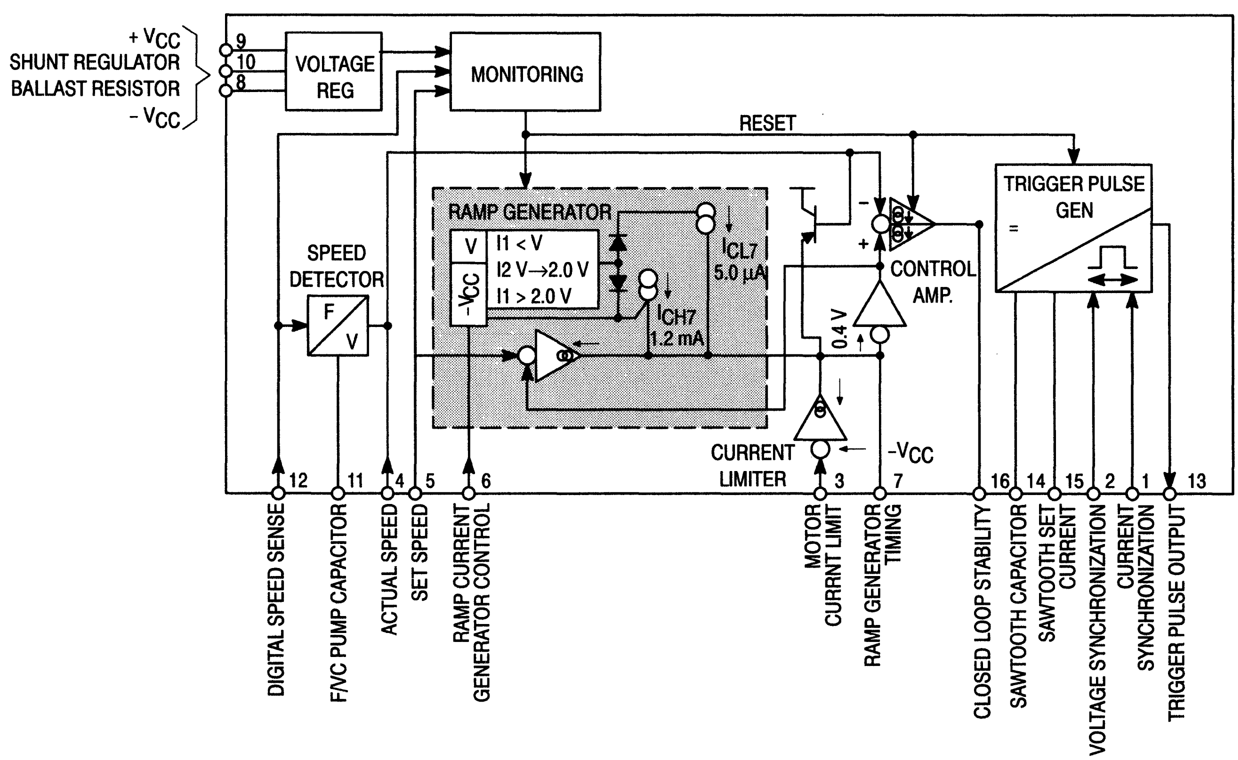
TDA1085A
T_A = 0° to +70°C, Case 648

This device contains all the necessary functions for the speed control of universal (ac/dc) motors in an open or closed loop configuration. Facility for defining the initial speed/time characteristic. The circuit provides a phase angle varied trigger pulse to the motor control triac.

- Guaranteed Full Wave Triac Drive
- Soft-Start from Power-up
- On-Chip Frequency/Voltage Converter and Ramp Generator
- Current Limiting Incorporated
- Direct Drive from AC Line

TDA1085C
T_A = –10° to +120°C, Case 648

Similar to the TDA1085A, but designed for commercial washing machine service.



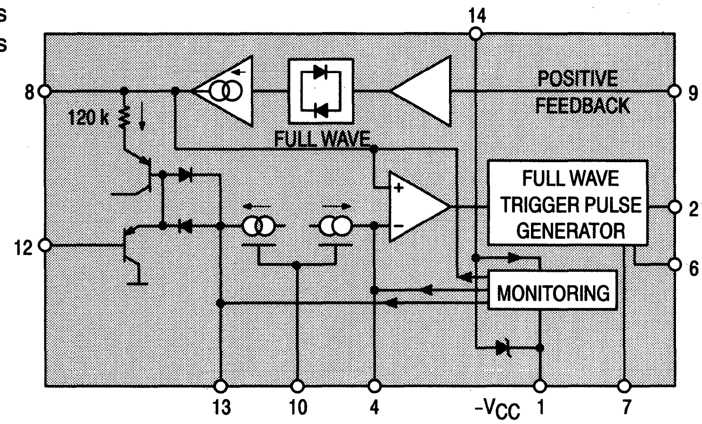
Motor Controllers (continued)

Triac Phase Angle Controller

TDA1185A
T_A = 0° to +70°C, Case 646

This device generates controlled triac triggering pulses and allows tacholess speed stabilization of universal motors by an integrated positive feedback function.

- Low Cost External Components Count
- Optimum Triac Firing (2nd and 3rd Quadrants)
- Repetitive Trigger Pulses when Triac Current is Interrupted by Motor Brush Bounce
- Triac Current Sensed to Allow Inductive Loads
- Soft-Start
- Power Failure Detection and General Circuit Reset
- Low Power Consumption: 1.0 mA

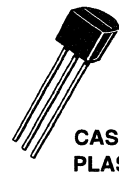


Voltage References

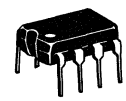
In Brief . . .

Motorola's line of precision voltage references is designed for applications requiring high initial accuracy, low temperature drift, and long term stability. Initial accuracies of ± 1.0%, and ± 2.0% mean production line adjustments can be eliminated. Temperature coefficients of 25 ppm/°C max (typically 10 ppm/°C) provide excellent stability. Uses for the references include D/A converters, A/D converters, precision power supplies, voltmeter systems, temperature monitors, and many others.

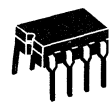
Page



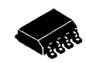
CASE 29
PLASTIC
LP, Z SUFFIX



CASE 626
PLASTIC
P SUFFIX



CASE 693
CERAMIC
JG, U SUFFIX



CASE 751
PLASTIC
D SUFFIX

Precision Low Voltage References

A family of precision low voltage bandgap reference devices designed for applications requiring low temperature drift.

Table 23. Precision Low Voltage References

V_{out} (V) Typ	I_O (mA) Max	V_{out}/T ppm/°C Max	Device 0° to + 70°C	Device – 55° to +125°C – 40° to + 85°C	Reg_{line} (mV) Max	Reg_{load} (mV) Max	Suffix/ Package
1.235 ± 12 mV 1.235 ± 25 mV	20	80 Typ	LM385BZ-1.2 LM385Z-1.2	LM285Z-1.2 (–40° to +85°C)	(Note 1)	1.0 (Note 2)	Z/29
2.5 ± 38 mV 2.5 ± 75 mV			LM385BZ-2.5 LM385Z-2.5	LM285Z-2.5 (–40° to +85°C)		2.0 (Note 3)	
2.5 ± 25 mV	10	25	MC1403A	MC1503A	3.0/4.5 (Note 4)	10 (Note 6)	U/693, D/751
		40	MC1403				
		55		MC1503			
5.0 ± 50 mV		25	MC1404AU5		6.0 (Note 5)		U/693
		40	MC1404U5				
		55		MC1504U5			
6.25 ± 60 mV		25	MC1404AU6				
		40	MC1404U6				
		55		MC1504U6			
10 ± 100 mV		25	MC1404AU10				
		40	MC1404U10				
		55		MC1504U10			
2.5 to 37	100	50 Typ	TL431C, AC, BC	TL431I, AI, BI (–40° to +85°C)	Shunt Reference Dynamic Impedance (z) ≤ 0.5 Ω		LP/29, P/626 JG/693, D/751
				TL431M			JG/693

Notes: 1. Micropower Reference Diode Dynamic Impedance (z) ≤ 1.0 Ω at I_R = 100 µA
2. 10 µA ≤ I_R ≤ 1.0 mA
3. 20 µA ≤ I_R ≤ 1.0 mA
4. 4.5 V ≤ V_{in} ≤ 15 V/15 V ≤ V_{in} ≤ 40V
5. (V_{out} + 2.5 V) ≤ V_{in} ≤ 40V
6. 0 mA ≤ I_L ≤ 10 mA

Data Conversion

In Brief . . .

Motorola's line of digital-to-analog and analog-to-digital converters includes several well established industry standards, and many are available in various linearity grades so as to suit most any application.

The A/D converters have 7 and 8-bit flash converters suitable for NTSC and PAL systems, CMOS has 8 to 10-bit converters, as well as other high speed digitizing applications.

The D/A converters have 6 and 8-bit devices, video speed (for NTSC and PAL) devices, and triple video DAC with on-board color palette for color graphics applications.

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Data Conversion

The line of data conversion products which Motorola offers spans a wide spectrum of speed and resolution/accuracy. Features, including bus compatibility, minimize external parts count and provide easy interface to microprocessor systems. Various technologies, such as Bipolar and CMOS, are utilized to achieve functional capability, accuracy and production repeatability. Bipolar technology generally results in higher speed, while CMOS devices offer greatly reduced power consumption.

Table 24. A-D Converters

Resolution (Bits)	Device	Nonlinearity Max	Conversion Time/Rate	Input Voltage Range	Supplies (V)	Temperature Range (°C)	Suffix/ Package	Comments
CMOS								
8	MC145040	± 1/2 LSB	10 µs	0 to V_{DD}	+5.0 ± 10%	– 40 to +85 (Suffix 2 devices)	P/738 FN/775	Requires External Clock, 11-Ch MUX
	MC145041		20 µs			– 40 to +125 (Suffix 1 devices)	DW/751D	Includes Internal Clock, 11-Ch MUX
	MC14442					– 40 to +85	P/710 FN/776	µP Compatible 11-Ch MUX S.A.R.
	MC14549B/ MC14559B	Successive Approximation Registers			+3.0 to +18	– 55 to +125 – 40 to +85	L/620 P/648	Compatible with MC1408 S.A.R. 8-bit D-A Converter
Triple 8-Bit	MC44250	1 LSB	15 MHz	1.6 to 4.6 V	+5.0 ± 10%	0 to +70	FN/777	3 Separate Video Channels
10	MC145050	± 1 LSB	21 µs	0 to V_{DD}	+5.0 ± 10%	– 40 to +125	P/738 DW/751D	Requires External Clock, 11-Ch MUX
	MC145051		44 µs					Includes Internal Clock, 11-Ch MUX
	MC145053						P/646 D/751A	Includes Internal Clock, 5-Ch MUX
8–10	MC14443/ MC14447	± 0.5% Full Scale	300 µs	Variable w/Supply	+5.0 to +18	– 40 to +85	P/648 DW/751G	µP Compatible, Single Slope, 6-Ch MUX
3-1/2 Digit	MC14433	± 0.05% ± 1 Count	40 ms	± 2.0V ± 200 mV	+5.0 to +8.0 –2.8 to –8.0		P/709 DW/751E	Dual Slope
Bipolar								
7	MC10321	± 1/2 LSB	40 ns	0 to 2.0 V_{pp} Max	+5.0 and –3.0 to –6.0	0 to +70	P/738 DW/751D	Video Speed, Gray Code TTL Outputs
8	MC10319	± 1 LSB					L/623 P/709 DW/751F Die Form	Video Speed Flash Converter, Internal Gray Code TTL Outputs

Table 25. D-A Converters

Resolution (Bits)	Device	Accuracy @ 25°C Max	Max Settling Time (± 1/2 LSB)	Supplies (V)	Temperature Range (°C)	Suffix/ Package	Comments
CMOS							
6	MC144110	—	—	+5.0 to +15	0 to +85	P/707 DW/751D	Serial input, Hex DAC, 6 outputs
	MC144111					P/646 DW/751G	Serial input, Quad DAC, 4 outputs

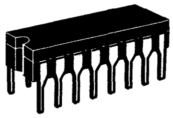
Table 25. D-A Converters (continued)

Resolution (Bits)	Device	Accuracy @ 25°C Max	Max Settling Time (± 1/2 LSB)	Supplies (V)	Temperature Range (°C)	Suffix/ Package	Comments
Bipolar							
8	DAC-08	± 1 LSB	150 ns	±4.5 to ±18	0 to +70	EQ, HQ/620 CP, HP, EP/648 CD, ED/751B	High-speed Multiplying
		± 1/2 LSB					
		± 1/4 LSB	135 ns				
	MC1408	± 1/2 LSB	300 ns Typ	+5.0, – 5.0 to –15	0 to +75	L8/620, P8/648	Multiplying
	MC1508				–55 to +125	L8/620	
4 x 3	MC10320	± 1/4 LSB	3.0 ns	+5.0 or ±5.0	0 to +70	L/733	125 MHz Color Graphics Triple DAC
	MC10320-1						90 MHz Color
8	MC10322	± 1/2 LSB	5.0 ns	+5.0, –5.2	– 40 to +85	P/649	TTL 40 MHz Min
	MC10324			–5.2			ECL 40 MHz Min

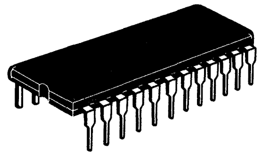
Table 26. A-D/D-A Converters

Resolution (Bits)	Device	Monotonicity (Bits)	Conversion Time	Input Voltage Range	Supplies (V)	Temperature Range (°C)	Suffix/ Package	Comments
CMOS — For Telecommunications								
13	MC145402	13	62.5 μs	± 3.28 V peak	± 5.0 to 6.0	–40 to +85	L/620	Digital signal processing (e.g., echo cancelling, high speed modems, phone systems with conferencing)

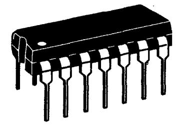
Data Conversion Package Overview



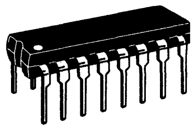
CASE 620
CERAMIC
L, Q SUFFIX



CASE 623
CERAMIC
L, L8 SUFFIX



CASE 646
PLASTIC
P SUFFIX



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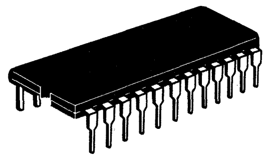

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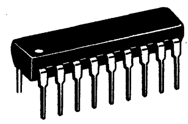
PLASTIC
P SUFFIX



CASE 707
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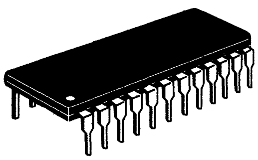
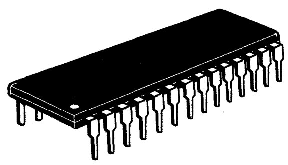
P SUFFIX



CASE 709
PLASTIC
P SUFFIX



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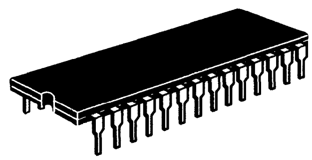
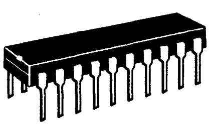
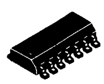
P SUFFIX



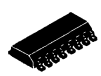
CASE 733
CERAMIC
L SUFFIX



CASE 738
PLASTIC
P SUFFIX



CASE 751A
PLASTIC
D SUFFIX



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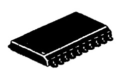
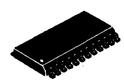
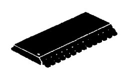
PLASTIC
D SUFFIX



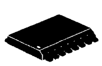
CASE 751D
PLASTIC
DW SUFFIX



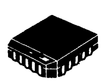
CASE 751E
PLASTIC
DW SUFFIX



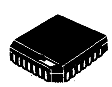
CASE 751F
PLASTIC
DW SUFFIX



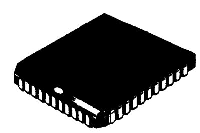
CASE 751G
PLASTIC
DW SUFFIX



CASE 775
PLASTIC
FN SUFFIX



CASE 776
PLASTIC
FN SUFFIX



CASE 777
PLASTIC
FN SUFFIX

Interface Circuits

In Brief . . .

Described in this section is Motorola's line of interface circuits, which provide the means for interfacing microprocessor or digital systems to the external world, or to other systems.

Also included are devices which allow a microprocessor to communicate with its own array of memory and peripheral I/O circuits.

The line drivers, receivers, and transceivers permit communications between systems over cables of several thousand feet in length, and at data rates of up to several megahertz. The common EIA data transmission standards, several European standards, IEEE-488, and IBM 360/370 are addressed by these devices.

The peripheral drivers are designed to handle high current loads such as relay coils, lamps, stepper motors, and others. Input levels to these drivers can be TTL, CMOS, high voltage MOS, or other user defined levels. The display drivers are designed for LCD or LED displays, and provide various forms of decoding.

Page

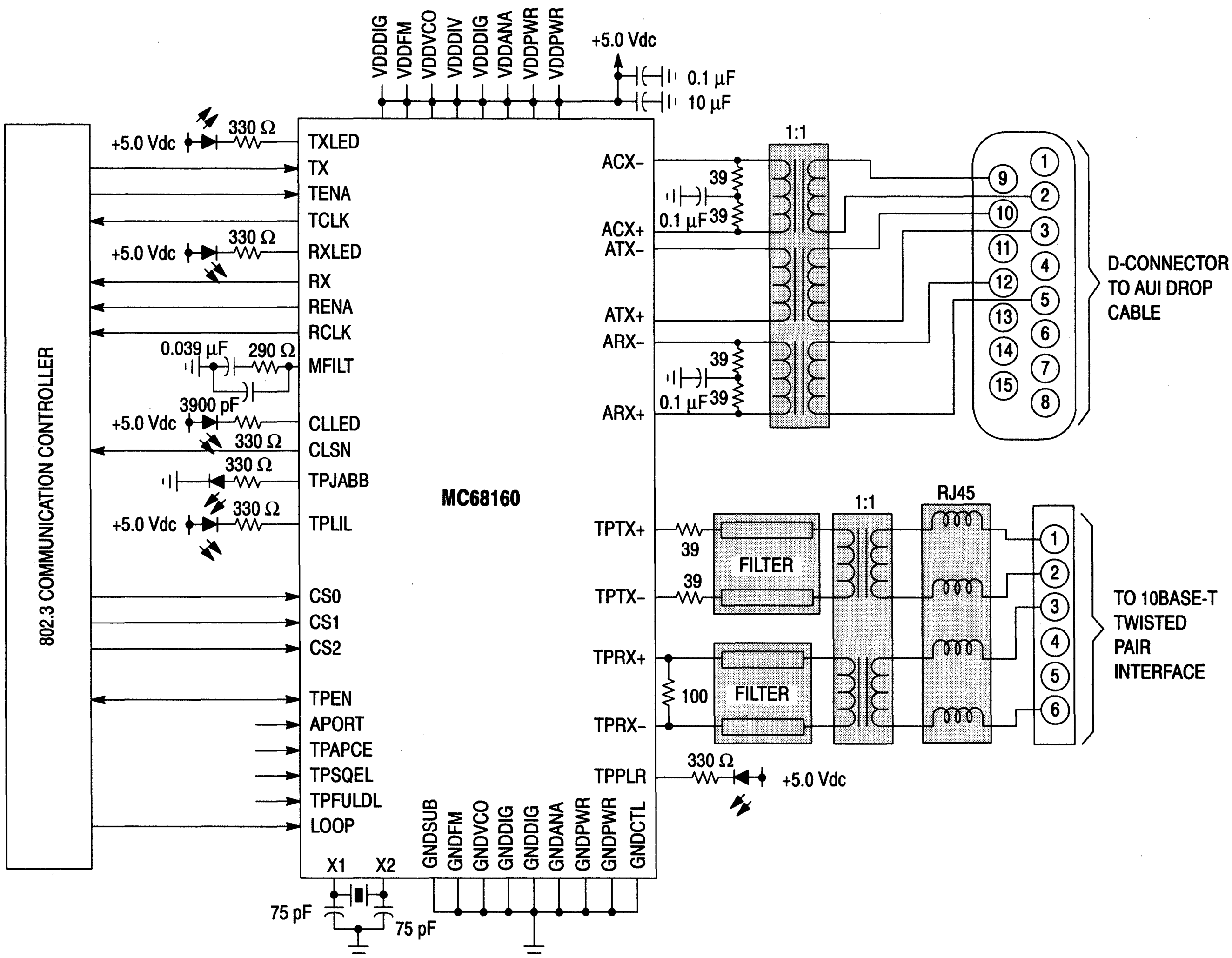
Enhanced Ethernet Serial Transceiver (EEST)

MC68160P

T_A = 0° to +70°C, Case 848D

The MC68160 is a BiCMOS integrated circuit for use in ethernet applications. The IC integrates the Attachment Unit Interface (AUI), the 10BASE-T interface and the communications controller interface. The communications interface is compatible with Motorola, AMD, Intel, National Semiconductor, Fujitsu, Western Digital controllers and is set by the bias of external pins.

Connection to the twisted pair media is accomplished with common 10BASE-T filters and transformers. The AUI requires standard transformers. (The EEST is packaged in a 52-pin Thin Quad Flat Pack.)



Communication Controller Selection

CS0	CS1	CS2	802.3 Communication Controller
1	1	0	Motorola MC68360, AMD 7990 & 79C900
0	1	0	Intel 8256, 82590, 82593, 82596
1	0	0	Fujitsu MB86950, MB86960
0	0	0	National 8390, 83C690, 83932B
1	1	1	Standby Low Current Mode

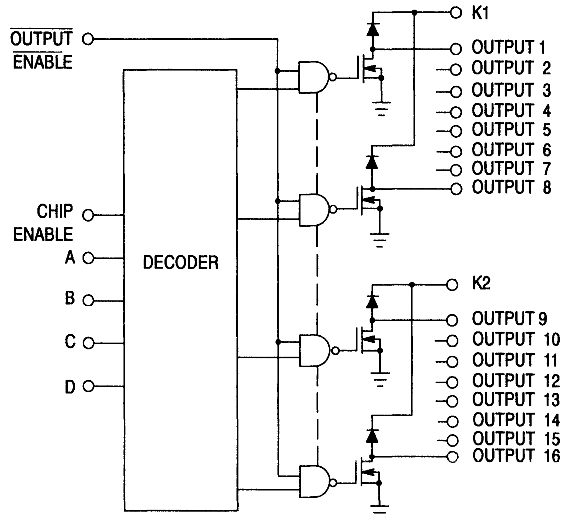
High Performance Decoder Driver/Sink Driver

MC34142DW, FN

T_A = 0° to +70°C, Case 751F, 776

The MC34142 is a high performance 4 to 16 multiplexed driver. This integrated circuit features a 4 to 16 decoder, 16 open drain N-channel MOS output devices with clamp diodes. The outputs are controlled by 4 address inputs, an output enable, and a chip enable.

Typical applications include solenoid drivers, LED drivers, lamp drivers, and relay drivers.

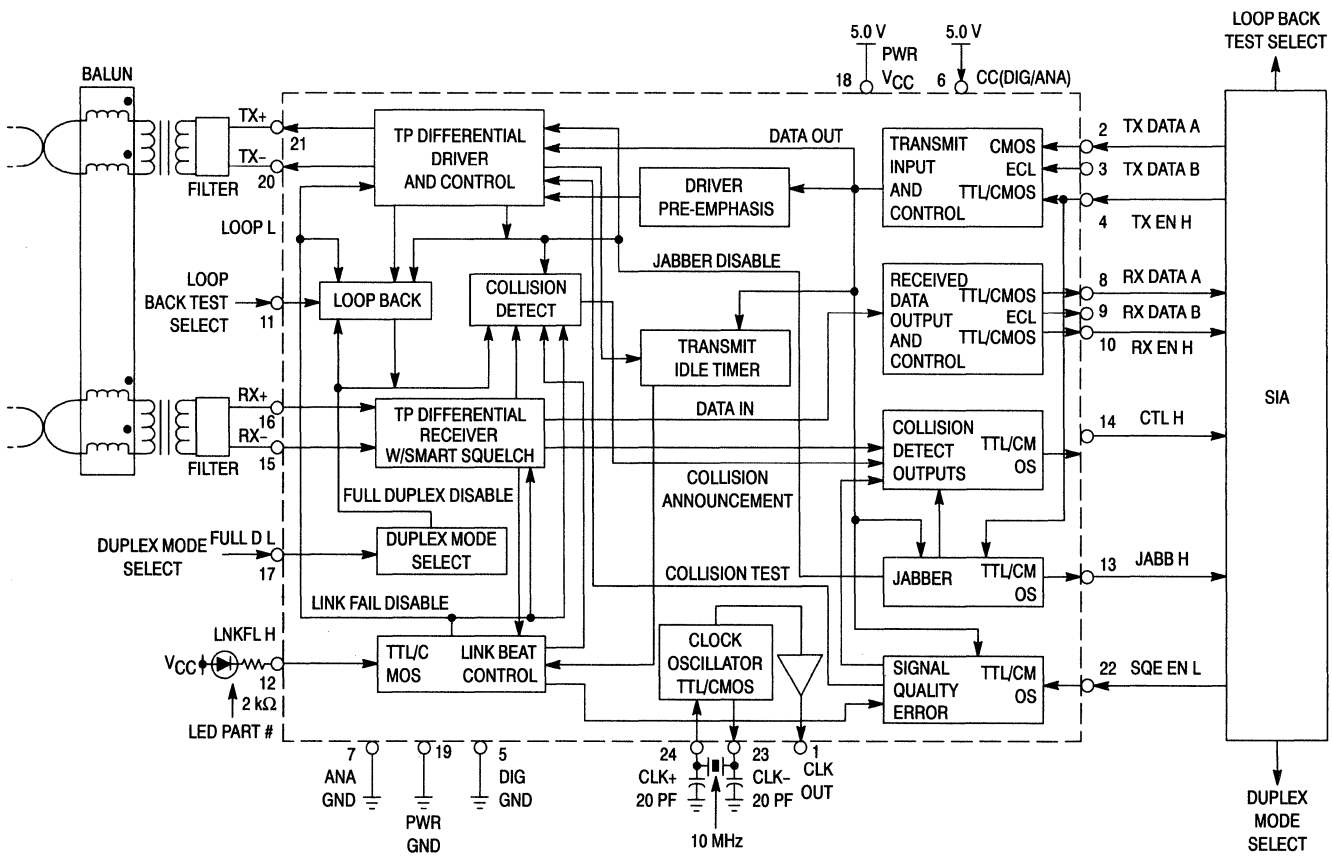


ISO 8802-3[IEEE 802.3] 10BASE-T Transceiver

MC34055DW, P

T_A = 0° to +70°C, Case 751E, 724

The Motorola 10BASE-T transceiver, designed to comply with the ISO 8802-3[IEEE 802.3] 10BASE-T specification, will support a Medium Dependent Interface (MDI) in an embedded Media Attachment Unit (MAU). The interface supporting the Data Terminal Equipment (DTE) is TTL, CMOS, and raised ECL compatible, and the interface to the Twisted Pair (TP) media is supported through standard 10BASE-T filters and transformers. Differential data intended for the TP media is provided a 50 ns pre-emphasis and data at the TP receiver, is screened by Smart Squelch circuitry for specific threshold, pulse width, and sequence requirements.



Microprocessor Bus Interface

Motorola offers a spectrum of line drivers and receivers which provide interfaces to many industry standard specifications. Many of the devices add key operational features, such as hysteresis, short circuit protection, clamp diode protection, or special control functions.

Table 27. Address and Control Bus Extenders

These devices are designed to extend the drive capabilities of today's standard microprocessors. All devices are fabricated with Schottky TTL technology for high speed.

V_{OL} @ 48 mA Max	V_{OH} @ –5.2 mA Min	Propagation Delay Max (ns)	Buffers Per Package	Device	Suffix/ Package	Comments
0.5	2.4	13	6	MC8T97/ MC6887	L/620 P/648	Noninverting
		11		MC8T98/ MC6888		Inverting

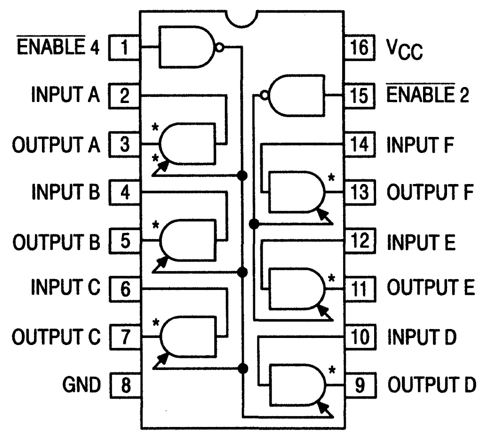
Hex 3-State Buffers/Inverters

T_A = 0° to +75°C

The noninverting MC8T97/MC6887 and inverting MC8T98/ MC6888 provide two Enable inputs, one controlling four buffers and the other controlling the remaining two buffers.

MC8T97/MC6887(1) — Noninverting
MC8T98/MC6888(1) — Inverting

(1)These devices may be ordered by either of the paired numbers.



*ADD INVERTER FOR MC6888/MC8T98.

Table 28. Microprocessor Data Bus Extenders

Driver Characteristics		Receiver Characteristics				
Output Current (mA)	Propagation Delay Max (ns)	Propagation Delay Max (ns)	Transceivers Per Package	Device	Suffix/ Package	Comments
48	14	14	4	MC8T26A (MC6880A)	P/648 L/620	Inverting Logic

Table 29. Magnetic Read/Write

Device	Comments	T_A (°C)	Suffix/ Package
MC3471	Tunnel/Straddle Erase Controller. Provides entire interface between floppy disk heads and the head control and write data signals for straddle erase heads.	0 to + 70	P/738
MC3470, A	Floppy Disk Read Amplifier System. A monolithic read amplifier system for reading differential AC signals from the magnetic head and converting to a digital output.		P/707
MC34167	Magnetic Tape Sense Amplifier. Trace independent preamplifiers with individual gain control. Optimized for use with 9-track magnetic tape memory systems.		

Single-Ended Bus Transceivers

Table 30. For Instrumentation Bus, Meets GPIB/IEEE Standard 488

Driver Characteristics		Receiver Characteristics				
Output Current (mA)	Propagation Delay Max (ns)	Propagation Delay Max (ns)	Transceivers Per Package	Device	Suffix/ Package	Comments
48	30	50	8	MC3447	P3/724 L/623 P/649	Input hysteresis, open collector, 3-state outputs with terminations
	17	25	4	MC3448A	P/648 D/751B L/620	Input hysteresis, open collector, 3-state outputs with terminations

Table 31. For High-Current Party-Line Bus for Industrial and Data Communications

Driver Characteristics		Receiver Characteristics				
Output Current (mA)	Propagation Delay Max (ns)	Propagation Delay Max (ns)	Transceivers Per Package	Device	Suffix/ Package	Comments
100	15	15	4	MC26S10	P/648 D/751B L/620	Open collector, outputs, common enable

Line Receivers

Table 32. General Purpose

S = Single Ended D = Differential	Type (1) of Output	t_{prop} Delay Time Max (ns)	Party Line Operation	Strobe or Enable	Power Supplies (V)	Device	Suffix/ Package	Receivers Per Package	Companion Drivers	Comments
D	TP OC	25	✓	✓	± 5.0	MC3450 MC3452	D/751B P/648 L/620	4	MC3453	Quad version of MC75107/108
	TP OC		✓	✓		MC75107 MC75108	P/646 L/632	2	MC75S110	Dual version of MC3450/2
S	TP	30	✓	✓	+ 5.0	MC3437	P/648 L/620	6		Input hysteresis

(1)OC = Open Collector, TP = Totem-pole output

Table 33. EIA Standard

S = Single Ended D = Differential	Type of Output	t_{prop} Delay Time Max (ns)	Party Line Operation	Strobe or Enable	Power Supplies (V)	Device	Suffix/ Package	Receivers Per Package	Companion Drivers	Comments
S	TP	4000	—	—	+ 5.0	MC14C89B MC14C89B	P/646 D/751A	4	MC14C88B	EIA-232-D/ EIA-562
S	R(2)	85	—	—		MC1489 MC1489A	D/751A P/646 L/632		MC1488	EIA-232-D
S, D	TP	30	✓	✓		AM26LS32 MC3486	P/648 D/751B L/620		AM26LS31 MC3487	EIA-422/423
		35	✓	✓		SN75173 SN75175	N/648 D/751B		MC75172B MC75174B	EIA-422/423/ 485

(2)R = Resistor Pull-up, TP = Totem-pole output

Line Drivers

Table 34. General Purpose

Output Current Capability (mA)	t_{prop} Delay Time Max (ns)	S = Single Ended D = Differential	Party Line Operation	Strobe or Enable	Power Supplies (V)	Device	Suffix/ Package	Receivers Per Package	Companion Drivers	Comments
15	15	D	✓	✓	± 5.0	MC3453	P/648 L/620	4	MC3450 MC3452	Quad version of MC75S110
			✓	✓		MC75S110	P/646 L/632	2	MC75107 MC75108	Dual version of MC3453

Table 35. 360/370 I/O Interface

60	45	S	✓	✓	+ 5.0	MC3481	P/648 L/620	4		Short circuit Fault flag
			✓	✓		MC3485	P/648			

Table 36. EIA Standard

Output Current Capability (mA)	t_{prop} Delay Time Max (ns)	S = Single Ended D = Differential	Party Line Operation	Strobe or Enable	Power Supplies (V)	Device	Suffix/ Package	Receivers Per Package	Companion Drivers	Comments
85	35	D	✓	✓	+ 5.0	MC75172B MC75174B	N/648 J/620	4	SN75173 SN75175	EIA-485
48	20		✓	✓		MC3487	P/648 D/751B L/620		MC3486	EIA-422 with 3-state outputs
			✓	✓		AM26LS31	PC/648 DC/620		AM26LS32	
						MC26LS31	D/751B		MC26LS32	
20		S	—	—	± 12	MC3488A (μA9636A)	P1/626 D/751B U/693	2	MC3486 AM26L532	EIA-423/232-D
15	3500				± 7.0 to ± 12	MC14C88B	P/646 D/751A	4	MC14C89B MC14C89B	EIA-232-D/ EIA-562
10	350				± 9.0 to ± 12	MC1488	P/646 D/751A L/632		MC1489 MC1489A	EIA-232-D
60	300	S/D		422 ✓ 423 —	± 5.0	AM26LS30	PC/648	2 (422) 4 (423)	AM26LS32 MC3486	EIA-422 EIA-423
						MC26LS30	D/751B		MC26LS32	Switchable

Table 37. Line Transceivers

Driver Prop Delay (Max ns)	Receiver Prop Delay Max (ns)	DE = Driver Enable RE = Receiver Enable	Party Line Operation	Power Supplies (V)	Device	Suffix/ Package	Drivers Per Package	Receivers Per Package	EIA Standard
20	30	DE, RE	✓	+ 5.0	MC34050	D/751B P/648	2	2	EIA-422
		DE	✓		MC34051	D/751B P/648			

Table 38. EIA-232-D/V.28 CMOS Drivers/Receivers

Device	Suffix/ Package	Pins	Drivers	Receivers	Power Supplies (V)	Features
MC145403	P/738 DW/751D	20	3	5	± 5.0 to ± 12	
MC145404			4	4		
MC145405			5	3		
MC145406	P/648 DW/751G	16	3			
MC145407	P/738 DW/751D	20			+ 5.0	Charge Pump
MC145408	P/724 DW/751E	24	5	5	± 5.0 to ± 12	
MC145705	P/738 DW/751D	20	2	3	+ 5.0	Charge Pump, Power Down
MC145706			3	2		
MC145707	P/724 DW/751E	24		3		

Table 39. Peripheral Drivers

Output Current Capability (mA)	Input Capability	Propagation Delay Time Max (μs)	Output Clamp Diode	Off State Voltage Max (V)	Device	Drivers Per Package	Suffix/ Package	Logic Function
300	TTL, DTL	1.0	✓	70	MC1472	2	P1/626	NAND
500	TTL, CMOS, PMOS				ULN2801	8	A/707	Invert
	14 V to 25 V PMOS			50	ULN2802			
	TTL, CMOS				ULN2803			
	6.0 V to 15 V MOS				ULN2804			
	TTL, CMOS PMOS				MC1411,B (ULN2001A)	7	P/648	
	14 V to 25 V PMOS				MC1412,B (ULN2002A)			
	TTL, 5.0 V CMOS				MC1413,B (ULN2003A)			
	8.0 V to 18 V MOS				MC1416,B (ULN2004A)			
	TTL, 5.0 V CMOS	0.15		35	MC34142	16	FN/776 DW/751F	1 of 16 Power Decoder
1500	TTL, 5.0 V CMOS	1.0		50	ULN2068B	4	B/648C	Invert

Table 40. IEEE 802.3 Transceivers

Device	Power Supply	10 BaseT	NRZ	IEEE	Comments	Suffix/ Package
MC34055	+ 5.0 Vdc	Transmit and Receive over 4 Pins	Raised ECL, CMOS	802.3 Type 10BaseT	Transceiver with non-return to zero (NRZ) interface. Intended for but not restricted to concentrators and repeator applications.	DW/751E P/724
MC68160			TTL, CMOS	802.3 Type 10BaseT/ AUI/NRZ	Interfaces gluelessly to Motorola's MC68360 communications controller.	P/648

CMOS Display Drivers

These CMOS devices include digit as well as matrix drivers for LEDs, LCDs, and VFDs. They find applications over a wide range of end equipment such as instruments, automotive dash boards, home computers, appliances, radios and clocks.

Table 41. Display Drivers

Display Type	Input Format	Drive Capability Per Package	On-Chip Latch	Display Control	Segment Drive Current	Device
LCD (Direct Drive)	Parallel BCD	7 Segments	✓	Blank	≈ 1.0 mA	MC14543B
				Blank, Ripple Blank		MC14544B
	Serial Binary [Compatible with the Serial Peripheral Interface (SPI) on CMOS MCUs]	33 Segments or Dots			20 µA	MC145453
Muxed LCD (1/4 Mux)		48 Segments or Dots			≈ 200 µA	MC145000
		44 Segments or Dots				MC145001
LED, Incandescent, Fluorescent[1]	Parallel BCD	7 Segments		Blank, Lamp Test	25 mA	MC14511B
				Blank, Ripple Blank, Lamp Test		MC14513B
				Blank	65 mA	MC14547B
Muxed LED (1/4 Mux)	Serial Binary [Compatible with the Serial Peripheral Interface (SPI) on CMOS MCUs]	4 Digits + Decimals	✓	Oscillator (Scanner)	50 mA (Peak)	MC14499
(1/5 Mux)		5 Characters + Decimals or 25 Lamps		Oscillator (Scanner), Low-Power Mode, Dimming	0 to 35 mA (Peak) Adjustable	MC14489
LED (Direct Drive)	Parallel Hex	7 Segments + A thru F Indicator			10 mA[2]	MC14495♦1
(Interfaces to Display Drivers)	Parallel BCD	7 Segments		Ripple Blank, Enable		MC14558B

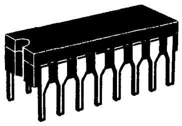
(1) Absolute maximum working voltage = 18 V
(2) On-chip current-limiting resistor

Table 42. Functions

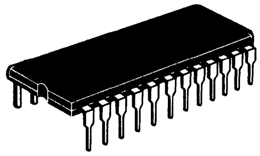
Device	Function	Package
MC14489	Multi-Character LED Display/Lamp Driver	738, 751D
MC14495♦1	Hexadecimal-to-7 Segment Latch/Decoder ROM/Driver	648, 751G
MC14499	4-Digit 7-Segment LED Display Decoder/Driver with Serial Interface	707, 751D
MC14511B	BCD-to-7-Segment Latch/Decoder/Driver	620, 648
MC14513B	BCD-to-7-Segment Latch/Decoder/Driver with Ripple Blanking	726, 707
MC14543B	BCD-to-7-Segment Latch/Decoder/Driver for Liquid Crystals	620, 648
MC14544B	BCD-to-7-Segment Latch/Decoder/Driver with Ripple Blanking	726, 707
MC14547B	High-Current BCD-to-7-Segment Decoder/Driver	620, 648
MC14558B	BCD-to-7-Segment Decoder	620, 648
MC145000	48-Segment Serial Input Multiplexed LCD Driver (Master)	709, 776
MC145001	44-Segment Serial Input Multiplexed LCD Driver (Slave)	707, 776
MC145453	33-Segment, Non-Multiplexed LCD Driver with Serial Interface	711, 777

♦ Replace ♦ with package identifier (see product data).

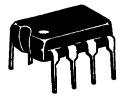
Interface Package Overview



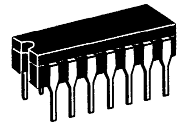
CASE 620
CERAMIC
D, DC, J, L SUFFIX



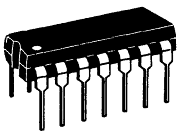
CASE 623
CERAMIC
L SUFFIX



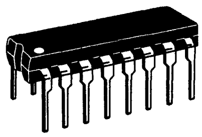
CASE 626
PLASTIC
P1 SUFFIX



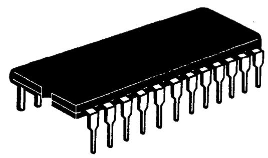
CASE 632
CERAMIC
L SUFFIX



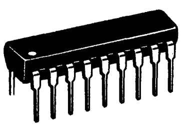
CASE 646
PLASTIC
P SUFFIX



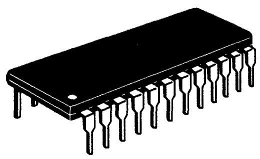
CASE 648, 648C
PLASTIC
B, N, P, PC SUFFIX



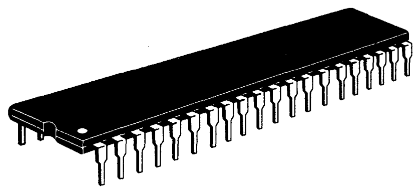
CASE 649
PLASTIC
P SUFFIX



CASE 707
PLASTIC
A SUFFIX



CASE 709
PLASTIC
P SUFFIX



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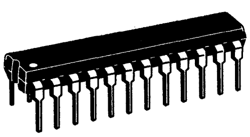
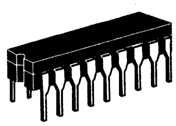
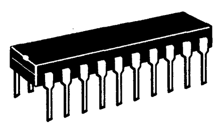
PLASTIC
P SUFFIX



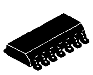
CASE 724
PLASTIC
P3 SUFFIX



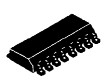
CASE 726
CERAMIC
L SUFFIX



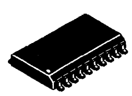
CASE 738
PLASTIC
P SUFFIX



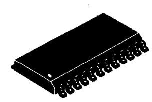
CASE 751A
PLASTIC
D SUFFIX



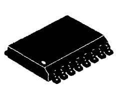
CASE 751B
PLASTIC
D SUFFIX



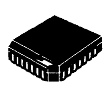
CASE 751D
PLASTIC
DW SUFFIX



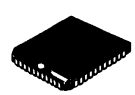
CASE 751E
PLASTIC
DW SUFFIX



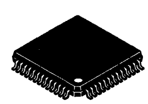
CASE 751G
PLASTIC
DW SUFFIX



CASE 776
PLASTIC
FN SUFFIX



CASE 777
PLASTIC
FN SUFFIX



CASE 848D
PLASTIC
P SUFFIX

Communication Circuits

In Brief . . .

RF

Radio communication has greatly expanded its scope in the past several years. Once dominated by public safety radio, the 30 to 1000 MHz spectrum is now packed with personal and low cost business radio systems. The vast majority of this equipment uses FM or FSK modulation and is targeted at short range applications. From mobile phones and VHF marine radios to garage door openers and radio controlled toys, these new systems have become a part of our lifestyle. Motorola Linear has focused on this technology, adding a wide array of new products including complete receivers processed in our exclusive 3.0 GHz MOSAIC® 1.5 process. New surface mount packages for high density assembly are available for all of these products, as is a growing family of supporting applications notes and development kits.

Telephone & Voice/Data

Traditionally, an office environment has utilized two distinctly separate wired communications systems – Telecommunications and Data communications. Each had its individual hardware components complement, and each required its own independent transmission line system: twisted wire pairs for Telecom and relatively high priced coaxial cable for Datacom. But times have changed. Today, Telecom and Datacom coexist comfortably on inexpensive twisted wire pairs and use a significant number of components in common. This has led to the development and enhancement of PBX (Private Branch Exchanges) to the point where the long heralded "office of the future," with simultaneous voice and data communications capability at each station, is no longer of the future at all. The capability is here today!

Motorola Semiconductor serves a wide range of requirements for the voice/data marketplace. We offer both CMOS and Linear technologies, each to its best advantage, to upgrade the conventional analog voice systems and establish new capabilities in digital communications. Early products, such as the solid-state single-chip crosspoint switch, the more recent monolithic Subscriber-Loop-Interface Circuit (SLIC), a single-chip Codec/Filter (Mono-Circuit), the Universal Digital Loop Transceivers (UDLT), basic rate ISDN (Integrated Services Digital Network), and single-chip telephone circuits are just a few examples of Motorola leadership in the voice/data area.

Page

RF Communications

Table 43. Wideband (FM/FSK) IFs

Device	V_{CC}	I_{CC}	Sensitivity (Typ)	IF	Mute	RSSI	Max Data Rate	Notes	Suffix/ Case
MC13055	3–12 V	25 mA	20 µV	40 MHz	✓	✓	2.0 Mb	Wideband Data IF	P/648 D/751B
MC13155	3–6 V	10 mA	100 µV	70 MHz	—		12 Mb	Video Speed FM IF	D/751B

Table 44. Wideband Single Conversion Receivers — VHF

Device	V_{CC}	I_{CC}	Sensitivity (Typ)	RF Input	IF	Mute	RSSI	Max Data Rate	Notes	Suffix/ Case
MC3356	3–9 V	25 mA	30 µV	200 MHz	10.7 MHz	✓	✓	500 kb	Includes front end mixer/L.O.	P/738 DW/751D
MC13156	2–7 V	3.0 mA	2.0 µV		21.4 MHz	—			CT-2 FM/Demodulator	DW/751E

Table 45. Narrowband Single Conversion Receivers — VHF

Device	V_{CC}	I_{CC}	12 dB SINAD Sensitivity (Typ)	RF Input	IF	Mute	RSSI	Max Data Rate	Notes	Suffix/ Case
MC3357	4–8 V	5.0 mA	5.0 µV	45 MHz	455 kHz	✓	—	>4.8 kb	Ceramic Quad Detector/Resonator	P/648
MC3359	4–9 V	7.0 mA	2.0 µV						Scan output option	P/707 DW/751D
MC3361B	2–8 V	6.0 mA		60 MHz					Lowest cost receiver	P648 D/751B
MC3367	1–5 V	1.0 mA	1.0 µV	75 MHz			—	1.2 kb	1 Cell Operation	DW/751F
MC3371	2–8 V	6.0 mA		60 MHz			✓	>4.8 kb	RSSI	P/648 D/751B
MC3372									RSSI, Ceramic Quad Detector/Resonator	

Table 46. Narrowband Dual Conversion Receivers — FM/FSK — VHF

Device	V_{CC}	I_{CC}	12 dB SINAD Sensitivity (Typ)	RF Input	IF1	IF2 (Limiter In)	Mute	RSSI	Data Rate	Notes	Suffix/ Case
MC3362	2.0 V to 7.0 V	3.0 mA	0.7 µV	180 MHz	10.7 MHz	455 kHz	—	✓	> 4.8 kb	Includes buffered VCO output	P/724 DW/751E
MC3363		4.0 mA	0.4 µV				✓			Includes RF amp/mute	DW/751F
MC3335			0.7 µV							Low cost version	DW/751D
MC13135		3.5 mA		200 MHz			—		> 50 kb	Voltage buffered RSSI	DW/751E
MC13136										High level IF resonator drive	

RF Communications (continued)

Table 47. Transmitters — AM/FM/FSK

Device	V_{CC}	I_{CC}	P_{out}	Max RF Freq Out	Max Mod Freq	Notes	Suffix/ Case
MC2831A	3.0 V to 8.0 V	5.0 mA	–30 dBm	50 MHz	50 kHz	FM transmitter. Includes low battery checker, tone oscillator	P/648 D/751B
MC2833		10 mA	–30 dBm to +10 dBm	150 MHz		FM transmitter. Includes two frequency multiplier/amplifier transistors	
MC13175	2.0 V to 5.0 V	40 mA	8.0 dBm	500 MHz	5.0 MHz	AM/FM transmitter. Single frequency PLL $f_{out} = 8 \times f_{ref}$	D/751B
MC13176				1.0 GHz		$f_{out} = 32 \times f_{ref}$	

Table 48. Balanced Modulator/Demodulator

Device	V_{CC}	I_{CC}	Function	Suffix/ Case
MC1596 MC1496	5.0 V to 30 V	10 mA	Carrier Balance >50 dB General purpose balanced modulator/ demodulator for AM, SSB, FM detection	L/632 P/646 D/751A

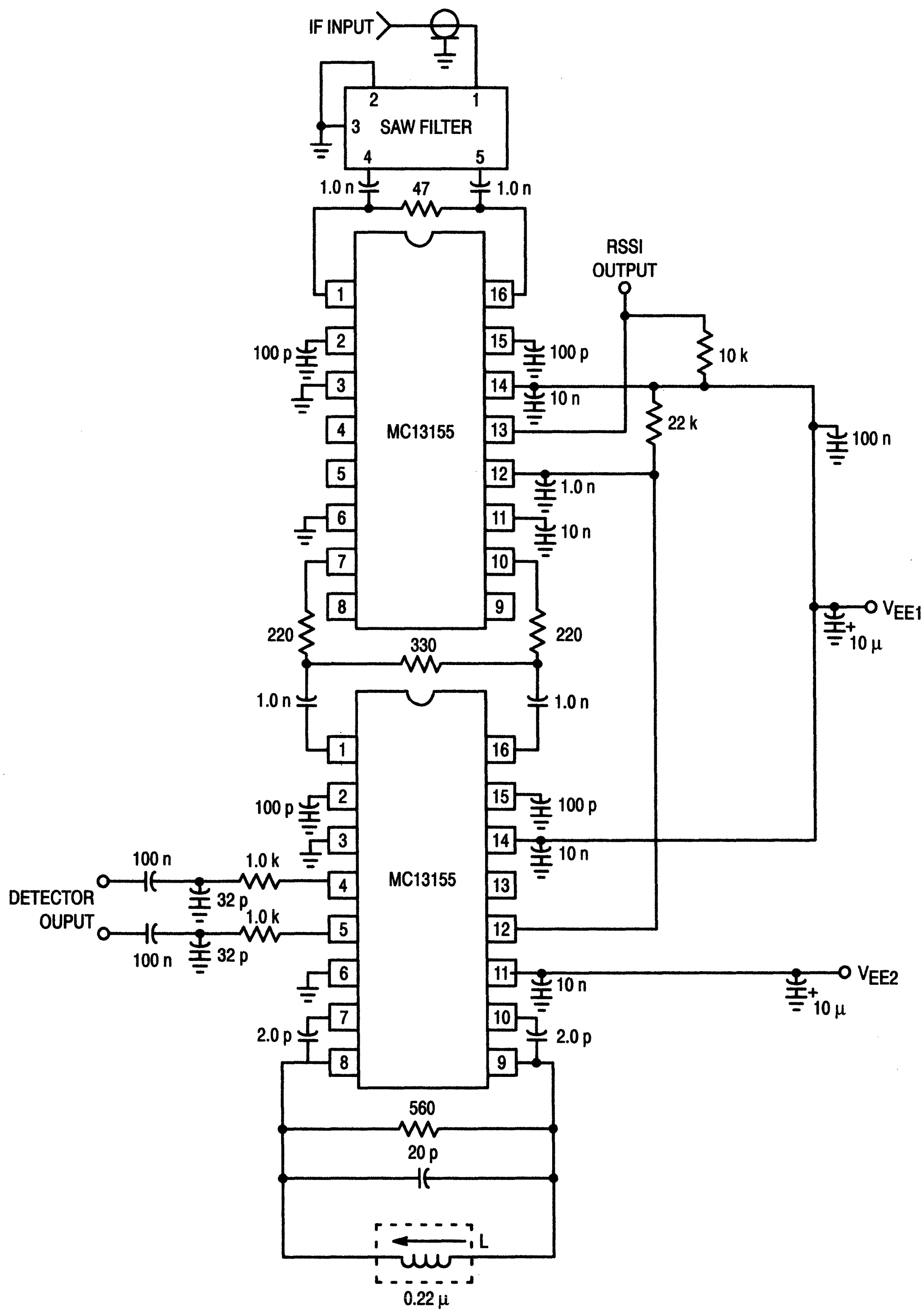
Wideband FM IF

MC13155D

T_A = 40° to +85°C, Case 648, 751B

The MC13155D is a complete wideband FM detector designed for satellite TV and other wideband data and analog FM applications. Devices may be cascaded for higher IF gain and extended Receive Signal Strength Indicator (RSSI) range.

- 12 MHz Video/Baseband Demodulator
- Ideal for Wideband Data and Analog FM Systems
- Limiter Output for Cascade Operation
- Low Drain Current: 7.0 mA
- Low Supply Voltage: 3.0 to 6.0 V
- Operates to 300 MHz



Wideband FM IF System

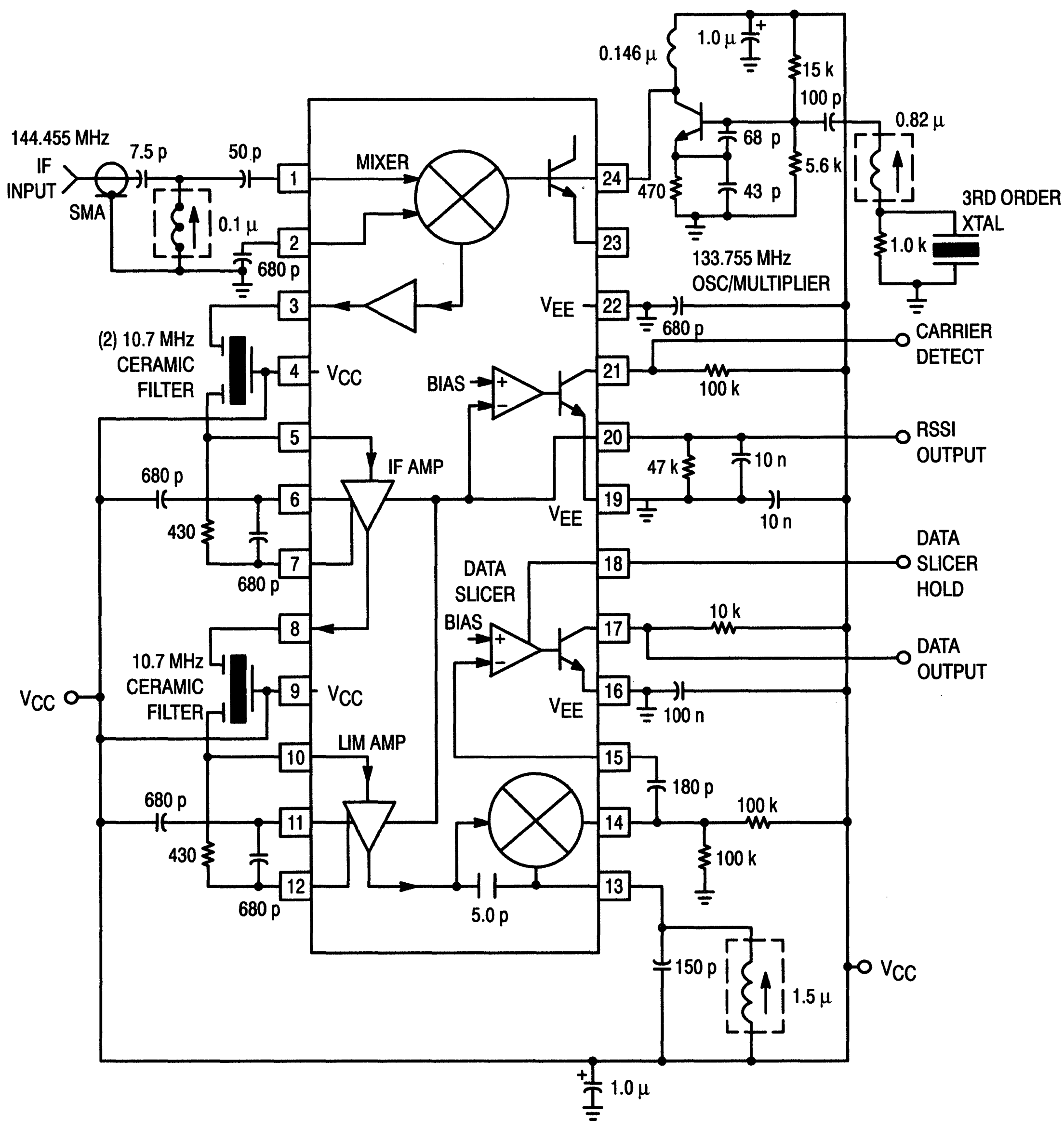
MC13156DW

T_A = –40° to +85°C, Case 751E

The MC13156 is a wideband FM IF subsystem targeted at high performance data and analog applications. Excellent high frequency performance is achieved, with low cost, through use of Motorola's MOSAIC 1.5™ RF bipolar process. The MC13156 has an onboard Colpitts VCO for PLL controlled multichannel operation. The mixer is useful to beyond 200 MHz and may be used in a differential, balanced, or single-ended configuration. The IF amplifier is split to accommodate two low cost cascaded filters. RSSI output is derived by summing the output of both IF sections. A precision data shaper has a hold function to preset the shaper for fast recovery of new data.

Applications for the MC13156 include CT-2, wideband data links, and other radio systems utilizing GMSK, FSK or FM modulation.

- 2.0 to 6.0 Vdc Operation
- Typical Sensitivity of 6.0 μV for 12 dB SINAD
- RSSI Range of Greater than 70 dB
- High Performance Data Shaper for Enhanced CT-2 Operation
- Internal 300 Ω and 1.4 kΩ Terminations for 10.7 MHz and 455 kHz Filters
- Split IF for Improved Filtering and Extended RSSI Range



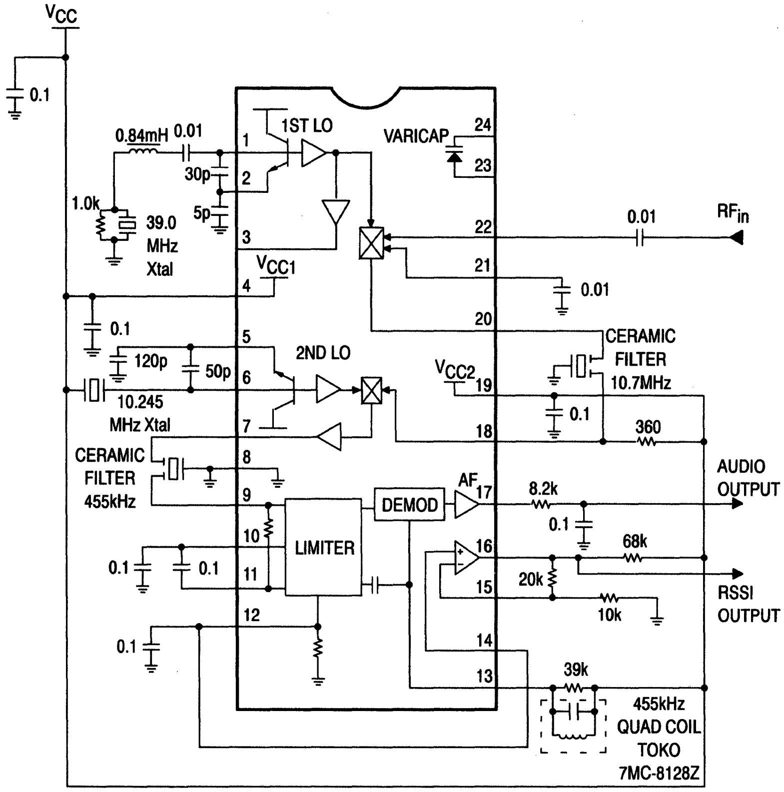
Narrowband FM Receiver

MC13135/136P, DW

$T_A = -40°$ to $+85°C$, Case 724, 751E

The MC13135 is a full dual conversion receiver with oscillators, mixers, Limiting IF Amplifier, Quadrature Discriminator, and RSSI circuitry. It is designed for use in security systems, cordless phones, and VHF mobile and portable radios. Its wide operating supply voltage range and low current make it ideal for battery applications. The Received Signal Strength Indicator (RSSI) has 65 dB of dynamic range with a voltage output, and an operational amplifier is included for a DC buffered output. Also, an improved mixer third order intercept enables the MC13135 to accommodate larger input signal levels.

- Complete Dual Conversion Circuitry
- Low Voltage: 2.0 to 6.0 Vdc
- RSSI with Op Amp: 65 dB Range
- Low Drain Current: 3.5 mA Typical
- Improved First and Second Mixer 3rd Order Intercept
- Detector Output Impedance: 25 Ω Typically



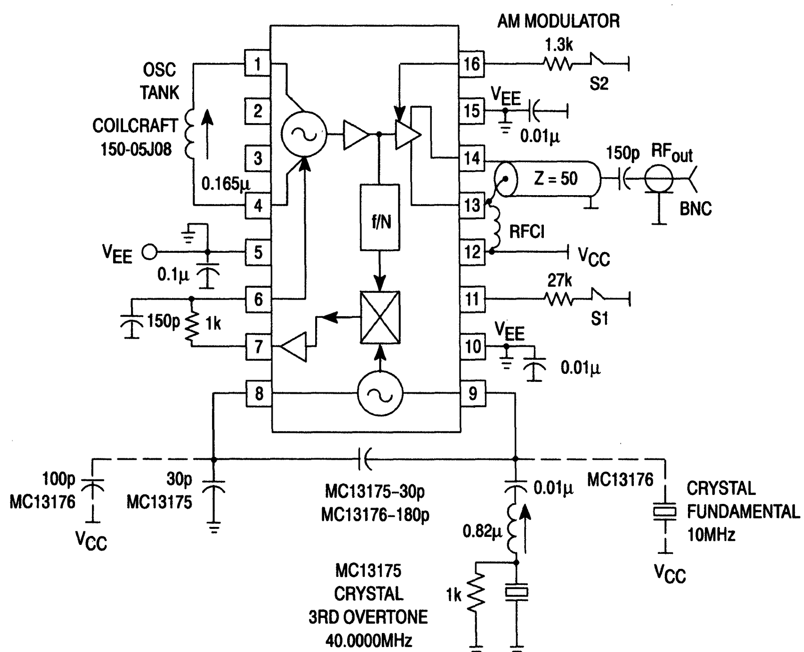
UHF, FM/AM Transmitter

MC13175/176D

$T_A = 0°$ to $+70°C$, Case 751B

The MC13175 and MC13176 are one chip FM/AM transmitter subsystems designed for AM/FM communication systems operating in the 260 to 470 MHz band covered by FCC Title 47; Part 15. They include a Colpitts crystal reference oscillator, UHF oscillator, ÷8 (MC13175) or ÷32 (MC13176) prescaler, and phase detector forming a versatile PLL system. Another application is as a local oscillator in a UHF or 900 MHz receiver. MC13175/176 offer the following features:

- UHF Current Controlled Oscillator
- Use Easily Available 3rd Overtone or Fundamental Crystals for Reference
- Low Number of External Parts Required
- Low Operating Supply Voltage (1.8–5.0 Vdc)
- Low Supply Drain Currents
- Power Output Adjustable (Up to +10 dBm)
- Differential Output for Loop Antenna or Balun Transformer Networks
- Power Down Feature
- ASK Modulated by Switching Output On and Off
- MC13175 — $f_o = 8 \times f_{ref}$
- MC13176 — $f_o = 32 \times f_{ref}$



Telecommunications

Subscriber Loop Interface Circuits (SLIC)

MC3419-1L

T_A = 0° to +70°C, Case 726

The replacement of two-to-four wire conversion hybrid transformers in Central Office, PBX, and Subscriber Carrier equipment with the SLIC has resulted in major improvement in telephone equipment. The SLIC family performs this task, along with most other **BORSHT** functions required by signal transmission. These include the provision of DC power to the telephone (**B**attery); **O**vervoltage protection; **R**ing trip detection; **S**upervisory features such as hook status and dial pulsing; 2-to-4 wire conversion, suppression of longitudinal signals (**H**ybrid).

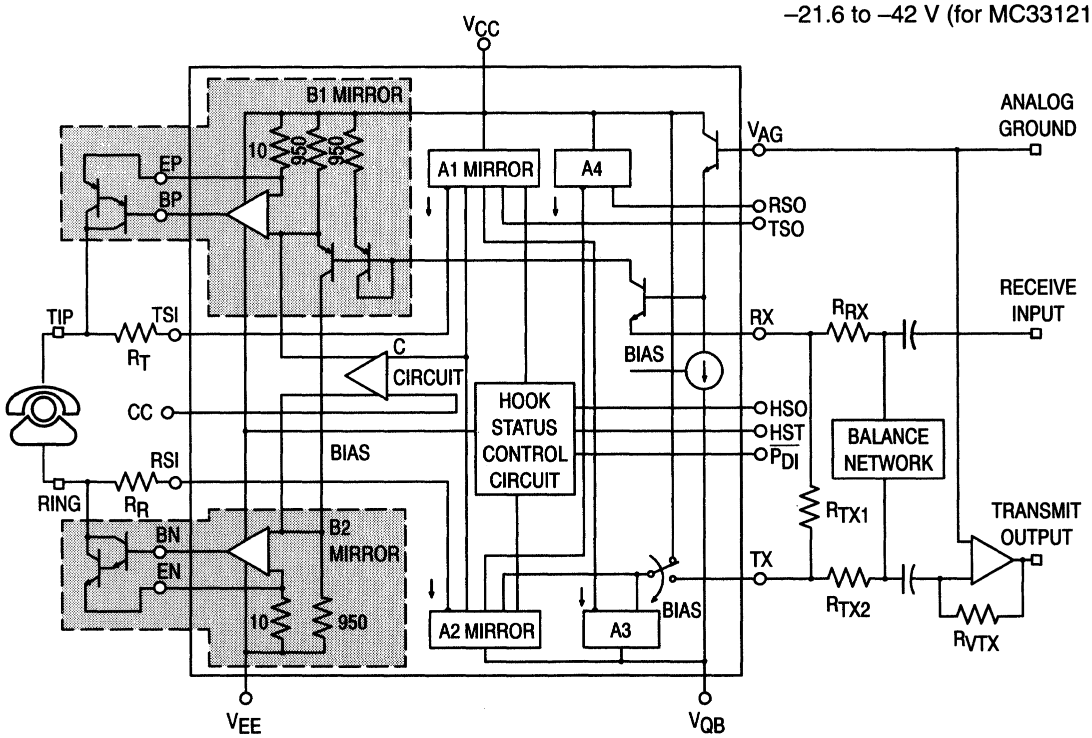
- All Key Parameters Externally Programmable
- Current Sensing Outputs Monitor Status of Both Tip and Ring Leads
- On-Hook Power Below 5.0 mW
- Digital Hook Status Output
- Power Down Input
- Ground Fault Protection
- Size and Weight Reduction Over Conventional Approaches
- The sale of this product is licensed under Patent No. 4,004,109. All royalties related to this patent are included in the unit price.

MC33120/1P, FN

T_A = –40° to +85°C, Case 738, 776

With a guaranteed minimum longitudinal balance of 58 dB, the MC33120/1 is ideally suited for Central Office applications, as well as PBXs, and other related equipment. Protection and sensing components on the two-wire side can be non-precision while achieving required system performance. Most BORSHT functions are provided while maintaining low power consumption, and a cost effective design. Size and weight reduction over conventional transformer designs permit a higher density system.

- All Key Parameters Externally Programmable with Resistors:
  - Transmit and Receive Gains
  - Transhybrid Loss
  - Return Loss
  - DC Loop Current Limit and Battery Feed Resistance
  - Longitudinal Impedance
- Single and Double Fault Sensing and Protection
- Minimum 58 dB Longitudinal Balance (2-wire and 4-wire) Guaranteed
- Digital Hook Status and Fault Outputs
- Power Down Input
- Loop Start or Ground Start Operation
- Size & Weight Reduction Over Conventional Approaches
- Available in 20 Pin DIP and 28 Pin PLCC Packages
- Battery Voltage: –42 to –58 V (for MC33120), –21.6 to –42 V (for MC33121)



Subscriber Loop Interface Circuits (SLIC) (continued)

MC33122

T_A = –40° to +85°C, Case *TBD

The MC33122 is designed to provide the interface between the four-wire side of a Central Office or remote terminal and the two-wire subscriber line. Interface functions include battery feed, proper loop termination AC impedance, adjustable transmit, receive and transhybrid gains, hookswitch and ring trip detection. Additionally, the MC33122 provides a minimum of 58 dB of longitudinal balance.

The transmit and receive signals are referenced to analog ground (VAG), easing the interface to Codecs, filters, etc. The logic interface is TTL and CMOS compatible.

Internal loop current power transistors sink and source current at tip and ring. Thermal shutdown is provided to protect against line faults. A switching regulator is used to reduce power dissipation and enhance reliability, and a clock input allows synchronization to minimize noise.

The MC33122 will be fabricated on a standard high voltage (90 V) BiMOS process to increase protection during lightning surges. It will be available in a 52 pin PLCC and 64 pin QFP package.

- Designed in Accordance with TR-000057 and TA-000909 Bellcore Objectives
- Suitable for CO, Digital Loop Carrier Systems (DLCS), and PBX
- Full On-Hook Transmission Capability
- On-Chip Loop Current Power Transistors
- Reduced Power Dissipation with Switching Regulator
- Minimum 58 dB Longitudinal Balance
- Externally Adjustable Impedance, Tx, Rx and Transhybrid Gains
- Current Limit Externally Adjustable to 50 mA
- Hook Switch Detection and Ring Tip Capability, Adjustable
- Polarity Reversal and Power Down Capability
- Ground Start Sequence Controls
- Two Relay Drivers

PBX Architecture (Analog Transmission)

PCM Mono-Circuits Codec-Filters (CMOS LSI)

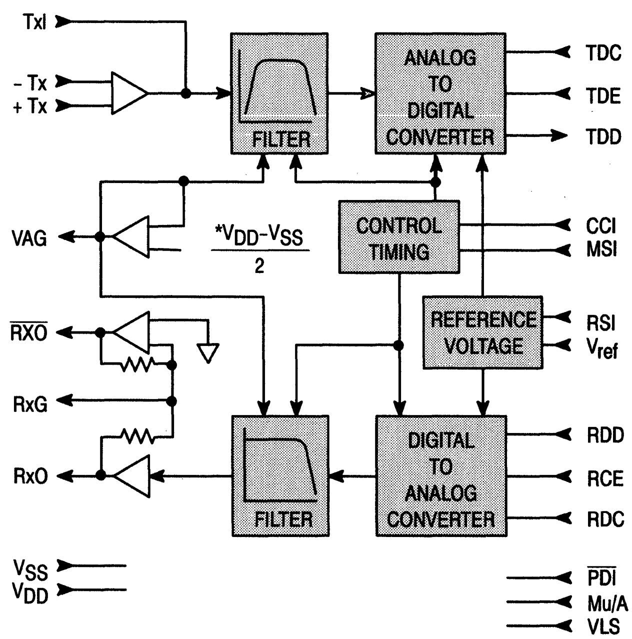
MC145500 Series

Case 620, 648, 708, 726, 736, 751, 776

The Mono-circuits perform the digitizing and restoration of the analog signals. In addition to these important functions, Motorola's family of pulse-code modulation mono-circuits also provides the band-limiting filter functions — all on a single monolithic CMOS chip with extremely low power dissipation.

The Mono-circuits require no external components. They incorporate the bandpass filter required for antialiasing and 60 Hz rejection, the A/D–D/A conversion functions for either U.S. Mu-Law or European A-Law companding formats, the low-pass filter required for reconstruction smoothing, an on-board precision voltage reference, and a variety of options that lend flexibility to circuit implementations. Unique features of Motorola's Mono-circuit family include wide power supply range (6 to 13 V) selectable on-board voltage reference (2.5, 3.1, or 3.8 V), and TTL or CMOS I/O interface.

Motorola supplies five versions in this series. The MC145500, MC145503 and MC145505 are general-purpose devices in 16 pin packages designed to operate in digital telephone or line card applications. The MC145501 is the same device (in an 18 pin package) that offers the capability of selecting from three peak overload voltages (2.5, 3.15 and 3.78 V). The MC145502 is the full-feature device that presents all of the options available on the chip. This device is packaged in a 22 pin DIP and 28 pin chip carrier package.



MC145554/57/64/67

Case 620, 648, 732, 738, 751D, 751G

These per channel PCM Codec-filters perform the voice digitization and reconstruction as well as the band limiting and smoothing required for PCM systems. They are designed to operate in both synchronous and asynchronous applications and contain an on-chip precision voltage reference. The MC145554 (Mu-Law) and MC145557 (A-Law) are general purpose devices that are offered in 16 pin packages. The MC145564 (Mu-Law) and MC145567 (A-Law), offered in 20 pin packages, add the capability of analog loop-back and push-pull power amplifiers with adjustable gain.

PBX Architecture (continued)

All four devices include the transmit bandpass and receive lowpass filters on-chip, as well as active RC pre-filtering and post-filtering. Fully differential analog circuit design assures lowest noise. Performance is specified over the extended temperature range of –40° to +85°C.

These PCM Codec-filters accept both industry standard clock formats. They also maintain compatibility with Motorola's family of MC3419/MC33120 SLIC products.

MC145480
Case 738, 751D

This 5.0 V, general purpose per channel PCM Codec-filter offers selectable Mu-Law or A-Law companding in 20 pin DIP and SOG packages. It performs the voice digitization and reconstruction as well as the band limiting and smoothing required for PCM systems. It is designed to operate in both synchronous and asynchronous applications and contains an on-chip precision reference voltage (1.575 V).

The transmit bandpass and receive lowpass filters, and the active RC pre-filtering and post-filtering are incorporated, as well as fully differential analog circuit design for lowest noise. Push-pull 300 Ω power drivers with external gain adjust are also included.

The MC145480 PCM Codec-filter accepts a variety of clock formats, including short-frame sync, long-frame sync, IDL, and GCI timing environments. This device also maintains compatibility with Motorola's family of Telecom products, including the MC145472 U Interface Transceiver, MC145474/75 S/T Interface Transceiver, MC145532 ADPCM Transcoder, MC145422/26 UDLT-I, MC145421/25 UDLT-II, and MC3419/MC33120 SLIC.

MC145540
Case 710, 751F

The MC145540 ADPCM Codec is a single chip implementation of a PCM codec-filter and an ADPCM encoder/decoder, and therefore provides an efficient solution for applications requiring the digitization and compression of voiceband signals. This device is designed to operate over a wide voltage range, 2.7 V to 5.25 V, and as such is ideal for battery powered as well as AC powered applications. The MC145540 ADPCM Codec also includes a serial control port and internal control and status registers that permit a microcomputer to exercise many built-in features.

The ADPCM Codec is designed to meet the 32 kbps ADPCM conformance requirements of CCITT Recommendation G.721 and ANSI T1.301. It also meets ANSI T1.303 and CCITT Recommendation G.723 for 24 kbps ADPCM operation, and the 16 kbps ADPCM standard, CCITT Recommendation G.726. This device also meets the PCM conformance specification of the CCITT G.714 Recommendation.

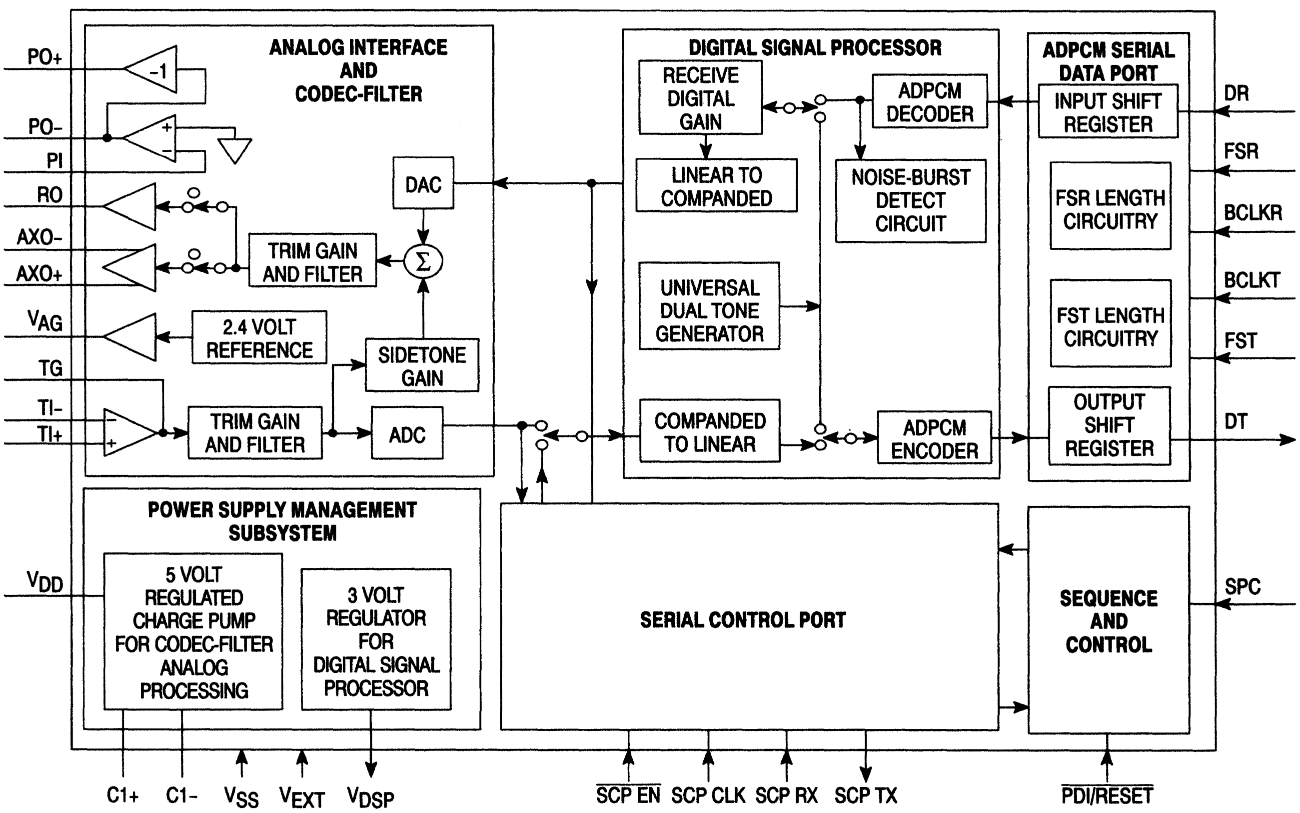


Figure 1. MC145540 ADPCM Codec Block Diagram

PBX Architecture (continued)

MC145537EVK
ADPCM Codec Evaluation Kit

The MC145537EVK is the primary tool for evaluation and demonstration of the MC145540 ADPCM Codec. It provides the necessary hardware and software interface to access the many features and operational modes of the MC145540 ADPCM Codec.

- Provides Stand Alone Evaluation on Single Board
- The Kit Provides Analog-to-Analog, Analog-to-Digital or Digital-to-Analog Connections — with Digital Connections being 64 kbps PCM, 32 or 24 kbps ADPCM, or 16 kbps CCITT G.726 or Motorola Proprietary ADPCM
- +5.0 V Only Power Supply, or 5.0 V Plus 2.7 to 5.25 V Supply
- Easily Interfaced to Test Equipment, Customer System, Second MC145537EVK or MC145536EVK (5.0 V Only) for Full Duplex Operation
- Convenient Access to Key Signals
- Piezo Loudspeaker
- EIA-232 Serial Computer Terminal Interface for Control of the MC145540 ADPCM Codec Features
- Compatible Handset Provided
- Schematics, Data Sheets, and User's Manual Included

Also Available — Filters:

MC145414
Dual Tuneable Low-Pass Sampled Data Filter

MC145432
2600 Hz Tone Signalling Filter

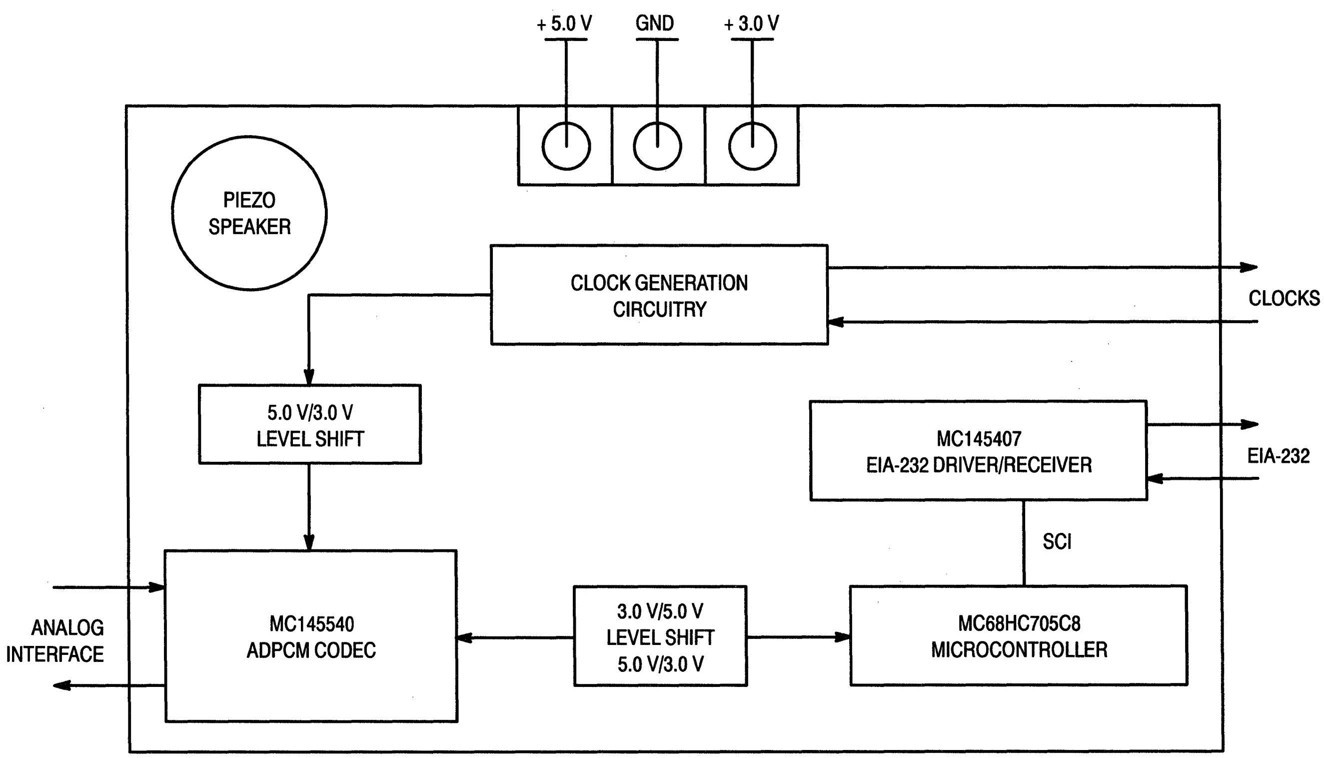


Figure 2. MC145537EVK Block Diagram

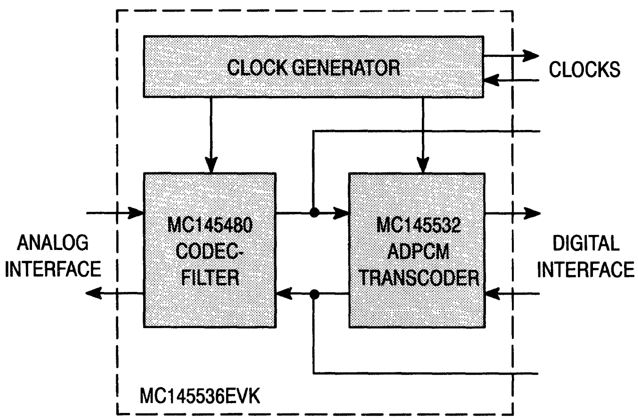
PBX Architecture (continued)

MC145536EVK

Codec-Filter/ADPCM Transcoder Evaluation Kit

The MC145536EVK is the primary tool for evaluation and demonstration of the MC145480 Single +5.0 V supply PCM Codec-Filter and the MC145532 ADPCM Transcoder (see "Telephone Accessory Circuits"). The MC145536EVK provides the necessary hardware needed to evaluate the many separate operating modes under which the MC145480 and MC145532 are intended to operate.

- Provides Stand Alone Evaluation on a Single Board
- Easily Interfaced to Test Equipment, Customer System, or Second MC145536EVK
- Convenient Access to Key Signals
- Generous Wire-Wrap Area for Application Development
- The Kit Provides Analog-to-Analog, Analog-to-Digital, or Digital-to-Analog Connections – with Digital Connections Being 64 kbps PCM; 32, 24, or 16 kbps Motorola Proprietary ADPCM
- Compatible Handset Included
- Schematics, Data Sheets, and User's Manual Included



Dual Tone Multiple Frequency Receiver

MC145436

Case 646, 751

This device contains the filter and decoder for detection of a pair of tones conforming to the DTMF standard with outputs in hexadecimal. Switched capacitor filter technology is used together with digital circuitry for the timing control and output circuits. The MC145436 provides excellent power-line noise and dial tone rejection.

Crosspoint Switches

Crosspoint switches implemented with semiconductor technology take the place of the huge banks of mechanical relay matrices once utilized in Central Offices and PBXs.

Motorola's crosspoint switches have latches to control the state of any particular switch in order to route analog or digital signals. These ICs find applications in PBXs, key systems, and test equipment.

Table 49.

Device	Description	Suffix/ Case
MC142100	4 × 4 × 1 Analog Switch • 4.2 to 18 V Operation • Low On-State Resistance	CL/620 CP/648 DW/751G
MC145100	4 × 4 × 1 Analog Switch • 4.2 to 18 V Operation • Low On-State Resistance • Power-On Reset	CP/648

ISDN Voice/Data Circuits

Integrated Services Digital Network

ISDN is the revolutionary concept of converting the present analog telephone networks to an end-to-end global digital network. ISDN standards make possible a wide variety of services and capabilities that are revolutionizing communications in virtually every industry.

Motorola's ISDN product family includes the MC145472 U-Interface Transceiver, the MC145474/75 S/T-Interface Transceivers, MC145488 Dual Data Link Controller, and the MC68302 Integrated Multi-Protocol Processor. These are supported by a host of related devices including the MC145480 +5.0 V PCM Codec-Filter, MC145532 ADPCM Transcoder, MC145540 ADPCM Codec, MC145500 family of single-chip codec/filters, MC145436 DTMF Decoder, MC33120 Subscriber Loop Interface Circuit, MC34129 Switching Power Supply Controller, MC145611 PCM Conference Circuit, and the MC145406/07 CMOS EIA 232-D Driver/ Receiver family.

Motorola's key ISDN devices fit into four ISDN network applications: a digital subscriber line card, an NT1 network termination, an ISDN terminal adapter, and an ISDN terminal. Digital subscriber line cards are used in central offices, remote concentrators, channel banks, T1 multiplexers, and other switching equipment. The NT1 network termination block illustrates the simplicity of remote U to S/T-interface conversion. The ISDN terminal adapter and ISDN terminal block show how Motorola ICs are used to combine voice and data in PC compatible boards, digital telephones, and other terminal equipment. Expanded applications such as a PBX may include these and other Motorola ISDN circuits. Many "non-ISDN" uses, such as pairgain applications, are appropriate for Motorola's ISDN devices as well.

U-Interface Transceiver

MC145472
Case 847B

MC14LC5472
Case 847B, 847

The MC145472/MC14LC5472 fully conforms to ANSI T1.601-1991, the North American standard for ISDN Basic Access on a single twisted-wire pair. The transceiver achieves a remarkable 10^{-7} bit error rate performance on all ANSI specified test loops with worst-case impairments present. The state-of-the-art 1.2 micron single-chip solution uses advanced design techniques to combine precision analog signal processing elements with three digital signal coprocessors to build an adaptively equalized echo cancelling receiver.

Two modes of handling U-interface maintenance functions are provided on the MC145472/MC14LC5472. In the automatic maintenance mode the U-interface transceiver handles all ANSI specified maintenance and channel procedures internally to minimize your software development effort. Automatic procedures include generating and monitoring the cyclic redundancy check, reporting and counting far end block errors (near end block errors too), handling the ACT and DEA bits, as well as monitoring and appropriately responding to embedded operations channel messages.

The optional manual maintenance mode lets you choose an inexpensive microcontroller, such as a member of Motorola's MC68HC05 family, to control and augment the standard maintenance channel functions. This flexible feature also allows for easy implementation of proprietary maintenance functions.

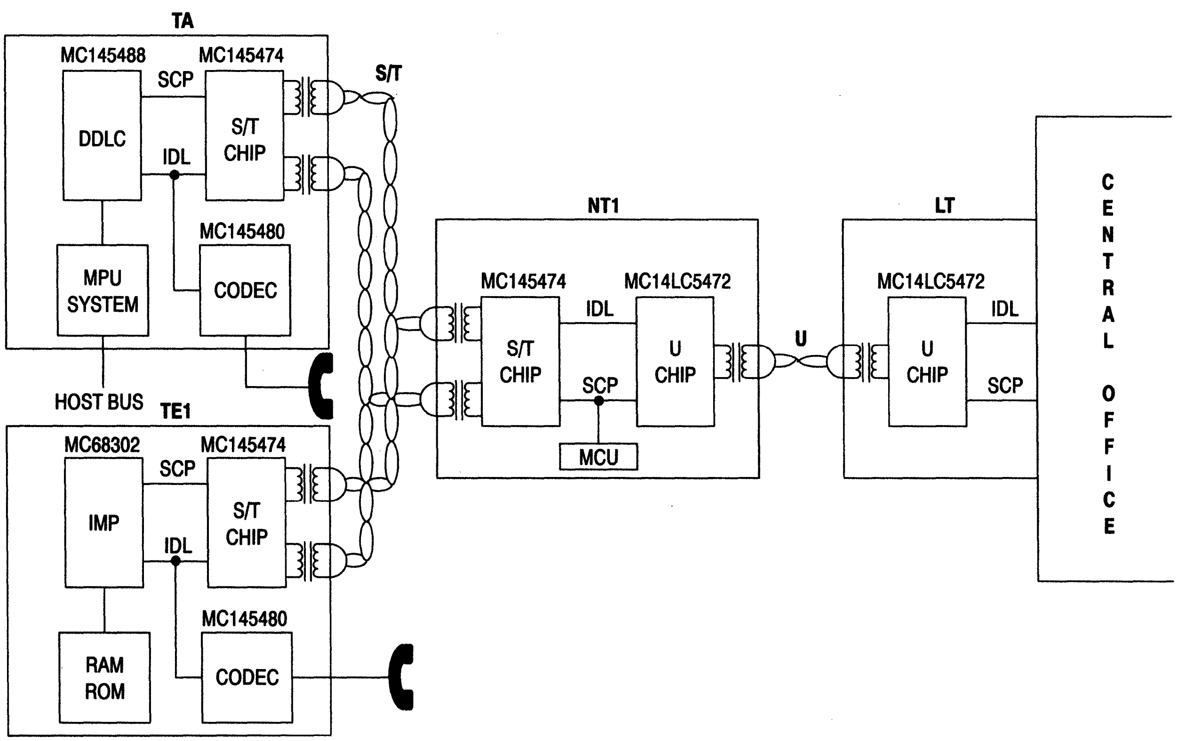
S/T-Interface Transceivers

MC145474
Case 736A

MC145475
Case 710, 751F

The MC145474/75 S/T-Interface Transceivers provide a CCITT I.430 compatible interface for use in line card, network termination, and ISDN terminal equipment applications. Manufactured with Motorola's advanced 1.5 micron CMOS mixed analog and digital process technology, the MC145474/75 is a physical layer device capable of operating in point-to-point or point-to-multipoint passive bus arrangements. In addition, the MC145475 can implement the optional NT1 Star topology.

This device features outstanding transmission performance. It reliably transmits over 2.5 kilometers in a point-to-point application with specifications of 1 kilometer. Comparable performance is achieved in all other topologies as well. Other features include pin selectable terminal or network operating modes, industry standard microprocessor serial control port, full support of the multiframing S and Q channels, a full range of loopbacks, and low power CMOS operation.



ISDN Voice/Data Circuits (continued)

Dual Data Link Controller

MC145488
Case 779

The MC145488 features two full-duplex serial HDLC channels with an on-chip Direct Memory Access (DMA) controller. The DMA controller minimizes the number of microprocessor interrupts from the communications channels, freeing the microprocessor's resources for other tasks. The DMA controller can access up to 64 k bytes of memory, and transfers either 8-bit bytes or 16-bit words to or from memory. The MC145488 DDLC is compatible with Motorola's MC68000 and other microprocessors.

In a typical ISDN terminal application, one DDLC communications channel supports the D-channel (LAPD) while the other supports the B-channel (LAPB). While the DDLC is ideally suited for ISDN applications, it can support many other HDLC protocol applications as well.

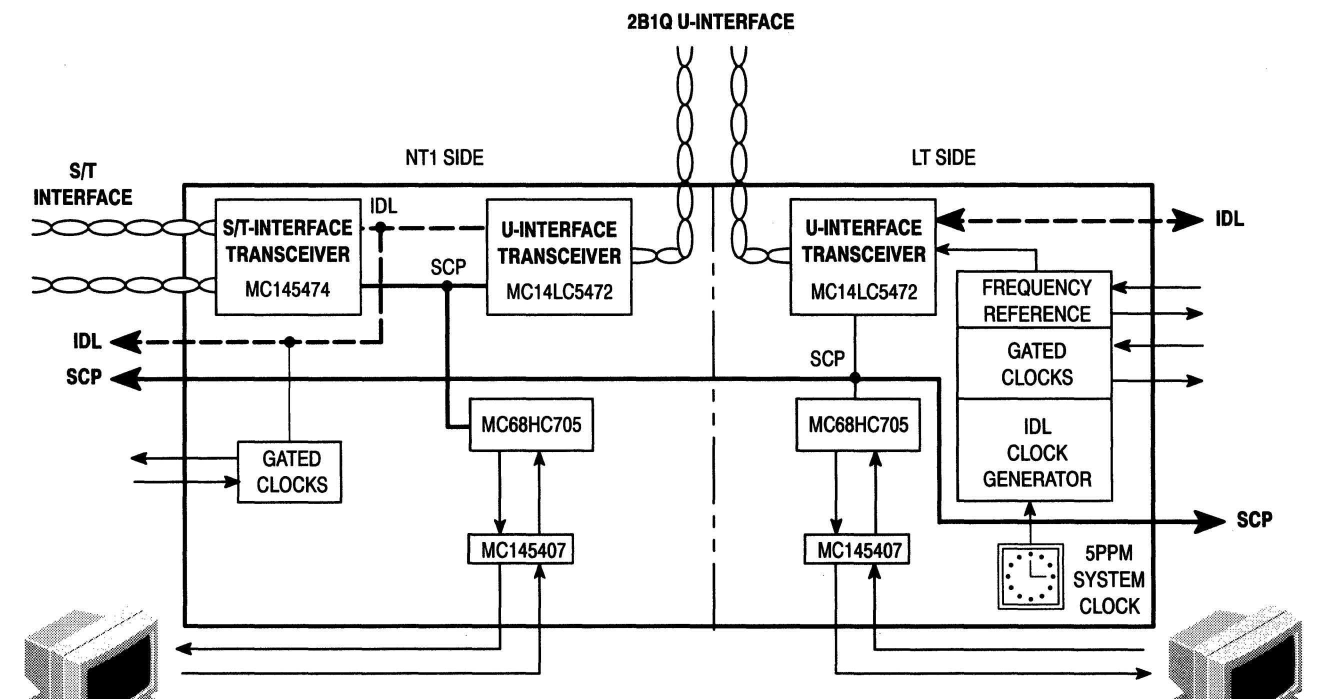
Some of the powerful extras found on the DDLC include automatic abort and retransmit of D-channel collisions in S/T-interface applications, address recognition, automatic recovery mechanisms for faulty frame correction, and several system test modes. Address recognition provides a reduction in the host microprocessor load by filtering data frames not addressed to the host. The DDLC can compare either SAPI or TEI fields of LAPD frames. For LAPD (Q.921) applications, both A and B addresses may be checked.

MC14LC5494EVK
U-Interface Transceiver Evaluation Kit

This kit provides the hardware and software to evaluate the many configurations under which the MC14LC5472 is able to operate. Used as a whole, it operates as both ends of the two-wire U interface that extends from the customer premises (NT1) to the switch line card (LT). The two halves of the board can be physically and functionally separated, providing independent NT1 and LT evaluation capability.

The kit provides the ability to interactively manipulate status registers in the MC14LC5472 U-Interface transceiver or in the MC145474/75 S/T-Interface transceiver with the aid of an external terminal. The device can also be controlled using the MC68302 Integrated Multiprotocol Processor application development system to complete a total Basic Rate ISDN evaluation solution.

A generous wire-wrap area is available to assist application development.



MC14LC5494EVK

Voice/Data Communication (Digital Transmission)

2-Wire Universal Digital Loop Transceiver (UDLT)

MC145422 Master Station
Case 708, 736, 751E

MC145426 Slave Station
Case 708, 736, 751E

The UDLT family of transceivers allows the use of existing twisted-pair telephone lines (between conventional telephones and a PBX) for the transmission of digital data. With the UDLT, every voice-only telephone station in a PBX system can be upgraded to a digital telephone station that handles the complex voice/data communications with no increase in cabling costs.

In implementing a UDLT-based system the A/D to D/A conversion function associated with each telset is relocated from the PBX directly to the telset. The SLIC (or its equivalent circuit) is eliminated since its signaling information is transmitted digitally between two UDLTs.

The UDLT master-slave system incorporates the modulation/demodulation functions that permit data communications over a distance up to 2 kilometers. It also provides the sequence control that governs the exchange of information between master and slave. Specifically, the master resides on the PBX line card where it transmits and receives data over the wire pair to the telset. The slave is located in the telset and interfaces the mono-circuit to the wire pair. Data transfer occurs in 10-bit bursts (8 bits of data and 2 signaling bits), with the master transmitting first, and the slave responding in a synchronized half-duplex transmission format.

UDLTs utilize a 256 kilobaud Modified Differential Phase Shift Keyed (MDPSK) burst modulation technique for transmission to minimize radio frequency, electromagnetic, and crosstalk interference. Implementation through CMOS technology takes advantage of low-power operation, increased reliability, and the proven capabilities to perform complex telecommunications functions.

Functional Features

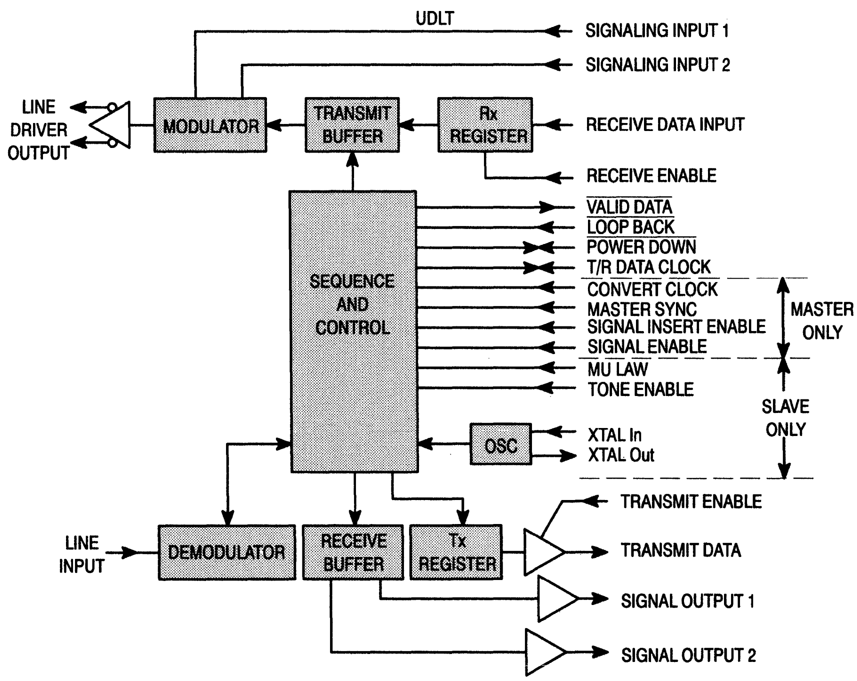
- Provides Synchronous Duplex 64 kbits/Second Voice/Data Channel and Two 8 kbits/Second Signaling Data Channels Over One 26 AWG Wire Pair Up to 2 km.
- Compatible with Existing and Evolving Telephone Switch Architectures and Call Signaling Schemes
- Automatic Detection Threshold Adjustment for Optimum Performance Over Varying Signal Attenuations
- Protocol Independent
- Single 5.0 V to 8.0 V Power Supply

MC145422 Master UDLT

- 2.048 MHz Master Clock
- Pin Controlled Power-Down and Loop-Back Features
- Variable Data Clock — 64 kHz to 2.56 MHz
- Pin Controlled Insertion/Extraction of 8 kbits/Seconds Channel into LSB of 64 kbits/Second Channel for Simultaneous Routing of Voice and Data Through PCM Voice Path of Telephone Switch

MC145426 Slave UDLT

- Compatible with MC145500 Series and Later PCM Mono-Circuits
- Automatic Power-Up/Down Feature
- On-Chip Data Clock Recovery and Generation
- Pin Controlled 500 Hz D3 or CCITT Format PCM Tone Generator for Audible Feedback Applications



Voice/Data Communication (Digital Transmission) (continued)

2-Wire ISDN Universal Digital Loop Transceiver II (UDLT II)

MC145421 Master
Case 623, 709, 751E

MC145425 Slave
Case 623, 709, 751E

Similar to the MC145422/26 UDLT, but provide 160 kbps in two 64 kbps and two 16 kbps (2B + 2D) format.

Data Set Interface Circuit (DSI)

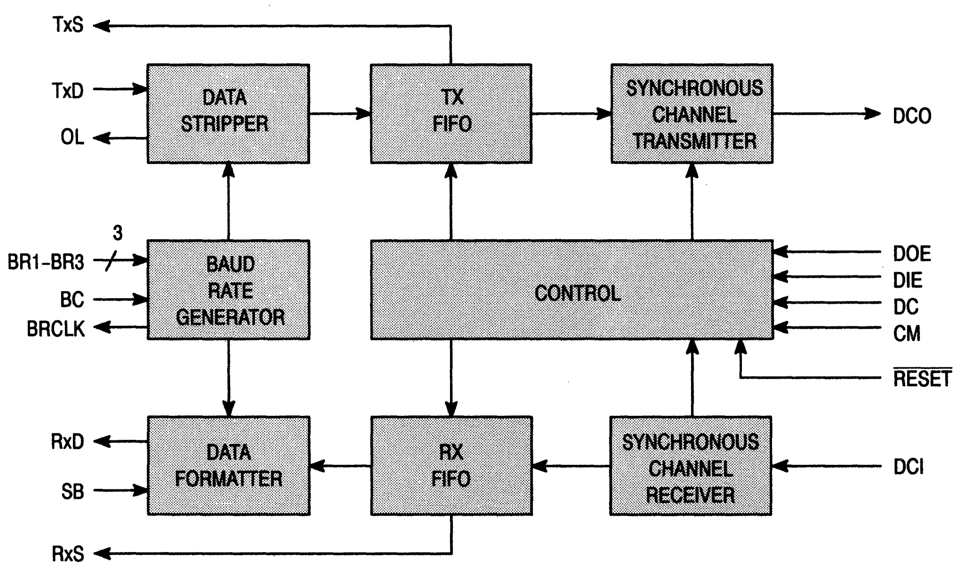
MC145428
T_A = –40° to + 85°C, Case 738, 751D

This new CMOS LSI circuit provides asynchronous-to-synchronous data conversion. It is particularly well-suited for use in conjunction with a UDLT-based integrated voice/data system. The MC145428 DSI provides EIA-232-to-time slot data conversion that permits direct interface between existing data equipment and the UDLT without modifications. With this interactive component, digitized voice information from the PCM Mono-Circuit and asynchronous data from computers or terminals can be transmitted simultaneously through a synchronous switching network.

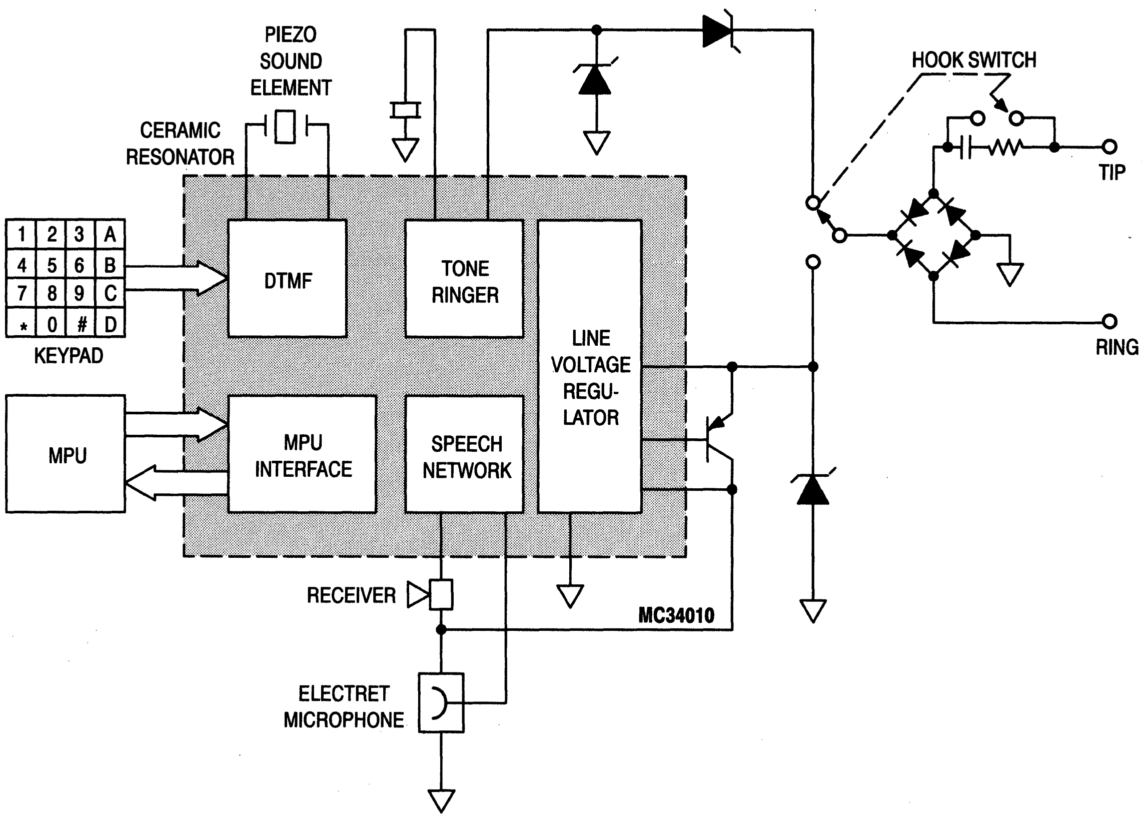
DSI circuits are also suited for data multiplexers, concentrators and deconcentrators, data rate changers, data-only switching, and PBX-based local area networks.

MC145428 Features
- Up to 128 kbps asynchronous data rate operation
- 0 up to 2.1 Mbps synchronous data rate operation
- On-board bit rate clock generator with pin selectable bit rates of 300, 1200, 2400, 4800, 9600, 19200, and 38400 bps or an externally supplied 16 times bit rate clock may be used
- Accepts asynchronous data words of 8 or 9 bits
- False start detection provided
- Automatic sync insertion and checking

DATA SET INTERFACE CIRCUIT



Electronic Telephone



The Complete Electronic Telephone Circuit

MC34010P, FN

T_A = –20° to +60°C, Case 711, 777

The conventional transformer-driven telephone handset is undergoing major innovations. The bulky transformer is disappearing. So are many of its discrete components, including the familiar telephone bell. They are being replaced with integrated circuits that perform all the major handset functions simply, reliably and inexpensively . . . functions such as 2-to-4 wire conversion, DTMF dialing, tone ringing, and a variety of related activities.

The culmination of these capabilities is the Electronic Telephone Circuit, the MC34010. These ICs place all of the above mentioned functions on a single monolithic chip.

These telephone circuits utilize advanced bipolar linear (I^2L) technology and provide all the necessary elements of a modern tone-dialing telephone. The MC34010 even incorporates an MPU interface circuit for the inclusion of automatic dialing in the final system.

- Provides all basic telephone functions, including DTMF dialer, tone ringer, speech network and line voltage regulator
- DTMF generator uses low cost ceramic resonator with accurate frequency synthesis technique
- Tone ringer drives piezoelectric transducer and satisfies EIA-470 requirements
- Speech network provides 2-to-4 wire conversion with adjustable sidetone utilizing an electret transmitter
- On-chip regulator insures stable operation over wide range of loop lengths
- I^2L technology provides low 1.4 V operation and high static discharge immunity
- Microprocessor interface port for automatic dialing features

Also Available

A broad line of additional telephone components for customizing systems design.

Audio Control Circuit

MC145429

Telset audio interface circuit for MPU-controlled independent adjustment of ear piece, speaker and ringer volume.

Dial Circuits

MC145412/13/16

Integrated Tone/Pulse 10-number Repertory Dialer.

MC145512/13

Integrated Tone/Pulse 10-number Repertory Dialer.

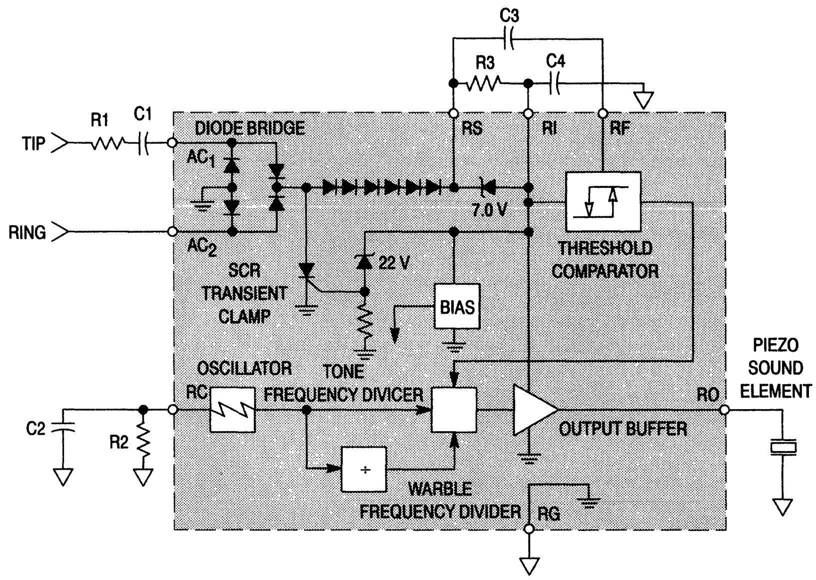
Tone Ringers

The MC34012, MC34017, and MC34117 Tone Ringers are designed to replace the bulky bell assembly of a telephone, while providing the same function and performance under a variety of conditions. The operational requirements spelled out by the FCC and EIA-470, simply stated, are that a ringer circuit MUST function when a ringing signal is provided, and MUST NOT ring when other signals (speech, dialing, noise) are on the line. The tone ringers described below were designed to meet those requirements with a minimum of external components.

MC34012P, D

T_A = –20° to +60°C, Case 626, 751

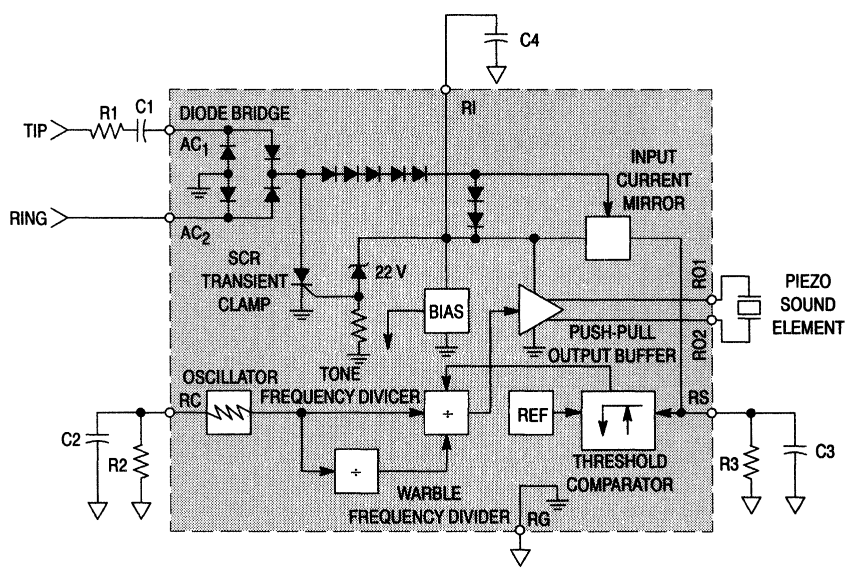
- Complete Telephone Bell Replacement
- On-Chip Diode Bridge and Transient Protection
- Single-Ended Output to Piezo Transducer
- Input Impedance Signature Meets Bell and EIA Standards
- Rejects Rotary Dial and Hook Switch Transients
- Adjustable Base Frequencies
- Output Frequency to Warble Ratio —
  MC34012-1:80
  MC34012-2:160
  MC34012-3:40



MC34017P, D

T_A = –20° to +60°C, Case 626, 751

- Complete Telephone Bell Replacement
- On-Chip Diode Bridge and Transient Protection
- Differential Output to Piezo Transducer for Louder Sound
- Input Impedance Signature Meets Bell and EIA Standards
- Rejects Rotary Dial and Hook Switch Transients
- Output Frequency to Warble Ratio —
  MC34017-1:80
  MC34017-2:160
  MC34017-3:40

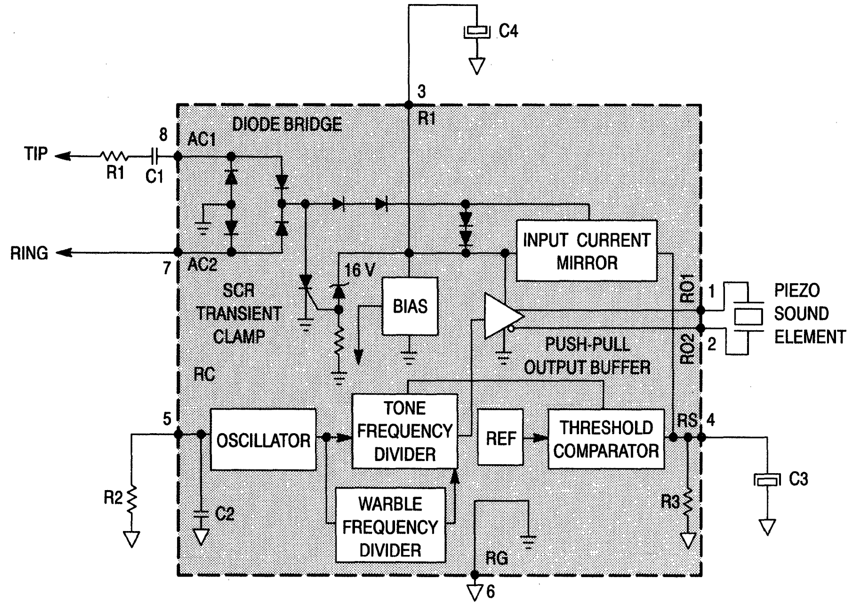


Tone Ringers (continued)

MC34217P, D

T_A = –20° to +60°C, Case 626, 751

- Complete Telephone Bell Replacement
- On-Chip Diode Bridge
- Internal Transient Protection
- Differential Output to Piezo Transducer for Louder Sound
- Input Impedance Signature Meets Bell and EIA Standards
- Rejects Rotary Dial and Hook Switch Transients
- Base Frequency and Warble Frequencies are Independently Adjustable
- Adjustable Base Frequency
- Reduced Number of Externals



Speech Networks

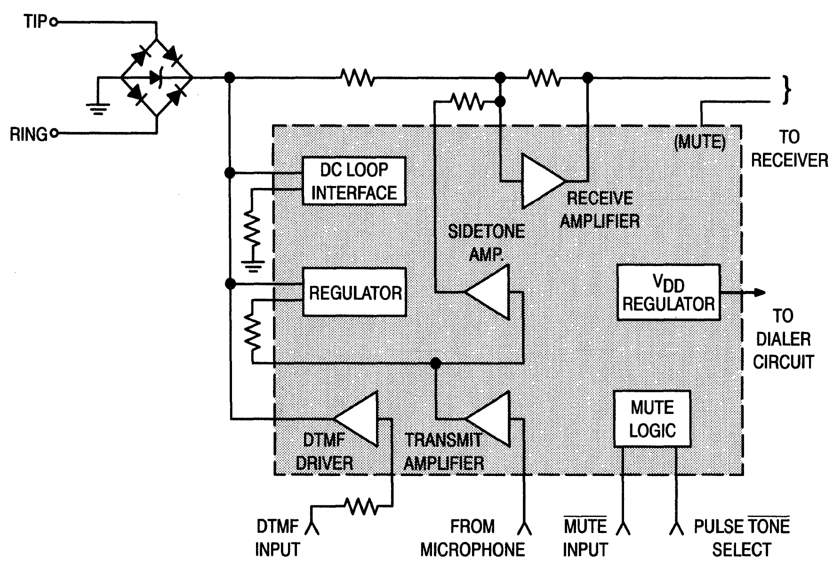
Speech Network with Dialer Interface

MC34014P, DW

T_A = –20° to +60° C, Case 707, 751D

The MC34014 is a Telephone Speech Network integrated circuit which incorporates adjustable transmit, receive, and sidetone functions, line interface circuit, dialer interface, and a regulated output voltage for a dialer circuit. It includes an equalization circuit to compensate for various line lengths and the conversion from 2-to-4 wire is accomplished with supply voltages as low as 1.5 V.

- Transmit, Receive, and Sidetone Gains Set by External Resistors
- Loop Length Equalization for Transmit, Receive, and Sidetone Functions
- Operates Down to 1.5 V (V +) in Speech Mode
- Provides Regulated Voltage for CMOS Dialer
- Speech Amplifiers Muted During Pulse and Tone Dialing
- DTMF Output Level Adjustable with a Single Resistor
- Compatible with 2-Terminal Electret Microphones
- Operates with Receiver Impedances of 150 Ω and Higher



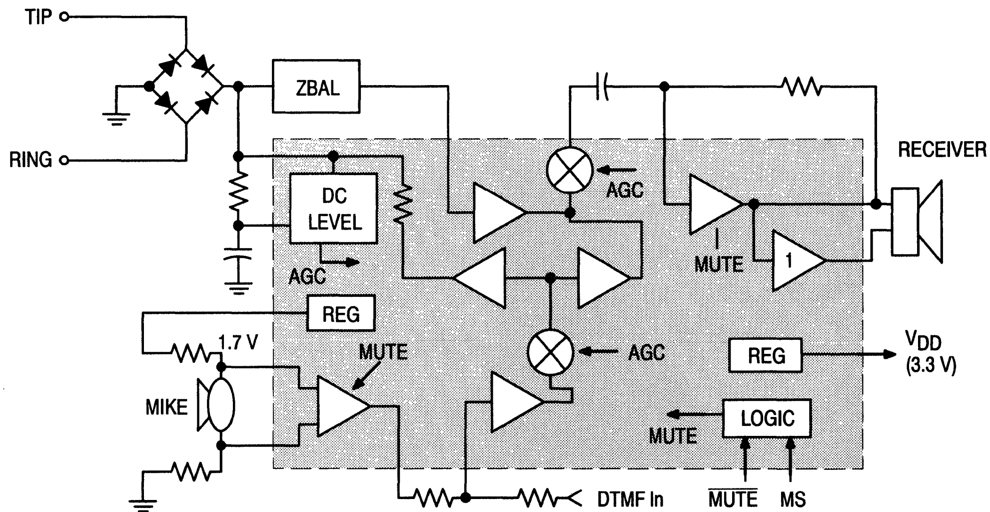
Speech Networks (continued)

Telephone Speech Network with Dialer Interface

MC34114P, DW

T_A = –20° to +70° C, Case 707, 751D

- Operation Down to 1.2 V
- Adjustable Transmit, Receive, and Sidetone Gains by External Resistors
- Differential Microphone Amplifier Input Minimizes RFI
- Transmit, Receive, and Sidetone Equalization on both Voice and DTMF Signals
- Regulated 1.7 V Output for Biasing Microphone
- Regulated 3.3 V Output for Powering External Dialer
- Microphone and Receive Amplifiers Muted During Dialing
- Differential Receive Amplifier Output Eliminates Coupling Capacitor
- Operates with Receiver Impedances of 150 Ω and Higher



Speakerphone

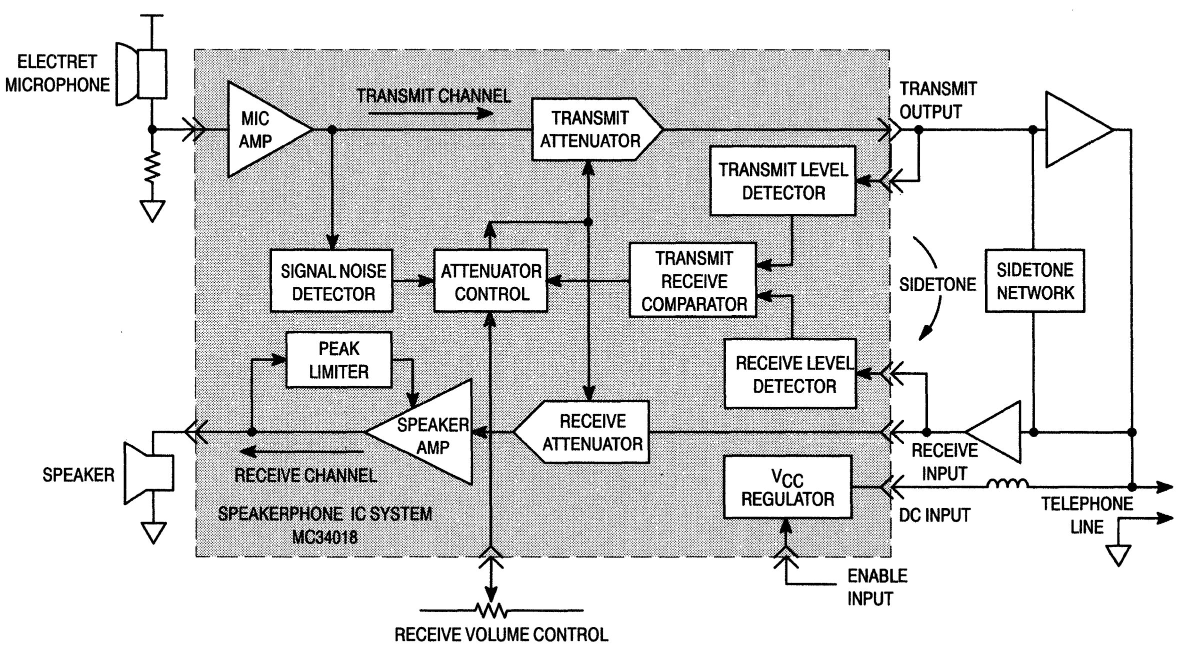
Voice Switched Speakerphone Circuit

MC34018P, DW

T_A = –20° to +60°C, Case 710, 751F

The MC34018 Speakerphone integrated circuit incorporates the necessary amplifiers, attenuators, and control functions to produce a high quality hands-free speakerphone system. Included are a microphone amplifier, a power audio amplifier for the speaker, transmit and receive attenuators, a monitoring system for background sound level, and an attenuation control system which responds to the relative transmit and receive levels as well as the background level. Also included are all necessary regulated voltages for both internal and external circuitry, allowing line-powered operation (no additional power supplies required). A Chip Select pin allows the chip to be powered down when not in use. A volume control function may be implemented with an external potentiometer. MC34018 applications include speakerphones for household and business uses, intercom systems, automotive telephones, and others.

- All Necessary Level Detection and Attenuation Controls for a Hands-Free Telephone in a Single Integrated Circuit
- Background Noise Level Monitoring with Long Time Constant
- Wide Operating Dynamic Range Through Signal Compression
- On-Chip Supply and Reference Voltage Regulation
- Typical 100 mW Output Power (into 25 Ω) with Peak Limiting to Minimize Distortion
- Chip Select Pin for Active/Standby Operation
- Linear Volume Control Function



Voice Switched Speakerphone with μProcessor Interface

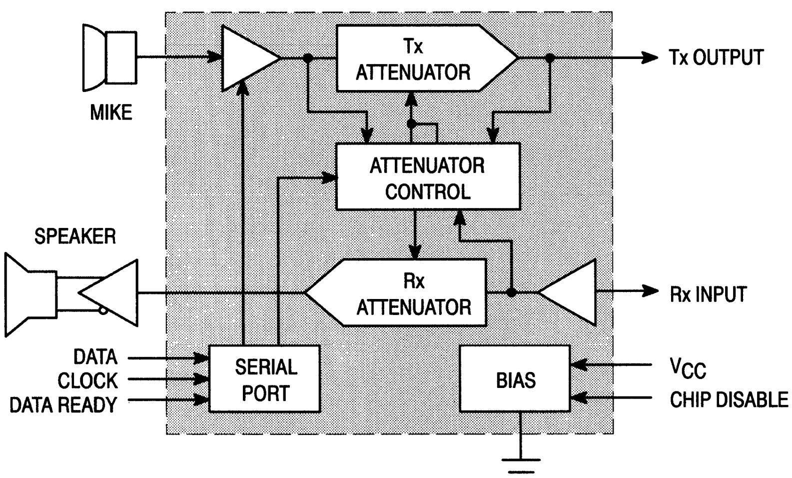
MC33218P, DW

T_A = –40° to +85°C, Case 724, 751E

The MC33218 Voice Switched Speakerphone circuit incorporates the necessary amplifiers, attenuators, level detectors, and control algorithm to form the heart of a high quality hands-free speakerphone system. Included are a microphone amplifier with adjustable gain, and mute control, transmit and receive attenuators which operate in a complementary manner, and level detectors and background noise monitors for both paths. A dial tone detector prevents dial tone from being attenuated by the receive background noise monitor. A Chip Disable pin permits powering down the entire circuit to conserve power.

Also included is an 8-bit serial μprocessor port for controlling the receive volume, microphone mute, attenuator gain, and operation mode (force to transmit, force to receive, etc.). Data rate can be up to 1.0 MHz. The MC33218 can be operated from a power supply, or from the telephone line, requiring typically 3.8 mA. It can also be used in intercoms and other voice-activated applications.

- Low Voltage Operation: 2.5 to 6.0 V
- 2-Point Sensing, Background Noise Monitor in Each Path
- Chip Disable Pin for Active/Standby Operation
- Microphone Amplifier Gain Set by External Resistors — Mute Function Included
- Dial Tone Detector to Inhibit Receive Idle Mode During Dial Tone Presence
- Microprocessor port for controlling:
  - Receive Volume Level (16 Steps)
  - Attenuator Range (26 or 52 dB, Selectable)
  - Microphone Mute
  - Force to Transmit, Receive, Idle or Normal Voice Switched Operation
- Compatible with MC34119 Speaker Amplifier



Speakerphone (continued)

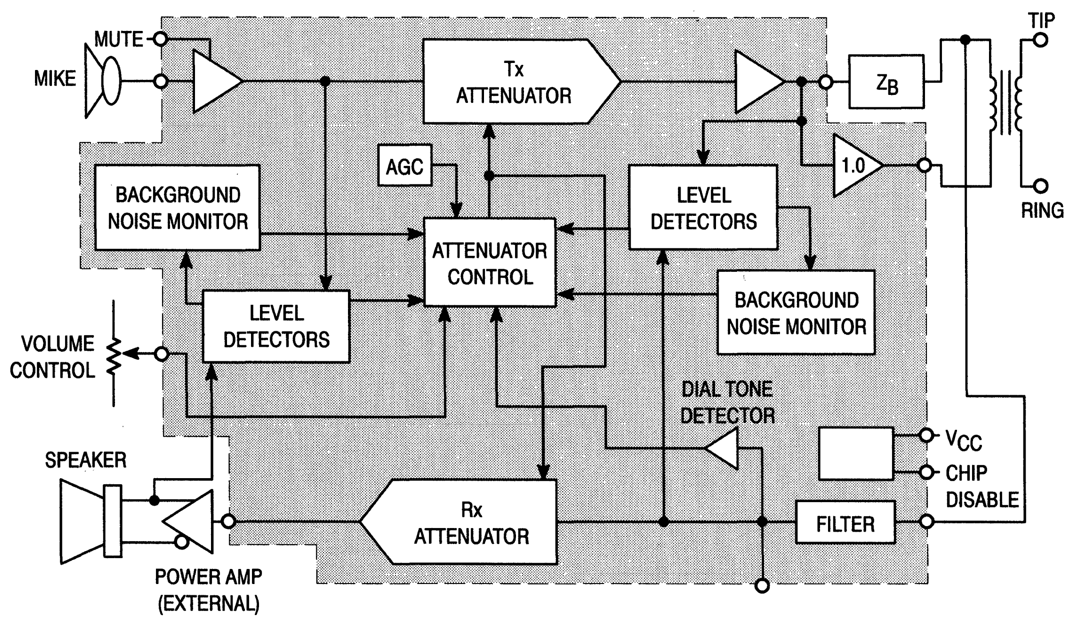
Voice Switched Speakerphone Circuit

MC34118P, DW
T_A = –20° to +60°C, Case 710, 751F

The MC34118 Voice Switched Speakerphone circuit incorporates the necessary amplifiers, attenuators, level detectors, and control algorithm to form the heart of a high quality hands-free speakerphone system. Included are a microphone amplifier with adjustable gain and mute control, Transmit and Receive attenuators which operate in a complementary manner, level detectors at input and output of both attenuators,and background noise monitors for both the transmit and receive channels. A dial tone detector prevents the dial tone from being attenuated by the Receive background noise monitor circuit. Also included are two line driver amplifiers which can be used to form a hybrid network in conjunction with an external coupling transformer. A high-pass filter can be used to filter out 60 Hz noise in the receive channel, or for other filtering functions. A Chip Disable pin permits powering down the entire circuit to conserve power on long loops where loop current is at a minimum.

The MC34118 may be operated from a power supply, or it can be powered from the telephone line, requiring typically 5.0 mA. The MC34118 can be interfaced directly to Tip and Ring (through a coupling transformer) for stand-alone operation, or it can be used in conjunction with a handset speech network and/or other features of a featurephone.

- Improved Attenuator Gain Range: 52 dB Between Transmit and Receive
- Low Voltage Operation for Line-Powered Applications (3.0 to 6.5 V)
- 4-Point Signal Sensing for Improved Sensitivity
- Background Noise Monitors for Both Transmit and Receive Paths
- Microphone Amplifier Gain Set by External Resistors — Mute Function Included
- Chip Disable for Active/Standby Operation
- On Board Filter Pinned-Out for User Defined Function
- Dial Tone Detector Inhibits Receive Idle Mode During Dial Tone Presence
- Compatible with MC34119 Speaker Amplifier



Speakerphone (continued)

Table 50. The Motorola Family of Speakerphone Integrated Circuits

MC34018	MC34118	MC33218
Two point sensing with slow idle, background noise monitor in Tx path only	Four point sensing with both fast and slow idle modes, background noise monitors in both Rx and Tx paths	Two point sensing with slow idle, background noise monitors in both Rx and Tx paths
No dial tone detector in receive path	Receive path has dial tone detector	Receive path has dial tone detector
Attenuator Characteristics: • Range: 44 dB • Tolerance: ±4 dB • Gain tracking not specified • White noise is constant	Attenuator Characteristics: • Range: 52 dB • Tolerance: ±2 dB • Gain Tracking: <1 dB • White noise reduces with volume	Attenuator Characteristics: • Range: 52 or 26 dB (selectable) • Tolerance: ±3 dB • Gain Tracking: <1 dB • White noise reduces with volume
External hybrid required	Hybrid amplifiers on board	External hybrid required
Speaker amplifier is on board (34 dB, 100 mW)	External speaker amplifier required (MC34119)	External speaker amplifier required (MC34119)
Filtering is external	Configurable filter on board	Filtering is external
Microphone amplifier has fixed gain and no muting	Microphone amplifier has adjustable gain and mute input	Microphone amplifier has adjustable gain, and can be muted through µP port
Supply Voltage: 4.0 V to 11 V	Supply Voltage: 2.8 V to 6.5 V	Supply Voltage: 2.5 V to 6.5 V
Supply Current: 6.5 mA typ., 9.0 mA max	Supply Current: 5.5 mA typ., 8.0 mA max	Supply Current: 4.0 mA typ., 5.0 mA max
Speaker amplifier reduces gain to prevent clipping	Receive gain is reduced as supply voltage falls to prevent clipping	Receive gain is reduced as supply voltage falls to prevent clipping
Volume control is linear. Cannot override voice switched operation except through additional circuitry. Attenuator gain is fixed at 44 dB (slightly variable). No microphone mute.	Volume control is linear, and microphone mute has separate pin. Cannot override voice switched operation except through additional circuitry. Attenuator gain is fixed at 52 dB.	8-bit µP serial port controls: • Volume control (16 steps) • Microphone mute • Range selection (26 dB or 52 dB) • Force to transmit, idle, receive, or normal voice switched operation
28 Pin DIP and SOIC packages	28 Pin DIP and SOIC packages	24 Pin narrow DIP and SOIC packages
External Required: • 12 Resistors • 11 Capacitors (≤1.0 µF) • 8 Capacitors (>1.0 µF)	External Required: • 14 Resistors • 12 Capacitors (≤1.0 µF) • 9 Capacitors (>1.0 µF)	External Required: • 12 Resistors • 11 Capacitors (≤1.0 µF) • 4 Capacitors (>1.0 µF)
Temperature Range: –20° to +60 °C	Temperature Range: –20° to +60 °C	Temperature Range: –40° to +85 °C

Telephone Accessory Circuits

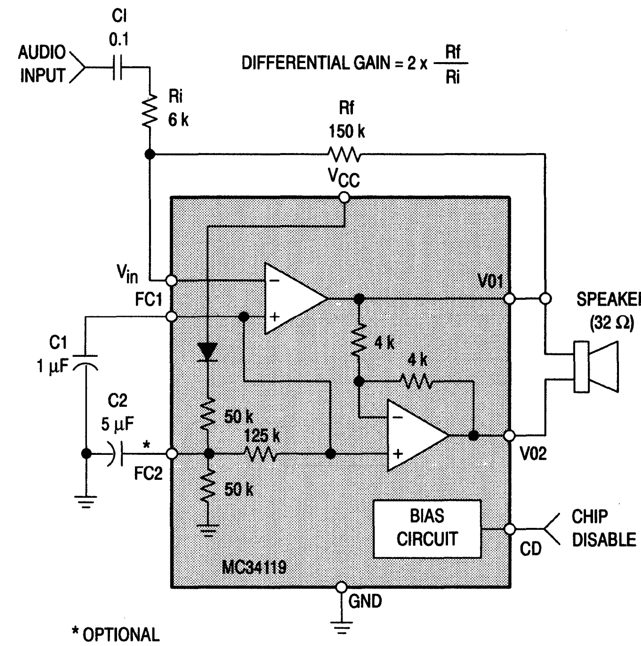
Audio Amplifier

MC34119P, D

T_A = 0° to +70°C, Case 626, 751

A low power audio amplifier circuit intended (primarily) for telephone applications, such as speakerphones. Provides differential speaker outputs to maximize output swing at low supply voltages (2.0 V min.). Coupling capacitors to the speaker, and snubbers, are not required. Overall gain is externally adjustable from 0 to 46 dB. A Chip Disable pin permits powering-down to mute the audio signal and reduce power consumption.

- Drives a Wide Range of Speaker Loads (16 to 100 Ω)
- Output Power Exceeds 250 mW with 32 Ω Speaker
- Low Distortion (THD = 0.4% Typical)
- Wide Operating Supply Voltage (2.0 V to 16 V) — Allows Telephone Line Powered Applications.
- Low Quiescent Supply Current (2.5 mA Typical)
- Low Power-Down Quiescent Current (60 µA Typical)



Current Mode Switching Regulator

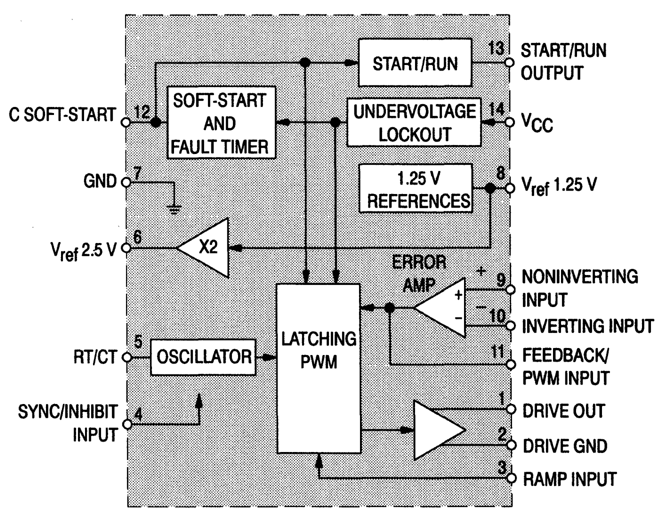
MC34129P, D

T_A = 0° to +70°C, Case 646, 751A

High performance current mode switching regulator for low-power digital telephones. Unique internal fault timer provides automatic restart for overload recovery. A start/run comparator is included to implement bootstrapped operation of V_{CC}.

Although primarily intended for digital telephone systems, these devices can be used cost effectively in many other applications. On-chip functions and features include:

- Current Mode Operation to 300 kHz
- Automatic Feed Forward Compensation
- Latching PWM for Cycle-By-Cycle Current Limiting
- Latched-Off or Continuous Retry after Fault Timeout
- Soft-Start with Maximum Peak Switch Current Clamp
- Internally Trimmed 2% Bandgap Reference
- Input Undervoltage Lockout



300 Baud FSK Modems

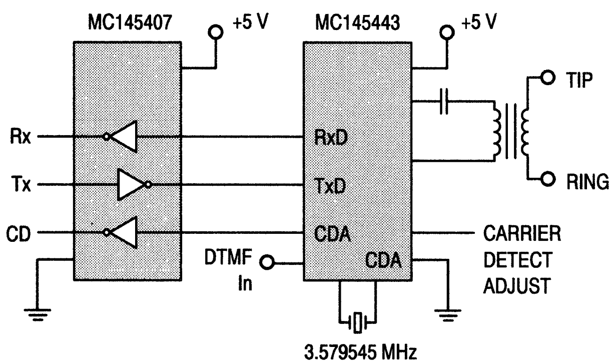
MC145442 Modem — CCITT V.21
Case 738, 751D

MC145443 Modem — Bell 103
Case 738, 751D

This powerful modem combines a complete FSK modulator/demodulator and an accompanying transmit/receive filter system on a single silicon chip. Designed for bidirectional transmission over the telephone network, the modem operates at 300 baud and can be obtained for compatibility with CCITT V.21 and Bell 103 specifications.

The modem contains an on-board carrier-detect circuit that allows direct operation on a telephone line (through a simple transformer), providing simplex, half-duplex, and full-duplex data communications. A built-in power amplifier is capable of driving –9.0 dBm onto a 600 Ω line in the transmit mode.

CMOS processing keeps power dissipation to a very low 45 mW, with a power-down dissipation of only 1.0 mW . . . from a single 5.0 V power supply. Available in a 20 pin dual-in-line P suffix, and a wide body surface mount DW suffix.



MC145444 — CCITT V.21
Case 804, 751D

This device includes the DTMF generator and call progress tone detector (CPTD) as well as the other circuitry needed for full-duplex, half-duplex, or simplex 300 baud data communication over a pair of telephone lines. It is intended for use with telemeter system or remote control system applications.

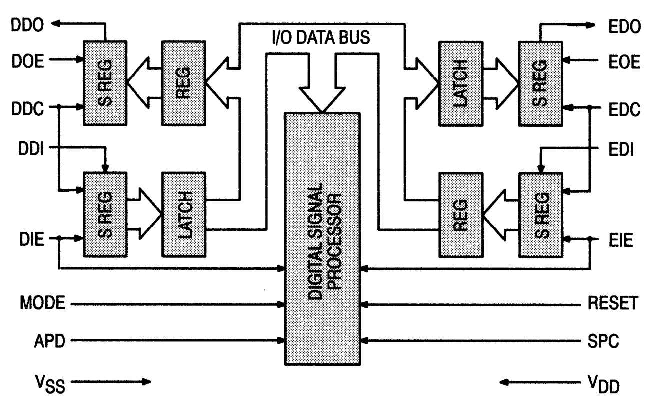
The differential line driver is capable of driving 0 dBm into a 600 Ω load. The transmit attenuator is programmable in 1 dB steps.

ADPCM Transcoder

MC145532
Case 620, 751G

The MC145532 Adaptive Differential Pulse Code Modulation (ADPCM) Transcoder provides a low cost, full-duplex, single-channel transcoder to (from) a 64 kbps PCM channel from (to) either a 16 kbps, 24 kbps, 32 kbps, or 64 kbps channel.

- Complies with CCITT Recommendation G.721 (Geneva 1986)
- Complies with the American National Standard (T1.301-1987)
- Full-Duplex, Single-Channel Operation
- Mu-Law or A-Law Coding is Pin Selectable
- Synchronous or Asynchronous Operation
- Easily Interfaces with any Member of Motorola's PCM Codec-Filter Mono-Circuit Family or Other Industry Standard Codecs
- Serial PCM and ADPCM Data Transfer Rate from 64 kbps to 5.12 Mbps
- Power Down Capability for Low Cost Consumption
- The Reset State is Automatically Initiated when the Reset Pin is Released.
- Simple Time Slot Assignment Timing for Transcoder Applications
- Single 5.0 V Power Supply
- Evaluation Kit MC145536 EVK Supports the MC145532 as well as the MC145480 PCM Codec-Filter. (See PBX Architecture Pages for More Information.)



Bit Rate Generators

MC14411
Case 709, 623

Internal (crystal controlled) 1.843 MHz oscillator and subsequent divider networks provide 16 different output clocks rates ranging from 75 Hz to 1.843 MHz for data communications equipment such as teleprinters, printers, CRT terminals and microprocessor systems.

MC145411
Case 648

Similar to the MC14411, this device utilizes a 1.843 MHz or 3.6864 MHz crystal frequency input divided to provide nine different output clock rates from 150 Hz to 1.843 MHz, or 300 Hz to 3.6864 MHz, respectively.

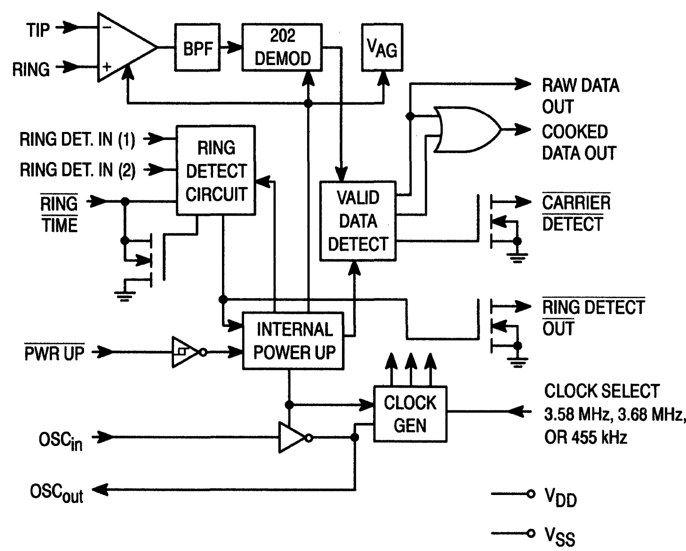
Calling Line Identification (CLID) Receiver with Ring Detector

MC145447
Case 648, 751G

The MC145447 is designed to demodulate Bell 202 1200 baud FSK asynchronous data. Its primary application is in products that will be used to receive and display the calling number, or the message waiting indicator sent to subscribers from participating central office facilities of the public switched telephone network. The device also contains a carrier detect circuit and telephone ring detector which may be used to power up the device.

Applications include adjunct boxes, answering machines, feature phones, fax machines, and computer interface products.

- Ring Detector On-Chip
- Ring Detect Output for MCU Interrupt
- Power-Down Mode Less Than 1.0 µA
- Single Supply: 3.5 V to 6.0 V
- Pin Selectable Clock Frequencies: 3.68 MHz, 3.58 MHz, or 455 kHz
- Two-Stage Power-Up for Power Management Control

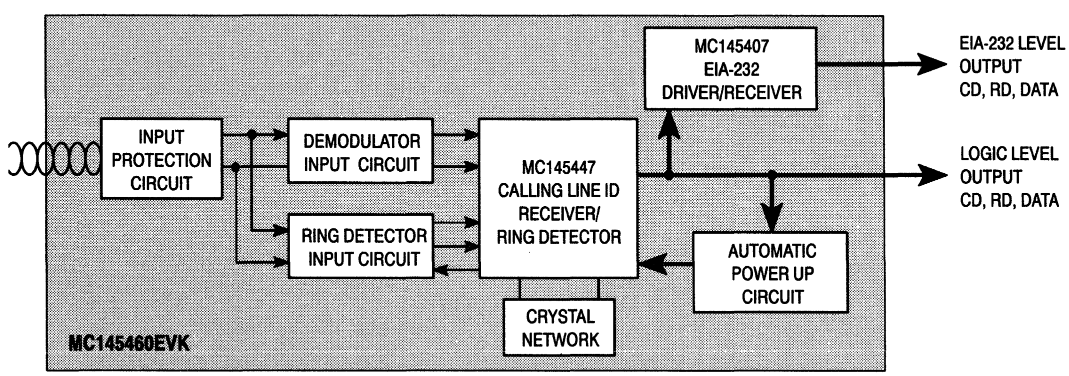


Calling Line ID Receiver Evaluation Kit

MC145460EVK

The MC145460EVK is a low cost evaluation platform for the MC145447. The MC145460EVK facilitates development and testing of products that support the Bellcore customer premises equipment (CPE) data interface, which enables services such as Calling Number Delivery (CND). The MC145447 can be easily incorporated into any telephone, FAX, PBX, key system, answering machine, CND adjunct box or other telephone equipment with the help of the MC145460EVK development kit.

- Easy Clip-On Access to Key MC145447 Signals
- Generous Prototype Area
- Configurable for MC145447 Automatic or External Power Up Control
- EIA-232 and Logic Level Ports for Connection to any PC or MCU Development Platform
- Carrier Detect, Ring Detect and Data Status LEDs
- Optional Tip and Ring Input Protection Network
- MC145460EVK User Guide, MC145447 Data Sheet, and Additional MC145447 Sample Included



Continuously Variable Slope Delta (CVSD) Modulator/Demodulator

MC34115P
T_A = 0° to +70°C, Case 648

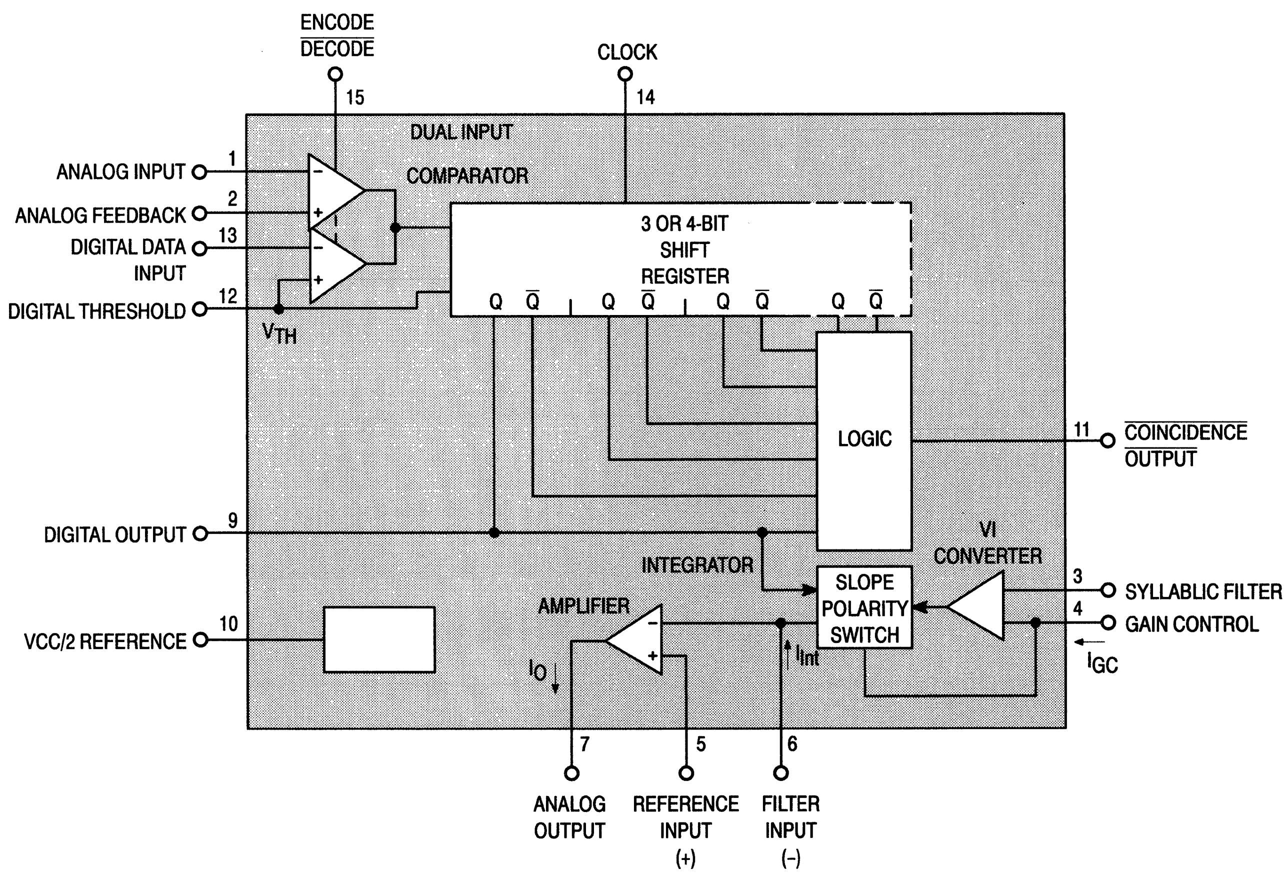
MC3417/18L
T_A = 0° to +70°C, Case 620

MC3517/18L
T_A = –55° to +125°C, Case 620

Provides the A/D-D/A function of voice communications by digital transmission.

The MC3517/18 series of CVSDs is designed for military secure communications and commercial telephone applications. A single IC provides both encoding and decoding functions in a 16 pin package.

- Encode and Decode Functions on the Same Chip with a Digital Input for Selection
- CMOS Compatible Digital Output
- Digital Input Threshold Selectable (V_{CC}/2 Reference Provided On-Chip)
- MC3417/MC3517/MC34115 Have a 3-Bit Algorithm (General Communications)
- MC3418/MC3518 Have a 4-Bit Algorithm (Commercial Telephone)



Communication Circuits

Table 51. Summary of Bipolar Telecommunications Circuits

Function	Features	Suffix/ Case	Device
SLICs			
PBX Applications	All gains externally programmable, most BORSHT functions, current limit adjustable to 100 mA.	L726	MC3419-1
Central Office, Remote Terminals, PBX Applications	All gains externally programmable, most BORSHT functions, current limit adjustable to 50 mA, 58 dB Longitudinal Balance, –21.6 V to –42 V.	P/738 FN/776	MC33121
Central Office, Remote Terminals, PBX Applications	All gains externally programmable, most BORSHT functions, current limit adjustable to 50 mA, 58 dB Longitudinal Balance, –42 V to –58 V.	P/738 FN/776	MC33120
Central Office, Remote Terminals, PBX Applications	All gains externally programmable, most BORSHT functions, current limit adjustable to 50 mA, 58 dB Longitudinal Balance, –21.6 V to –58 V, ring trip, on-hook transmission, polarity reversal.	TBD(1)	MC33122
Complete Telephone Circuit			
POTS Circuit + MPU Dialing	Speech network, tone ringer, DC loop current interface, DTMF dialer with serial port control.	P/711 FN/777	MC34010
Tone Ringers			
Adjustable Tone Ringer	Single-ended output, meets FCC requirements, adjustable REN, different warble rates.	P/626 D751	MC34012-1, 2, 3
Adjustable Tone Ringer	Differential output, meets FCC requirements, adjustable REN, different warble rates.	P/626 D751	MC34017-1, 2, 3
Adjustable Tone Ringer	Differential output, meets FCC requirements, adjustable REN, single warble rates.	P/626 D751	MC34217
Speech Networks			
Basic Phone Line Interface	Loop current interface, speech network, line length compensation, speech/dialing modes, Bell System compliant.	P/707 DW/751D	MC34014
Basic Phone Line Interface	Loop current interface, speech network, line length compensation, speech/dialing modes, Bell System and foreign countries.	P/707 DW/751D	MC34114
Speakerphone Circuits			
Complete Speaker Phone with Speaker Amplifier	All level detection (2 pt.), attenuators, and switching controls, mike and speaker amp.	P/710 DW751F	MC34018
Complete Speaker Phone with Hybrid, Filter	All level detection (4 pt.), attenuators, and switching controls, mike amp with mute, hybrid, and filter.	P/710 DW751F	MC34118
Complete Speaker Phone with MPU Interface	All level detection, attenuators, and switching controls, mike amp, MPU interface for: volume control, mode selection, mike mute.	P/724 DW751E	MC33218
Audio Amplifiers			
1 Watt Audio Amp	1.0 W output power into 16 Ω, 35 V maximum.	D/751	MC13060
Low Voltage Audio Amp	400 mW, 8.0 to 100 Ω, 2.0 to 16 V, differential outputs, chip-disable input pin.	P/626 D751	MC34119
Companders			
Basic Compander	2.1 V to 7.0 V, no precision externals, 80 dB range, –40° to +85°C, independent compressor and expander.	P/646 D/751A	MC33110
Compander with Features	3.0 V to 7.0 V, no precision externals, 80 dB range, –40° to +85°C, independent compressor and expander, pass through and mute functions, two op amps.	P/648 D/751B	MC33111

(1) To Be Determined

Table 51. Summary of Bipolar Telecommunications Circuits (continued)

Function	Features	Suffix/ Case	Device
Switching Regulator			
Current Mode Regulator	For phone line power applications, soft-start, current limiting, 2% accuracy.	P/646 D/751A	MC34129
Voice Encoder/Decoders			
Continuously Variable Slope Modulator/Demodulator (CVSD)	Telephone quality voice encoding/decoding, variable clock rate, 3-bit coding, for secure communications, voice storage/retrieval, answering machines, 0° to 70°C.	P/738 DW/751G	MC34115
	Same as above except 4-bit coding.	P/738 DW751G	MC3418
	Same as MC34115, –55° to 125°C temperature range.	L/620	MC3517
	Same as MC3418, –55° to 125°C temperature range.	L/620	MC3518

(1) To Be Determined

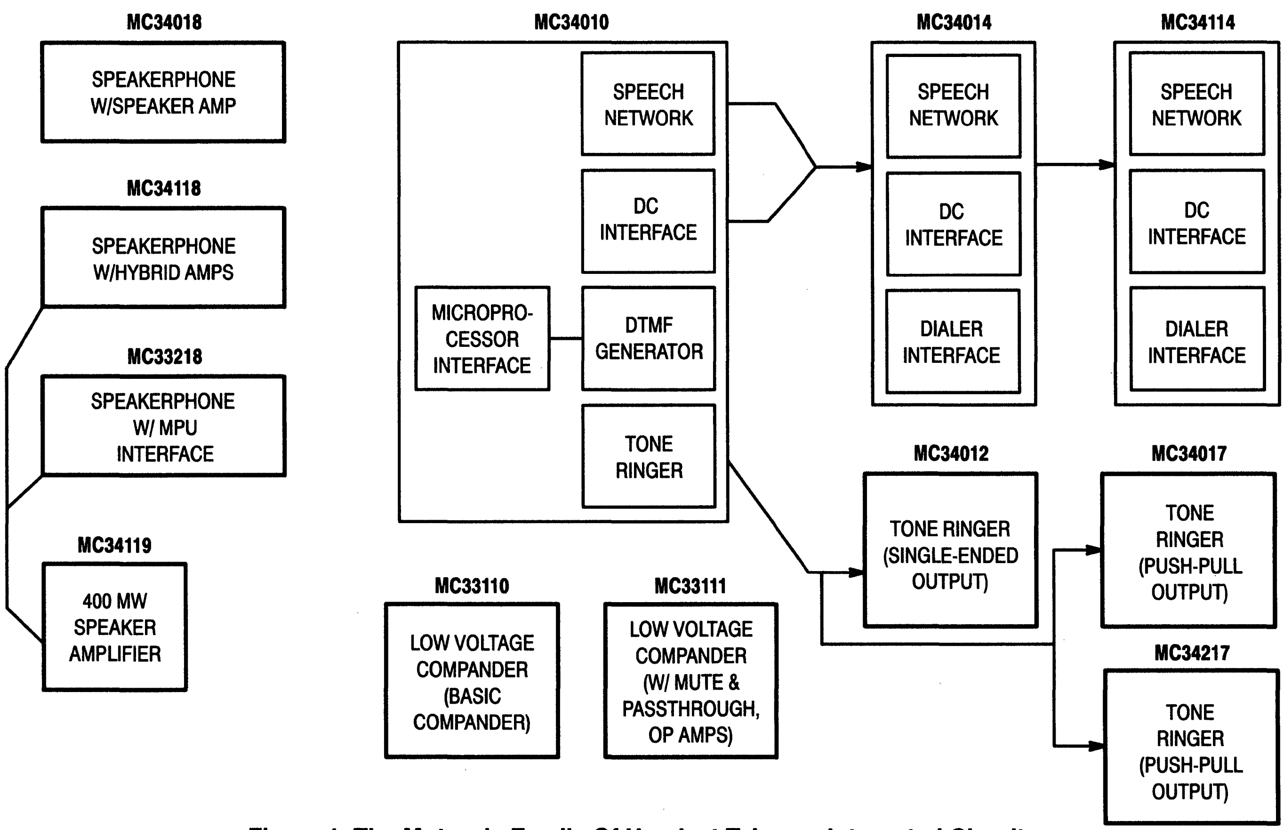


Figure 1. The Motorola Family Of Handset Telecom Integrated Circuits

Phase-Locked Loop Components

Motorola offers a choice of phase-locked loop components ranging from complete functional frequency synthesizers for dedicated applications to a wide selection of general purpose PLL circuit elements. Technologies include CMOS for lowest power consumption and bipolar for high speed operation. Typical applications include TV, CATV, radios, scanners, cordless telephones plus home and personal computers.

Table 52. PLL Frequency Synthesizers

Divider Programming Format	External Prescaler Modulus	Single-Ended (3-State) Phase Detector Output	Double-Ended Phase Detector Output	f_{max} (MHz)	Functional Supply Range (V)	Device	Suffix/ Case
Serial	Single	✓	✓	20	3.0–9.0	MC145155-2	P/707, DW/751D, FN/775
		✓	✓	20	3.0–9.0	MC145157-2	P/648, DW/751G, FN/775
	Dual	✓ ✓(1)	—	15	3.0–9.0	MC145149	P/738, DW/751D
		✓	✓	20	3.0–9.0	MC145156-2	P/738, DW/751D, FN/775
		✓	✓	20	3.0–9.0	MC145158-2	P/648, DW/751G, FN/775
	Dual	Frequency Detector	Analog Detector	15	3.0–9.0	MC145159-1	P/738, DW/751D, FN/775
	Not Required	✓ ✓(1)	—	60	2.5–5.5	MC145161	P/648, DW/751G
		✓ ✓(1)	—	60	2.5–5.5	MC145167	P/648, DW/751G
		✓ ✓(1)	—	60	2.5–5.5	MC145169	P/648, DW/751G
		✓	✓	160(2)	2.5–6.0	MC145170	P/648, D/751B
		✓	✓	1100	4.5–5.5	MC145191	F/751J
		✓	✓	1100	2.7–5.0	MC145192	F/751J
Parallel	Single	✓	—	4	4.5–12	MC145106	P/707, DW/751D, FN/775
		✓	✓	20	3.0–9.0	MC145151-2	P/710, FN/776, DW/751F
	Dual	—	✓	20	3.0–9.0	MC145152-2	P/710, FN/776, DW/751F
	Not Required	✓ ✓(1)	—	60	2.5–5.5	MC145160	P/707, DW/751D
		✓ ✓(1)	—	60	2.5–5.5	MC145166	P/648, DW/751G
		✓ ✓(1)	—	60	2.5–5.5	MC145168	P/648, DW/751G
4-Bit Bus	Single	✓	✓	20	3.0–9.0	MC145145-2	P/707, DW/751D
	Dual	✓	✓	20	3.0–9.0	MC145146-2	P/738, DW/751D

(1)Accommodates two loops per package.
(2)180 MHz version available, see data sheet.

Table 53. Intended Applications

General Purpose	Cordless Phones
MC145106	MC145160
MC145145-2	MC145161
MC145146-2	MC145166
MC145149	MC145167
MC145151-2	MC145168
MC145152-2	MC145169
MC145155-2	
MC145156-2	
MC145157-2	
MC145158-2	
MC145159-1	
MC145170	
MC145191	
MC145192	

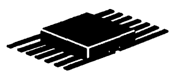
Phase-Locked Loop Components (continued)

Table 54. Additional Phase-Locked Loop Functions

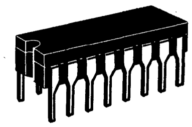
Function	Family	Devices (0° to 70°C)	Suffix/Case
Oscillators			
Crystal Oscillator	MECL	MC12061	P/648, L/620
Voltage-Controller Oscillator	MECL	MC1648(3)	P/646, L/632, F/607
Voltage-Controlled Multivibrator	MECL	MC1658(3)	P/648, L/620
Dual Voltage-Controlled Multivibrator	TTL	MC4024/ MC4324(1)	P/648, L/632, F/607
Voltage-Controller Oscillators	TTL/LS	SN74LS724	P.626, L/693
Phase Detectors			
Digital Mixer	MECL	MC12000	P/646, L/632
Phase-Frequency Detector	MECL	MC12040	
Phase-Frequency Detector	TTL	MC4044 MC4344(1)	P/646, L/632, F/607
Analog Mixer, Double Balanced	MECL	MC12002(3)	P/646, L/632
Modulator/Demodulator	Linear	MC1496(2)/ MC1596(1)	P/646, L/632
Control Functions			
Counter-Control Logic	MECL	MC12014	P/648, L/620
Prescalers/Counters			
UHF — 2,500 MHz	MECL	MC1690(3)	F/650, L/620
2-Modulus ÷ 5/ ÷ 6, 600 MHz	MECL	MC12009(3)	P/648, L/620
2-Modulus ÷ 8/ ÷ 9, 600 MHz	MECL	MC12011(3)	
2-Modulus ÷ 10/ ÷ 11, 600 MHz	MECL	MC12013(3)	
Low Power 2-Modulus ÷ 32/ ÷ 33, 225 MHz	MECL	MC12015(4)	P/626, D/751
Low Power 2-Modulus ÷ 40/ ÷ 41, 225 MHz	MECL	MC12016(4)	
Low Power 2-Modulus ÷ 64/ ÷ 65, 225 MHz	MECL	MC12017(4)	
Low Power 2-Modulus ÷ 128/ ÷ 129, 520 MHz	MECL	MC12018(4)	
Low Power 2-Modulus ÷ 20/ ÷ 21, 225 MHz	MECL	MC12019(4)	
Low Power 2-Modulus ÷ 64/ ÷ 65, ÷ 128/ ÷ 129 Pos. Edge 1.1 GHz	MECL	MC12022A(4)	
Low Power 2-Modulus ÷ 64/ ÷ 65, ÷ 128/ ÷ 129 Neg. Edge 1.1 GHz	MECL	MC12022B(4)	
Low Power ÷ 64 Prescaler, 225 MHz 3.2 to 5.5 V_{CC}	MECL	MC12023	
Low Power ÷ 64 Prescaler, 1.1 GHz	MECL	MC12073	
Low Power ÷ 256 Prescaler, 1.1 GHz	MECL	MC12074	
UHF ÷ 2 Prescaler, 750 MHz	MECL	MC12090	P/648, L/620, F/650
Programmable ÷ N Decade	TTL	MC4316/ MC4316(1)	P/648, L/620, F/650

(1)T_A = –55° to +125°C (3)T_A = –30° to +85°C
(2)T_A = 0° to 70°C (4)T_A = –40° to +85°C
Plastic packages available for commercial temperature range only.
NOTE: For more information see SG366/D

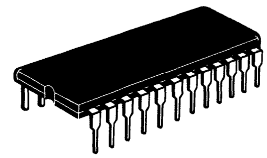
Communications Circuits Package Overview



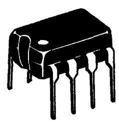
CASE 607
CERAMIC
F SUFFIX



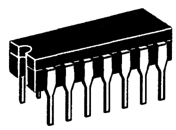
CASE 620
CERAMIC
L SUFFIX



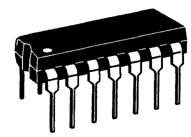
CASE 623
CERAMIC
L SUFFIX



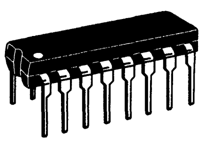
CASE 626
PLASTIC
P SUFFIX



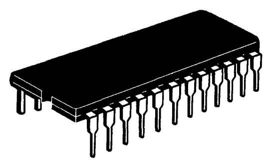
CASE 632
CERAMIC
L SUFFIX



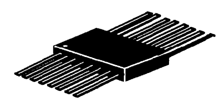
CASE 646
PLASTIC
P SUFFIX



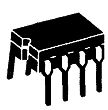
CASE 648
PLASTIC
P SUFFIX



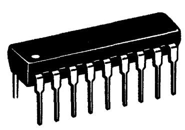
CASE 649
PLASTIC
P SUFFIX



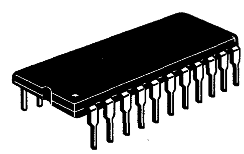
CASE 650
CERAMIC
F SUFFIX



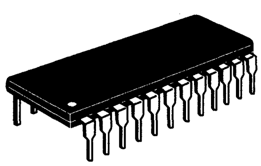
CASE 693
CERAMIC
L SUFFIX



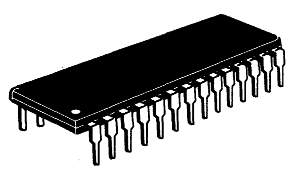
CASE 707
PLASTIC
P SUFFIX



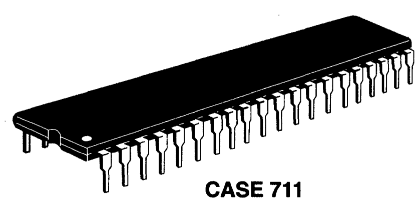
CASE 708
PLASTIC
P SUFFIX



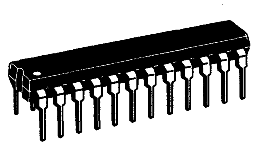
CASE 709
PLASTIC
P SUFFIX



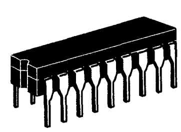
CASE 710
PLASTIC
P SUFFIX



CASE 711
CERAMIC
P SUFFIX

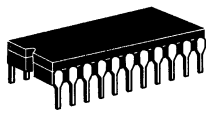


CASE 724
PLASTIC
P, N SUFFIX

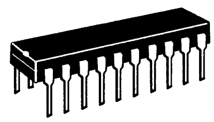


CASE 726
CERAMIC
L SUFFIX

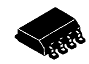
Communications Circuits Package Overview (continued)



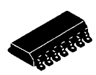
CASE 736, 736A
CERAMIC
L SUFFIX



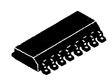
CASE 738
PLASTIC
P SUFFIX



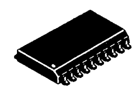
CASE 751
PLASTIC
S0-8, SOP-8
D SUFFIX



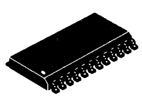
CASE 751A
PLASTIC
SO-14
D SUFFIX



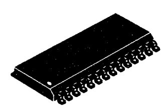
CASE 751B
PLASTIC
SO-16
D SUFFIX



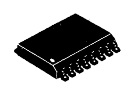
CASE 751D
PLASTIC
SO-20L
DW SUFFIX



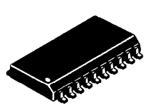
CASE 751E
PLASTIC
SO-24L
DW SUFFIX



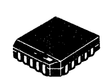
CASE 751F
PLASTIC
SO-28L
DW SUFFIX



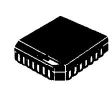
CASE 751G
PLASTIC
SO-16L
DW SUFFIX



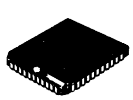
CASE 751J
PLASTIC
SO-20
F SUFFIX



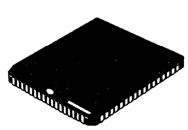
CASE 775
PLASTIC
PLCC-20
FN SUFFIX



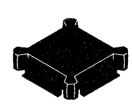
CASE 776
PLASTIC
PLCC-28
FN SUFFIX



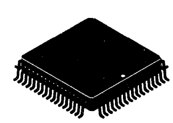
CASE 777
PLASTIC
PLCC-44
FN SUFFIX



CASE 779
PLASTIC
PLCC-68
FN SUFFIX



CASE 847
PLASTIC
PQFP-68
FU SUFFIX



CASE 847
CERAMIC
CQFP-68
FE SUFFIX

Consumer Electronic Circuits

In Brief . . .

These integrated circuits reflect Motorola's continuing commitment to semiconductor products necessary for consumer system designs. This tabulation is arranged to simplify selection of consumer integrated circuit devices that satisfy the primary functions for home entertainment products, including Television, Hi-Fi Audio and AM/FM Radio.

Page

Entertainment Radio Receiver Circuits

Table 55. Entertainment Receiver RF/IF

Function	Features	Suffix/ Case	Device
E.T.R. Front End	Mixer/VCO/AGC for Electronically Tuned AM Stereo Receivers	P/648 D751B	MC13025

Table 56. C-Quam® AM Stereo Decoders

Function	Features	Suffix/ Case	Device
Basic AM Stereo Decoder	Monaural/Stereo AM Detector/Indicator, 6 to 10 V Operation	P/738	MC13020
Advanced AM Stereo Decoder	Medium Voltage 2 to 8 V, Decoder and IF Amp	DW/751F	MC13022
AM Stereo Personal Radio	Complete Low Voltage AM Stereo Receiver	P/724	MC13024
Low V AM Stereo Receiver	IF/Decoder for Advanced C-Quam Receivers	D/751B	MC13028

Table 57. Audio Amplifiers

Function	P_O (Watts)	V_{CC} Vdc Max	V_{in} @ Rated P_O mV Typ	I_D mA Typ	R_L (Ohms)	Suffix/ Case	Device
Mini Watt SOIC Audio Amp	1.0 W	35	80	11	16	D/751	MC13060
Low Power Audio Amp	400 mW	16	—	2.5 mA	8–100	D/751 P/626	MC34119

Table 58. Audio Amplifiers

Function	P_O (Watts)	V_{CC} Vdc Max	V_{in} @ Rated P_O mV Typ	I_D mA Typ	R_L (Ohms)	Suffix/ Case	Device
Mini Watt SOIC Audio Amp	1.0 W	35	80	11	16	D/751	MC13060
Low Power Audio Amp	400 mW	16	—	2.5 mA	8–100	D/751 P/626	MC34119

Table 59. Audio Attenuator

Function	V_{CC} Range (Vdc)	THD (%)	Tone Control Range dB Typ	Attenuation Range dB Typ	Suffix/ Case	Device
Electronic Attenuator	8–18	0.6 Typ	± 13	80	P/626	MC3340

Video Circuits

Table 60. Video Circuits

Function	Features	Suffix/ Case	Device
Encoders			
RGB to PAL/NTSC Encoder	RGB and Sync inputs, Composite Video out; PAL/NTSC selectable.	P/738 DW/751D	MC1377
Advanced RGB to PAL/NTSC Encoder	RGB and Sync inputs, Composite Video and S-VHS out; PAL/NTSC selectable; subcarrier from crystal or external source.	P/738 DW/751D	MC13077
Decoders			
TV Color Processor	PAL/NTSC input, RGB outputs; also RGB inputs, Fast blanking, ideal for text, graphics, overlay.	P/711	TDA3301B
TV Color Processor	PAL/NTSC input, RGB outputs	P/724	TDA3330
Chroma 10 Timebase and Color NTSC/PAL Decoder	PAL/NTSC input, RGB outputs; horizontal and vertical timing processors.	P/711	MC13017
Chroma 4 Multistandard Decoder (TV set)	PAL/NTSC/S-VHS input, RGB outputs; horizontal and vertical timing outputs; all digital internal filters, no external tank; μP and crystal controlled.	P/711	MC44001
Chroma 4 Multistandard Decoder (Multimedia)	PAL/NTSC/S-VHS input, RGB/YUV outputs; horizontal and vertical timing outputs; all digital internal filters, no external tanks; μP and crystal controlled.	FN/777	MC44011
Video Capture Chip Set			
Chroma 4 Multistandard Decoder (Multimedia)	PAL/NTSC/S-VHS input, RGB/YUV outputs; horizontal and vertical timing outputs; all digital internal filters, no external tanks; μP and crystal controlled.	FN/777	MC44011
PAL Digital Delay Line	For PAL applications of the MC44011 and MC44001.	P/648 D/751	MC44140
Pixel Clock PLL/Sync Sep.	PAL/NTSC sync separator, 6-40 MHz pixel clock PLL.	D/751	MC44145
Triple 8-Bit Video DAC	TTL inputs, 75 Ω drive outputs.	FU/824	MC44200
Triple 8-Bit Video A/D	Video clamps for RGB/YUV, 15 MHz, TTL outputs.	FN/777	MC44250
	Video clamps for RGB/YUV, 18 MHz, High Z TTL outputs.	FN/777	MC44251
Advanced NTSC Comb Filter	Composite Video input; YC outputs in digital and analog form; all digital internal filters.	FU/898	MC141621
Advanced PAL/NTSC Comb Filter	Composite Video input; YC outputs in digital and analog form; all digital internal filters.	FU/898	MC141625
Deflection			
Horizontal Processor	Linear balanced phase detector, oscillator and predriver, adjustable DC loop gain and duty cycle.	P/626	MC1391
Waveform Generator for Monitors	Provides geometry correction by generating 10 waveforms to modulate deflection circuitry. Supports multifrequency operation.	P/711	MC1388
Line Deflection Transistor Driver	Provides optimum drive control of the power transistor, peak current limiting, overvoltage and thermal protection.	P/648	MC44614
Waveform Generator for Projection TV Convergence Function	Provides geometry correction by generating 18 waveforms to modulate deflection circuitry. Supports multifrequency operation.	P/711	MC44615A

Table 60. Video Circuits (continued)

Function	Features	Suffix/ Case	Device
Comb Filters			
Enhanced Comb Filter	Fast 8-Bit A/D Converter, Two 8-Bit D/A Converters, Two Line-Delay Memories, utilizes NTSC Subcarrier Frequency Clock, CMOS Technology	FU/898	MC141620
Advanced NTSC Comb Filter	Composite Video input; YC outputs in digital and analog form; all digital internal filters.	FU/898	MC141621
Advanced PAL/NTSC Comb Filter	Composite Video input; YC outputs in digital and analog form; all digital internal filters.	FU/898	MC141625
IF Circuits			
Advanced Video IF	Complete video/audio IF system for high performance analog TV receivers.	P/724 DW/751F	MC44301
Video Detector	3rd IF, video detector, video buffer and AFC buffer.	P/626	MC1330A
IF Amplifier	1st and 2nd video IF amplifiers, 50 dB gain at 45 MHz, 60 dB AGC range.	D/751 P/626	MC1350
Tuner PLL Circuits			
PLL Tuning Circuits	1.3 GHz, 20 mV sensitivity, selectable prescaler, op amp, 7 band buffers, I^2C interface.	P/707	MC44802A
	1.3 GHz, 5.0 mV sensitivity, selectable prescaler, op amp, 4 band buffers, SPI interface, lock detect.	P/648 D/751	MC44807 MC44817
	1.3 GHz, 10 mV sensitivity, selectable prescaler, op amp, 7 band buffers, I^2C interface, 3 DACs.	P/738	MC44810
	1.3 GHz, 20 mV sensitivity, prescaler, 3 band buffers, I^2C interface, replacement for Siemens MPG3002.	D/751	MC44824
	1.3 GHz, 5.0 mV sensitivity, prescaler, op amp, 4 band buffers, I^2C interface, lock detect.	D/751	MC44818
Modulators			
Color TV Modulator	RF Oscillator and Modulator.	P/626	MC1373
Color TV Modulator with Sound	RF Oscillator/Modulator, and FM Sound Oscillator/Modulator.	P/646	MC1374
Video Data Converters			
Single Channel 7-Bit A/D	7-Bit, 25 MHz, 2.0 V input range, ± 5.0 V supplies, TTL output, no pipeline delay.	P/738 DW/751D	MC10321
Single Channel 7-Bit A/D	8-Bit, 25 MHz, 2.0 V input range, ± 5.0 V supplies, TTL output, no pipeline delay.	P/709 DW/751E	MC10319
Triple 8-Bit Video A/D	Video clamps for RGB/YUV, 15 MHz conversion.	FN/777	MC44250
	Video clamps for RGB/YUV, 18 MHz conversion, High Z outputs.	FN/777	MC44251
Single Channel 8-Bit Video DAC	40 MSPS, video controls ± 5.0 V, TTL inputs.	P/649	MC10322
	40 MSPS, video controls – 5.0 V, ECL inputs.	P/649	MC10324
Triple 8-Bit Video DAC	TTL inputs, 75 Ω drive outputs.	FU/824	MC44200
Television Subsystems			
Monomax Black and White TV Subsystem	IF, Video processor, horizontal and vertical timing, for NTSC applications, 525 line systems.	P/710	MC13001X
Monomax Black and White TV Subsystem	IF, Video processor, horizontal and vertical timing, for PAL applications, 625 line systems.	P/710	MC13007X
Monitor Subsystem			
Multimode Color Monitor Processor	Triple video amplifiers, horizontal PLLs and deflection timing, vertical ramp generator, 30 to 57 kHz.	B/0051	MC13081

Table 60. Video Circuits (continued)

Function	Features	Suffix/ Case	Device
Sound			
Sound IF Detector	Interchangeable with ULN2111A.	P/646	MC1357
Sound IF with Preamp	Sound IF, Low Pass Filter, FM Detector, DC Volume Control, Preamplifier, 100 μV sensitivity, 4.0 W output into 16 Ω.	P/648C	TDA3190
Miscellaneous			
Video Overlay Synchronizer	Complete Color TV Video Overlay Synchronizer, remote or local system control.	P/711 FN/777	MC1378
Subcarrier Reference Generator	Provides continuous subcarrier sine wave and 4x subcarrier, locked to incoming burst.	P/626 D/751	MC44144
Closed Caption Decoder	Conforms to FCC, NTSC standards, underline and italics control.	P/707	MC144143
Sync Separator/Pixel Clock PLL	PAL/NTSC sync separator with vertical and composite sync output, 6 to 40 MHz pixel clock PLL.	D/751	MC44145
Dual Video Amplifiers	Gain @ 4.43 MHz = 6 dB ±1 dB, fixed gain, internally compensated, CMOS Technology.	P/626 F/904	MC14576B
	Gain @ 5 MHz = 10 dB max, 10 MHz = 6 dB max, adjustable gain, internally compensated, CMOS Technology.	P/626 F/904	MC14577B
Transistor Array	One differential pair and 3 isolated transistors, 30 V, 50 mA.	D/751	CA3146
Transistor Array	One differential pair and 3 isolated transistors, 15 V, 50 mA.	P/626 D/751	MC3346

Video Circuits (continued)

Bringing video into the personal computer allows a multitude of multimedia application dreams to become possible. Old applications can be done in new ways. Totally new applications, before impossible, become reality.

Moving beyond text and graphics to real images is what Motorola can bring to the user. Utilizing Motorola integrated circuits, video can be captured, processed and brought onto the screen where the video image can be scaled, clipped, zoomed, windowed, overlayed. or process enhanced in ways never before possible.

Also included in this selector guide you will find products for TV and other TV related functions that will allow you to produce advanced TV products. These products span the range of applications including tuner control, video decoding, closed-captioning, stereo sound decoding and video encoding and synchronizing.

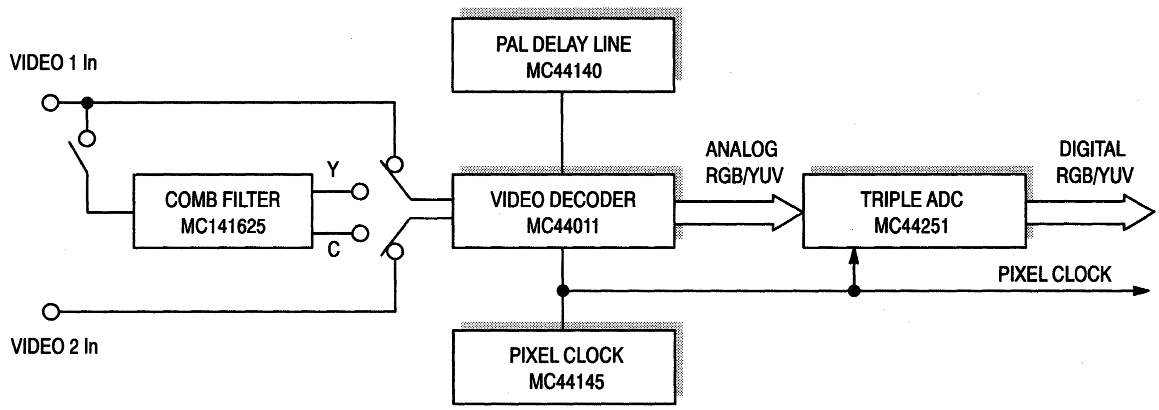


Figure 2. Video Input Processing

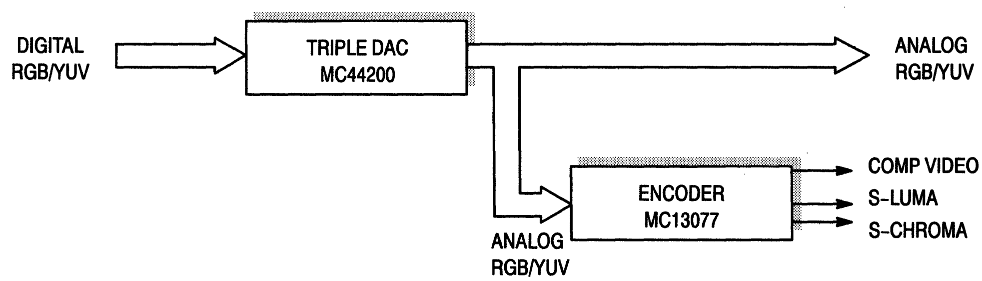


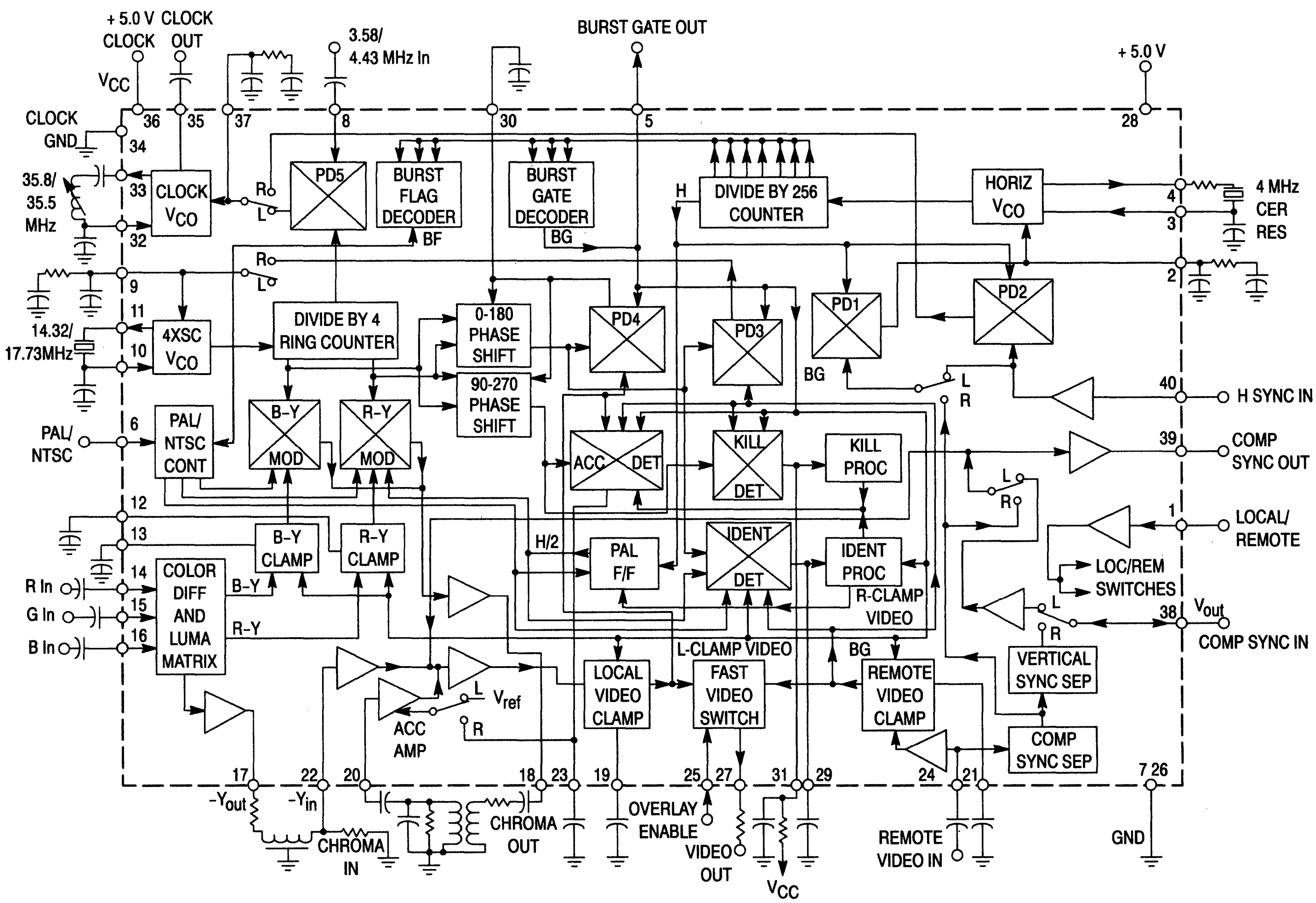
Figure 3. Video Output Processing

Composite Video Overlay Synchronizer

MC1378P, FN
Case 711, 777

The MC1378 contains a complete encoder function, i.e. quadrature color modulators, RGB matrix, and blanking level clamps, plus a complete complement of synchronizers to lock a microcomputer based video source to any remote video source. The MC1378 can be used as a local system timing and encoding source, but it is most valuable when used to lock the microcomputer source to a remotely originated video signal.

- Contains All Needed Reference Oscillators
- Can Be Operated in PAL or NTSC Mode, 625 or 525 Line
- Wideband, Full Fidelity Color Encoding
- Local or Remote Modes of Operation
- Minimal External Components
- Single 5.0 V Supply
- Works with Non-Standard Video

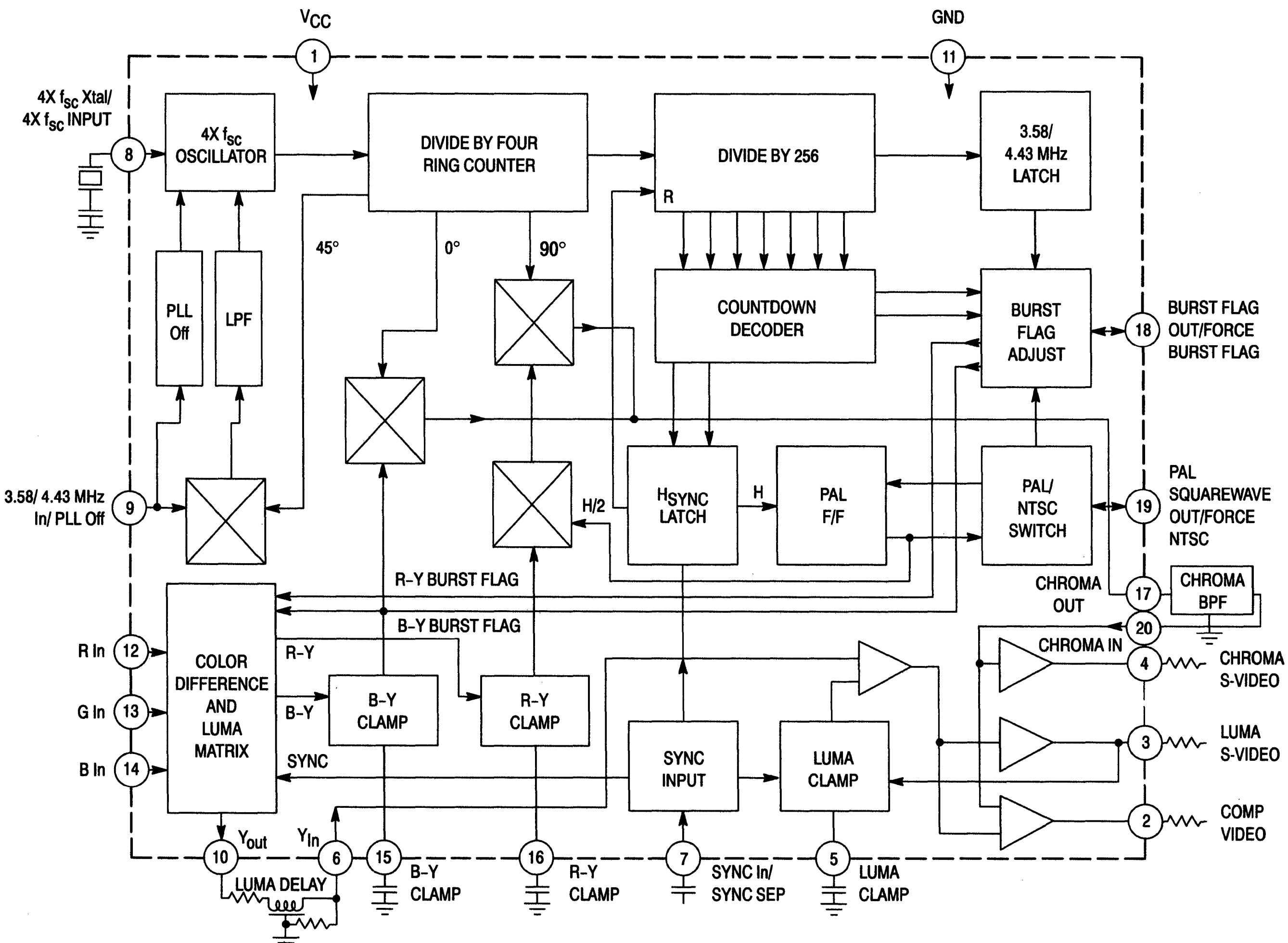


Advanced PAL/NTSC Encoder

MC13077P, DW
Case 738, 751D

The MC13077 is an economical, high quality, RGB encoder for PAL or NTSC applications. It accepts red, green, blue and composite sync inputs and delivers either composite PAL or NTSC video, and S-Video Chroma and Luma outputs. The MC13077 is manufactured using Motorola's high density, bipolar MOSAIC® process.

- Single 5.0 V Supply
- Composite Output
- S-Video Outputs
- PAL/NTSC Switchable
- PAL Squarewave Output
- PAL Sequence Resettable
- Internal/External Burst Flag
- Modulator Angles Accurate to 90°
- Burst Position/Duration Determined Digitally
- Subcarrier Reference from a Crystal or External Source

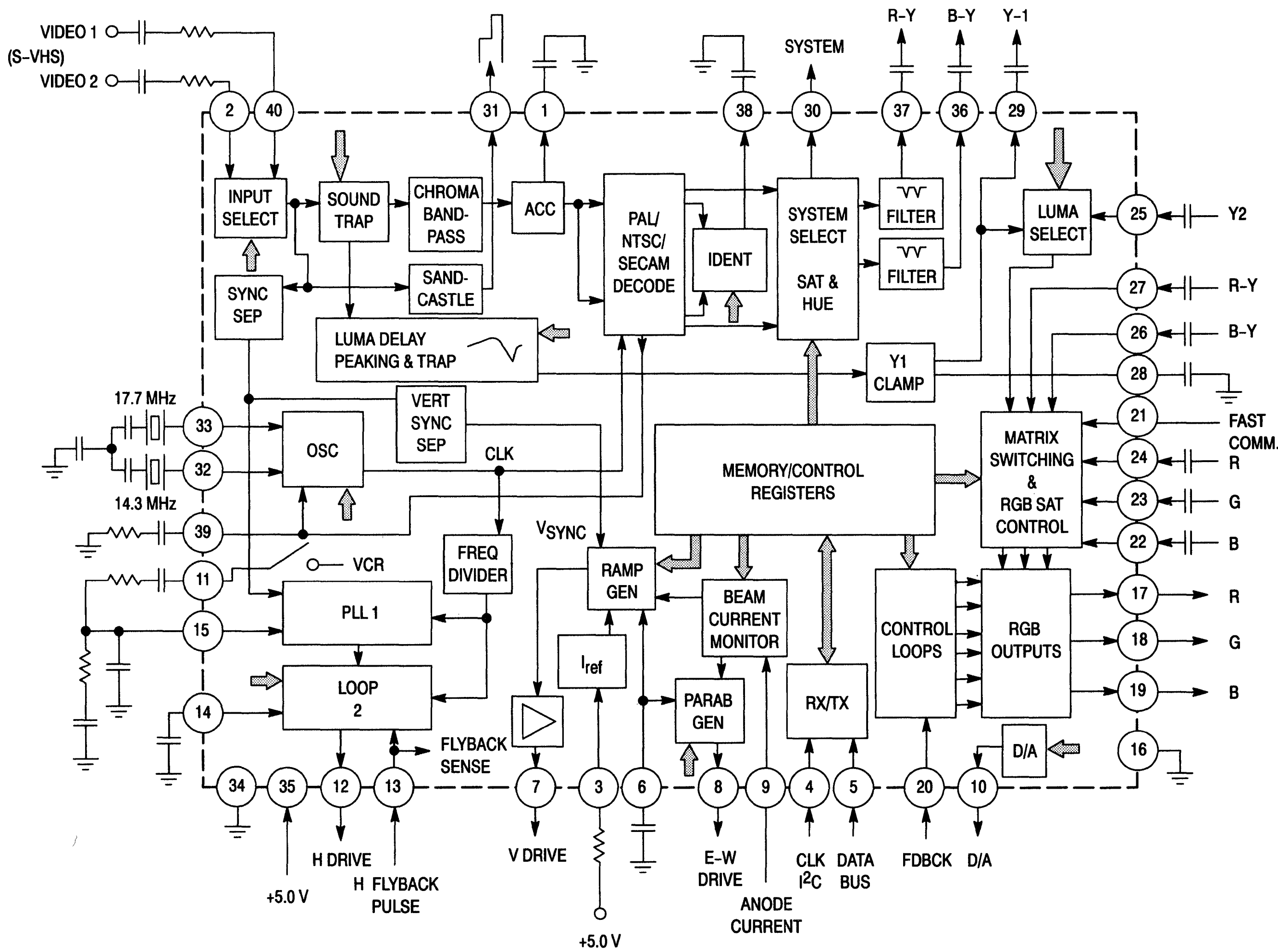


Multistandard Video/Timebase Processor

MC44001P
Case 711

The MC44001 is a highly advanced circuit which performs most of the basic functions required for a color TV. All of its advanced features are under processor control via an I^2C bus, enabling potentiometer controls to be removed completely. In this way the component count may be reduced dramatically, allowing significant cost savings together with the possibility of implementing sophisticated automatic test routines. Using the MC44001, TV manufacturers will be able to build a standard chassis for anywhere in the world.

- Operation from a Single +5.0 V Supply; Typical Current Consumption Only 100 mA
- Full PAL/SECAM/NTSC Capability
- Dual Composite Video or S-VHS Inputs
- All Chroma/Luma Channel Filtering, and Luma Delay Line are Integrated Using Sampled Data Filters Requiring No External Components
- Filters Automatically Commutate with Change of Standard
- Chroma Delay Line is Realized with Companion Device (MC44140)
- RGB Drives Incorporate Contrast and Brightness Controls and Auto Gray Scale
- Switched RGB Inputs with Separate Saturation Control
- Auxiliary Y, R-Y, B-Y Inputs
- Line Timebase Featuring H-Phase Control and Switchable Phase Detector Gain and Time Constant
- Vertical Timebase Incorporating the Vertical Geometry Corrections
- E-W Parabola Drive Incorporating the Horizontal Geometry Corrections
- Beam Current Monitor with Breathing Compensation



Digitally Controlled Video Processor for Multimedia Applications

MC44011FN
Case 777

The MC44011, a member of the MC44000 Chroma 4 family, is designed to provide RGB or YUV outputs from a variety of inputs. The inputs may be either PAL or NTSC composite video (two inputs), S-VHS, RGB, and color difference (R-Y, B-Y).

The MC44011 provides a sampling clock output for use by a subsequent analog to digital converter. The sampling clock (6.0 to 40 MHz) is phase-locked to the horizontal frequency. Additional outputs include composite sync, vertical sync, field identification, luminance, burst gate, and horizontal frequency.

Control of the MC44011, and reading of status flags is accomplished via an I^2C bus.

- Multistandard Decoder, Accepts NTSC and PAL Composite Video
- Dual Composite Video or S-VHS Inputs
- All Chroma and Luma Channel Filtering, and Luma Delay Line are Integrated Using Sampled Data Filters Requiring no External components
- Digitally Controlled via I^2C Bus
- Auxiliary Y, R-Y, B-Y Inputs
- Switched RGB Inputs with Separate Saturation Control
- Line-Locked Sampling Clock for Digitizing Video Signals
- Burst Gate Pulse Output for External Clamping
- Vertical Sync and Field Ident Outputs
- Software Selectable YUV or RGB Outputs Able to Drive A/D Converters

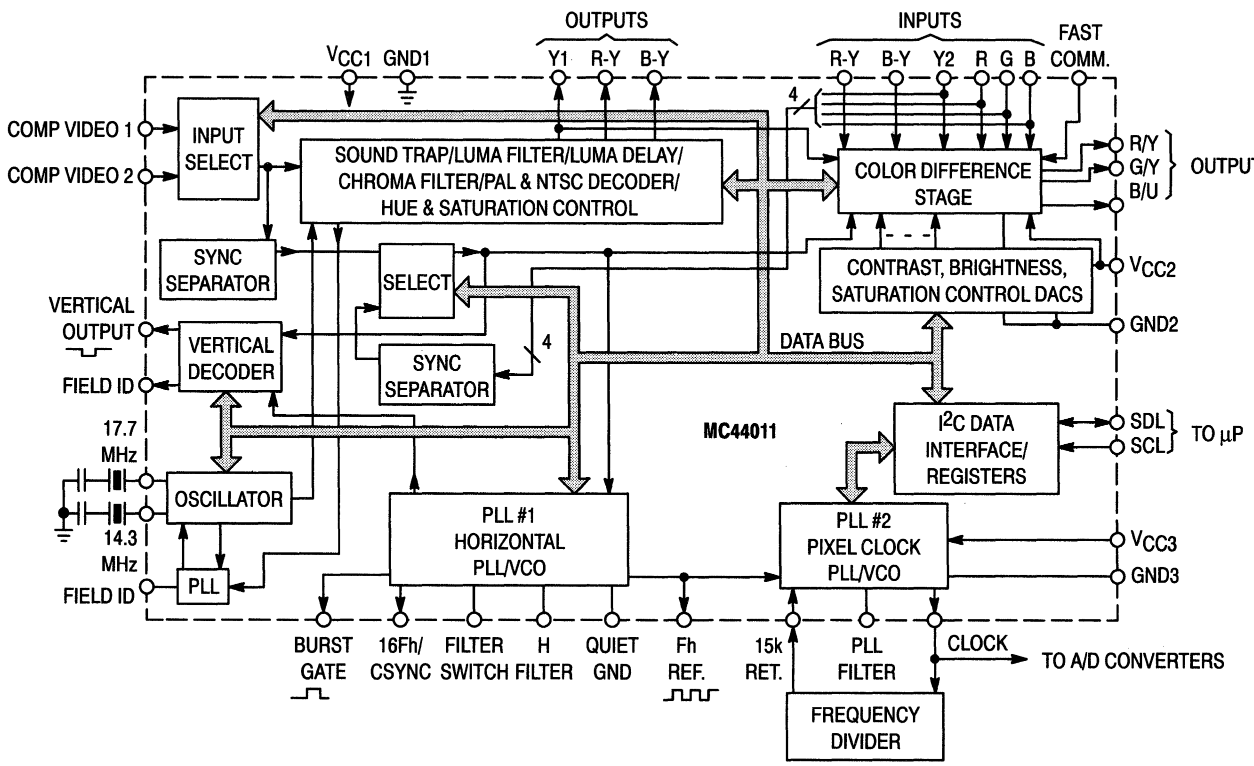


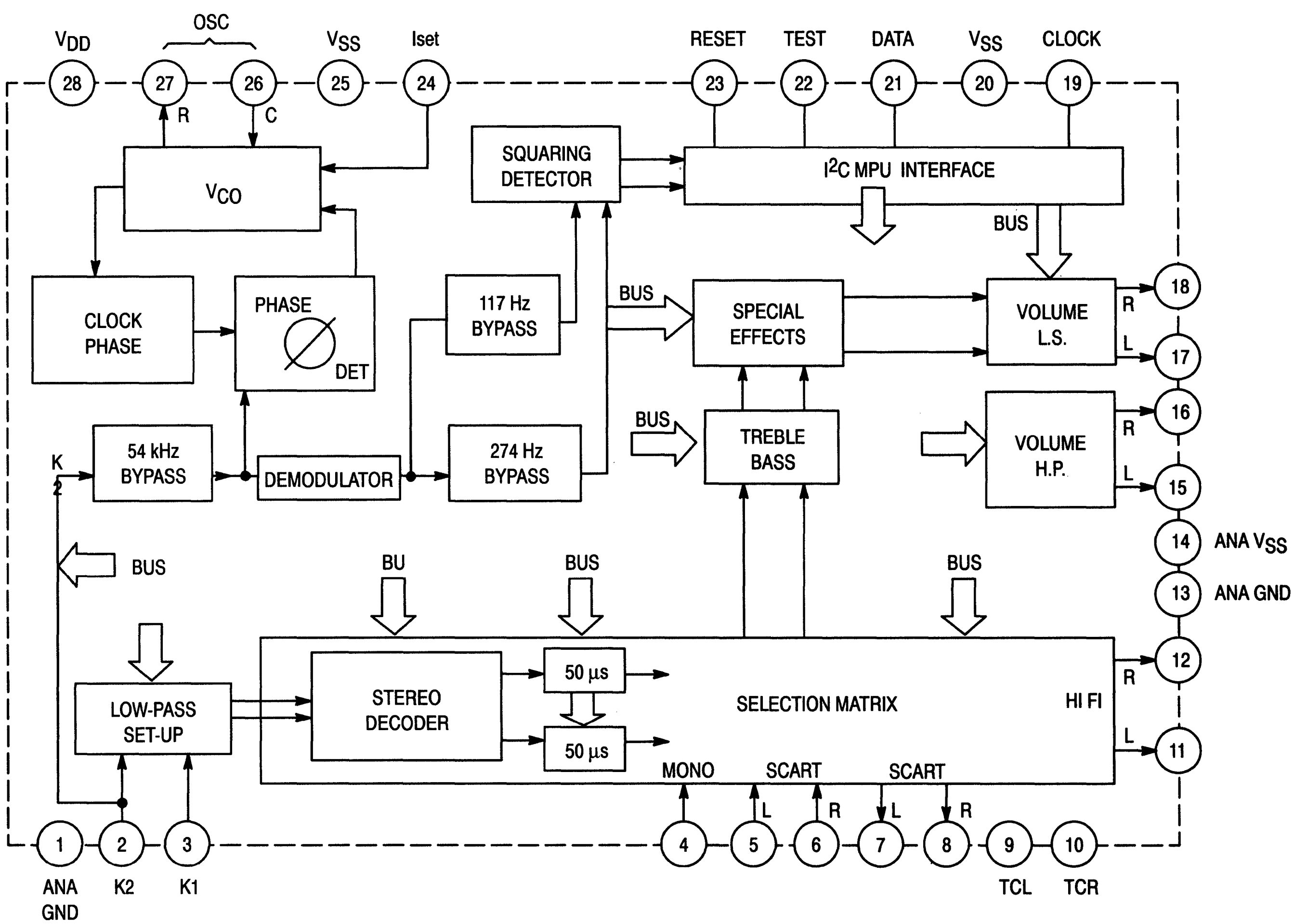
Figure 4. MC44011 Block Diagram

TV Stereo Decoder for NICAM and German System

MC44131P
Case 710

The MC44131 combines all of the functions necessary for the decoding and sound control in accordance with the NICAM and German Standard transmission systems. It is controlled via a microprocessor and I^{2}C bus.

- Pilot Tone Decoding
- Baseband Stereo Signal Decoding
- Signal De-emphasis
- Direct Balance Adjustment via Software
- I^{2}C Bus Controlled Routing of the Baseband/Monaural/SCART Inputs to Loudspeaker/Headphone/Hi Fi/Scart Outputs
- Loudspeaker Output Control of Tone, Special Effects, Independent Left-Right Volume Control
- Headphone Output Control of Independent Left-Right Volume Control

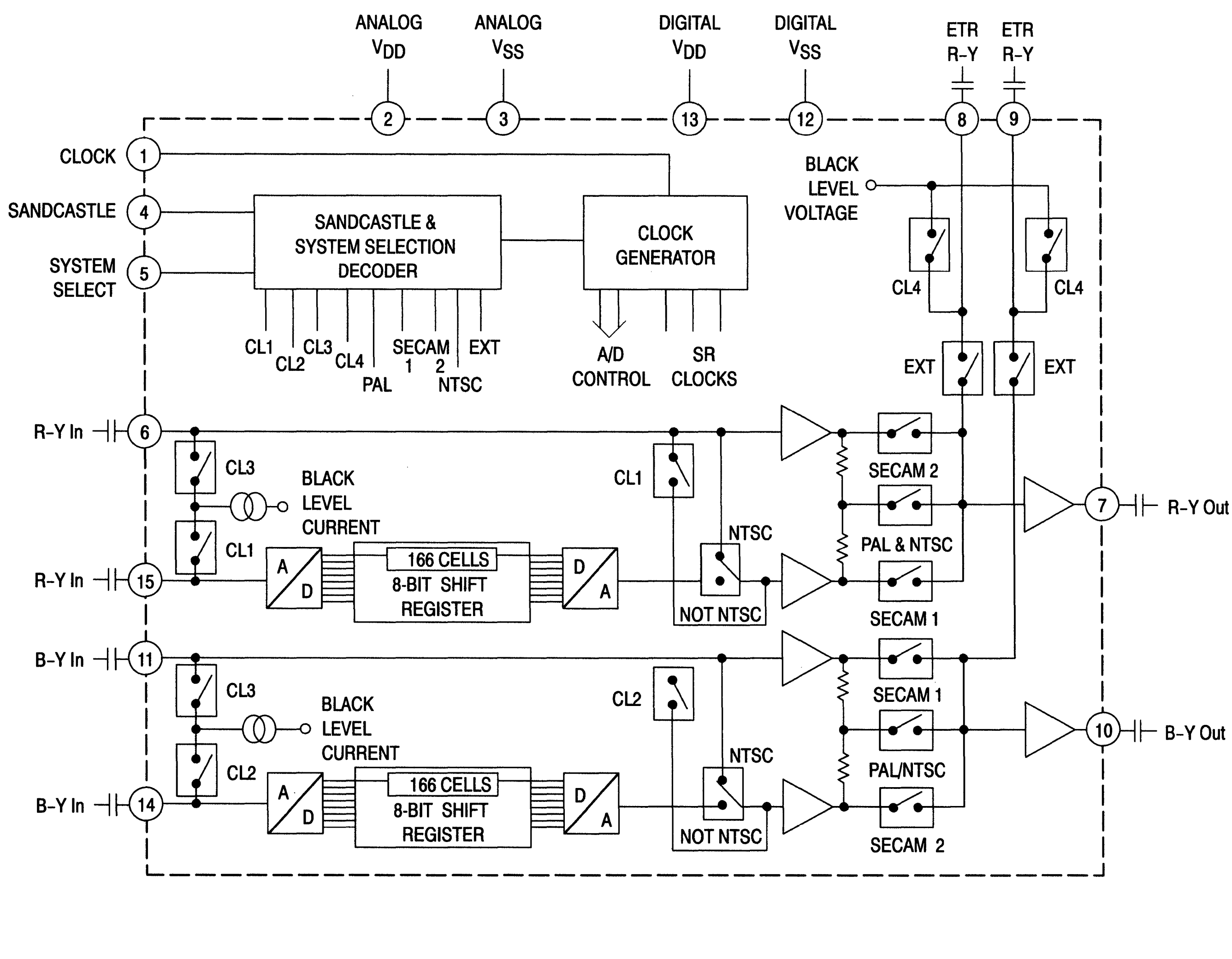


Digital Chroma Delay Line

MC44140P, DW
Case 648, 751G

The MC44140 is a monolithic 64 μs delay line, intended for color TV applications. It may be used as a baseband chroma correction circuit (with PAL), or as a chroma delay line (with SECAM). The device has been designed for use with the MC44000 as part of Chroma 4, or with the MC44011, but may also be used as a general purpose delay line for other applications.

- Part of SYSTEM 4 Concept
- Works with Baseband Color Difference Signals
- PAL (4.43 MHz)/SECAM/NTSC Capability
- Uses 17.734475 MHz Clock with PAL/SECAM Signals
- 8-Bit Sampling at 1/6 Clock Frequency
- External Inputs (Satellite ...)
- Minimum Number of External Components
- Low Current (35 mA), +5.0 V Supply



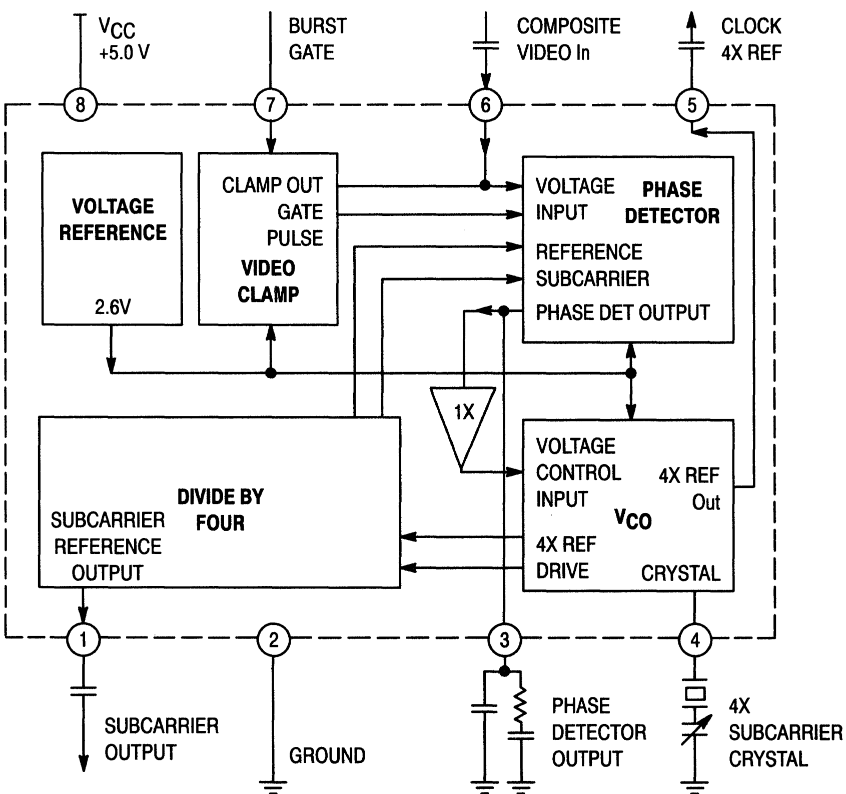
Subcarrier Reference

MC44144P, D
Case 626, 751

The MC44144 is a phase-locked-loop for video applications that provides the subcarrier frequency, and 4 times subcarrier frequency locked to the color burst. It contains, on a single chip, a phase detector, voltage controlled oscillator, divide-by-four, and video clamp.

The MC44144 is manufactured using Motorola's high density, bipolar MOSAIC® process.

- Provides 4X Frequency Locked to Color Burst
- Provides Regenerated Subcarrier Output
- 5.0 V Operation

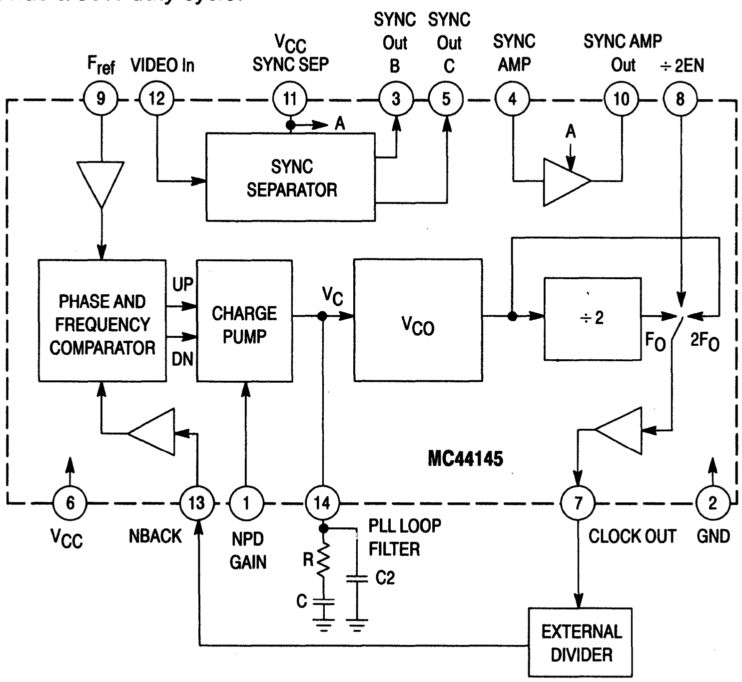


Pixel Clock Generator and Sync Separator

MC44145D
Case 751A

The MC44145 Pixel Clock Generator is a component of the M44000 family. This device contains a sync separator with horizontal and vertical outputs, and clock generation circuitry for the digitization of any video signal, along with the necessary circuitry for clock generation such as a phase comparator and a ÷ 2 to provide a 50% duty cycle.

- Stand Alone PLL Circuit
- Switchable Divider for 50% Duty Cycle
- Integrated Sync Separator
- Integrated Buffer Amplifier

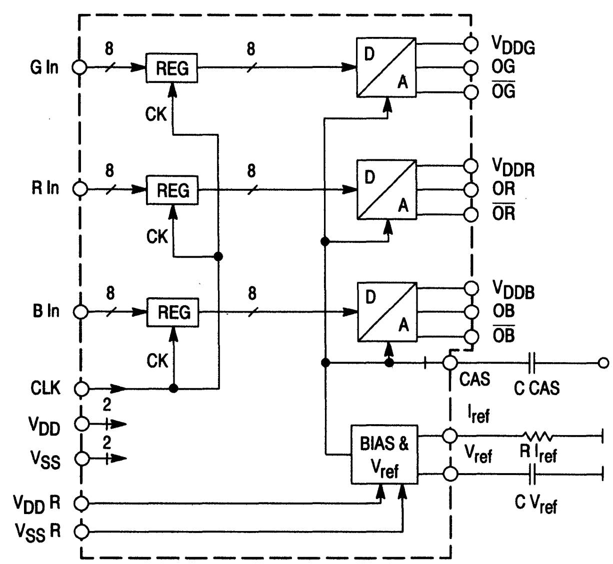


Triple 8-Bit D/A Converter

MC44200FU
Case 824A

The MC44200 is a monolithic digital to analog converter for three independent channels fabricated in CMOS technology. The part is specifically designed for video applications. Differential outputs are provided, allowing for a large output voltage range.

- 8-Bit Resolution
- Differential Outputs
- 80 msps Conversion Speed
- Large Output Voltage Range
- Low Current Mode
- Single 5.0 V Power Supply
- TTL Compatible Inputs
- Integrated Reference Voltage



Triple 8-Bit A/D Converter

MC44250/51FN
Case 777

The MC44250 and MC44251 contain three independent parallel analog to digital converters. Each ADC consists of 256 latching comparators and an encoder. Input clamps allow for AC coupling of the input signals, and DC coupling is also allowed. For video processing performance enhancements, a dither generator with subsequent digital correction is provided to each ADC. The outputs of the MC44251 can be set to a high impedance state.

These A/Ds are especially suitable as front end converters in TV picture processing.

- 15 MHz Maximum Conversion Speed (MC44250)
- 18 MHz Maximum Conversion Speed (MC44251)
- Input Clamps Suitable for RGB and YUV Applications
- Built-in Dither Generator with Subsequent Digital Correction
- Single 5.0 V Power Supply

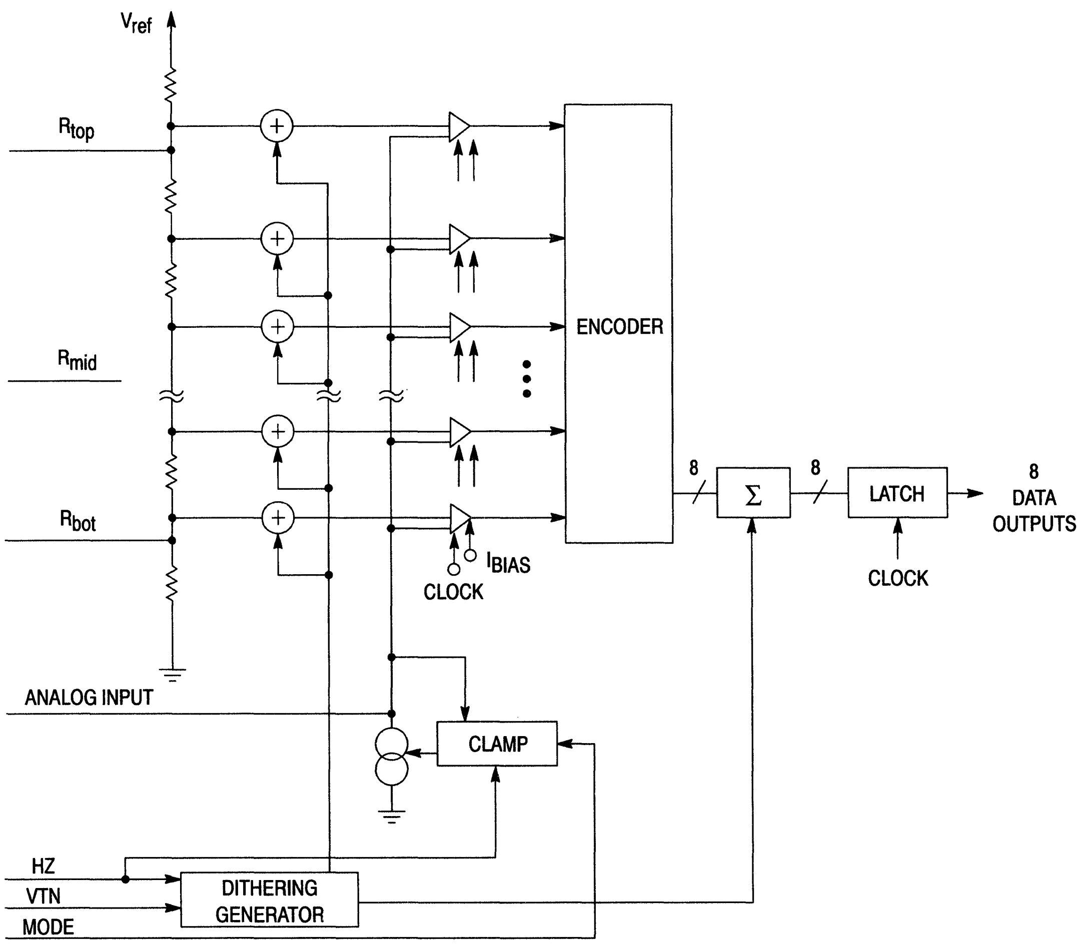


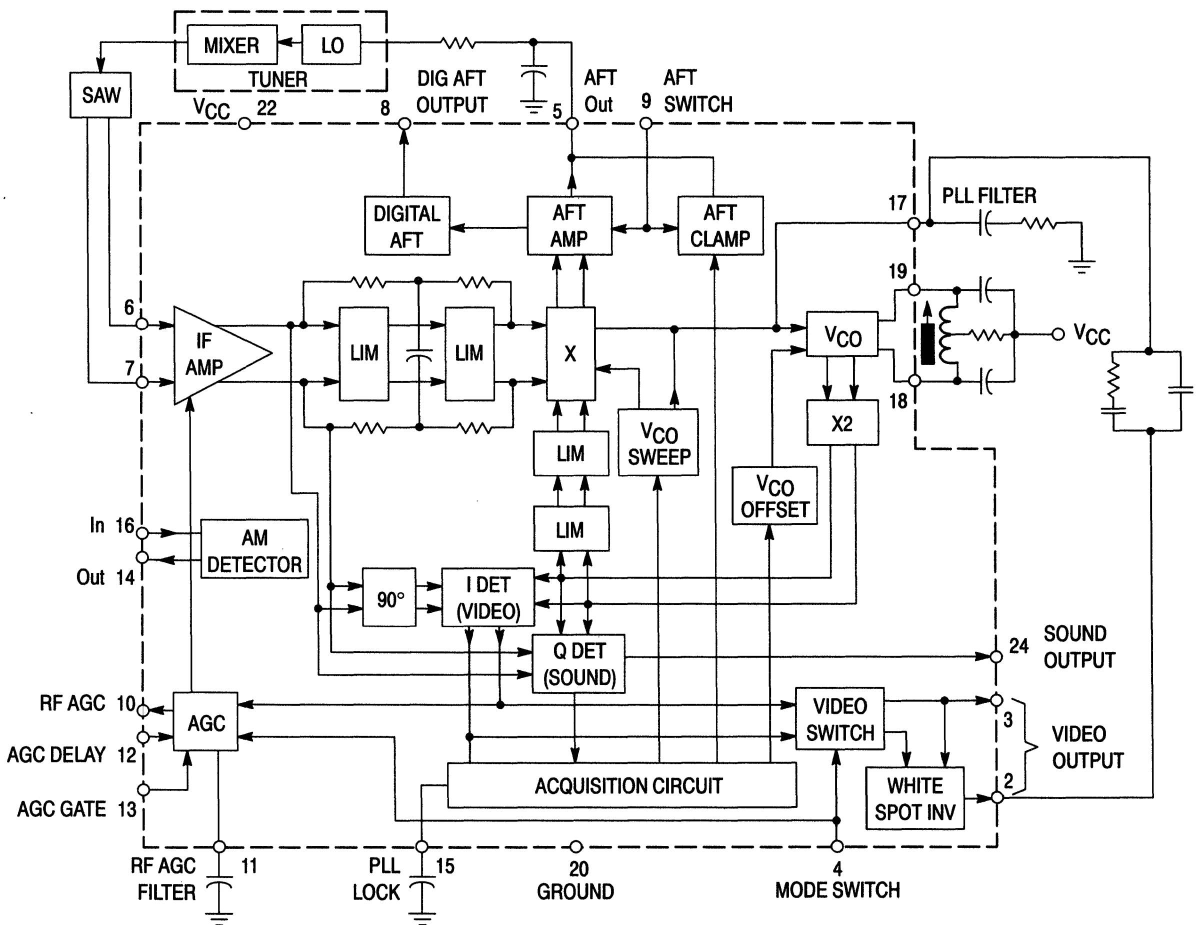
Figure 5. Simplified Diagram of One of the ADCs

Multistandard Video IF

MC44301P, DW
Case 724, 751F

The MC44301 is a single channel TV IF and PLL detector system for all standard transmission systems. This device enables the designer to produce a high quality IF system with white spot inversion, AFT and AGC. The MC44301 was designed with an emphasis on linearity to minimize sound/picture intermodulation.

- Single Coil Adjustment for AFT and PLL
- V_{CO} at 1/2 IF for Minimum Beats
- Simple Circuitry for Low System Cost
- White Spot Inversion
- Symmetrical ± 2.0 MHz AFT Pull-In
- Demodulates Positive or Negative Modulation
- Auxiliary AM Detector for AM Sound
- Simple Alignment Procedure

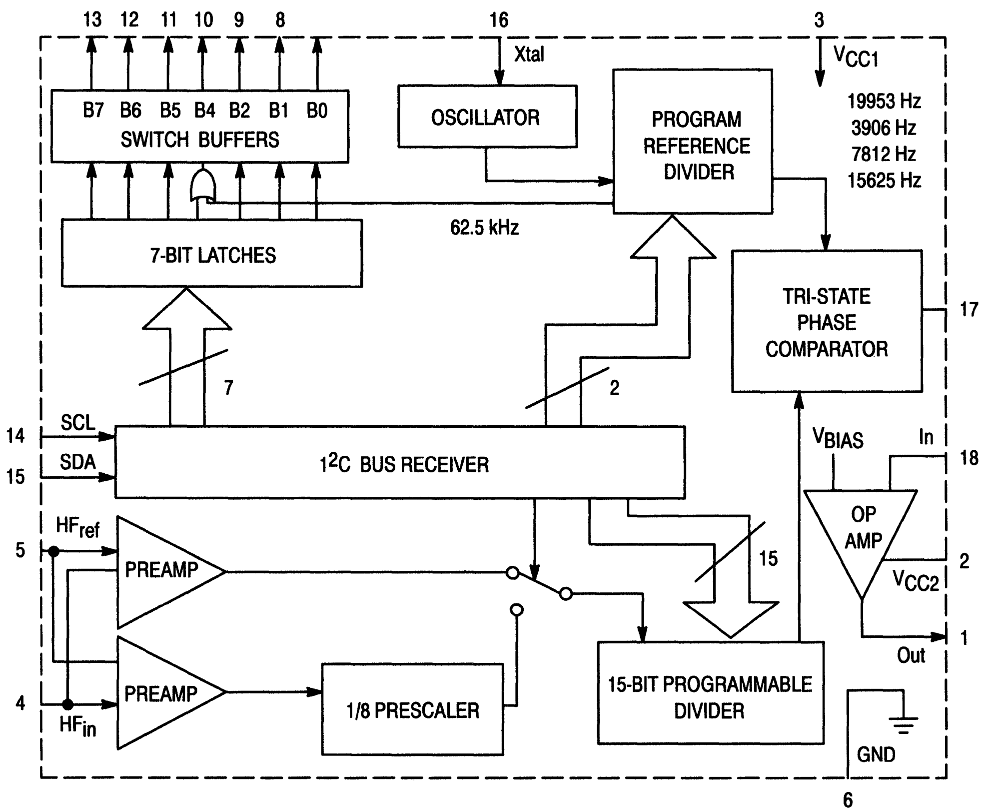


1.3 GHz Tuner PLL with I²C Control

MC44802AP
Case 707

The MC44802A is a tuning circuit for TV applications. It contains, on one chip, all the functions required for PLL control of a V_{CO}. This integrated circuit also contains a high frequency prescaler (which can be bypassed by software control) and thus handle frequencies up to 1.3 GHz.

- Complete Single Chip System for MPU Control (I²C Bus)
- Selectable ÷ 8 Prescaler Accepts Frequencies Up to 1.3 GHz
- Programmable Reference Divider
- Tri State Phase/Frequency Comparator
- Op Amp for Direct Tuning Voltage Output: 30 V
- Seven High Current Buffers: 10 mA, 12 V
- Output Options for 62.5 kHz, Reference Frequency and the Programmable Divider
- Software Compatible with the MC44810
- I²C Interface

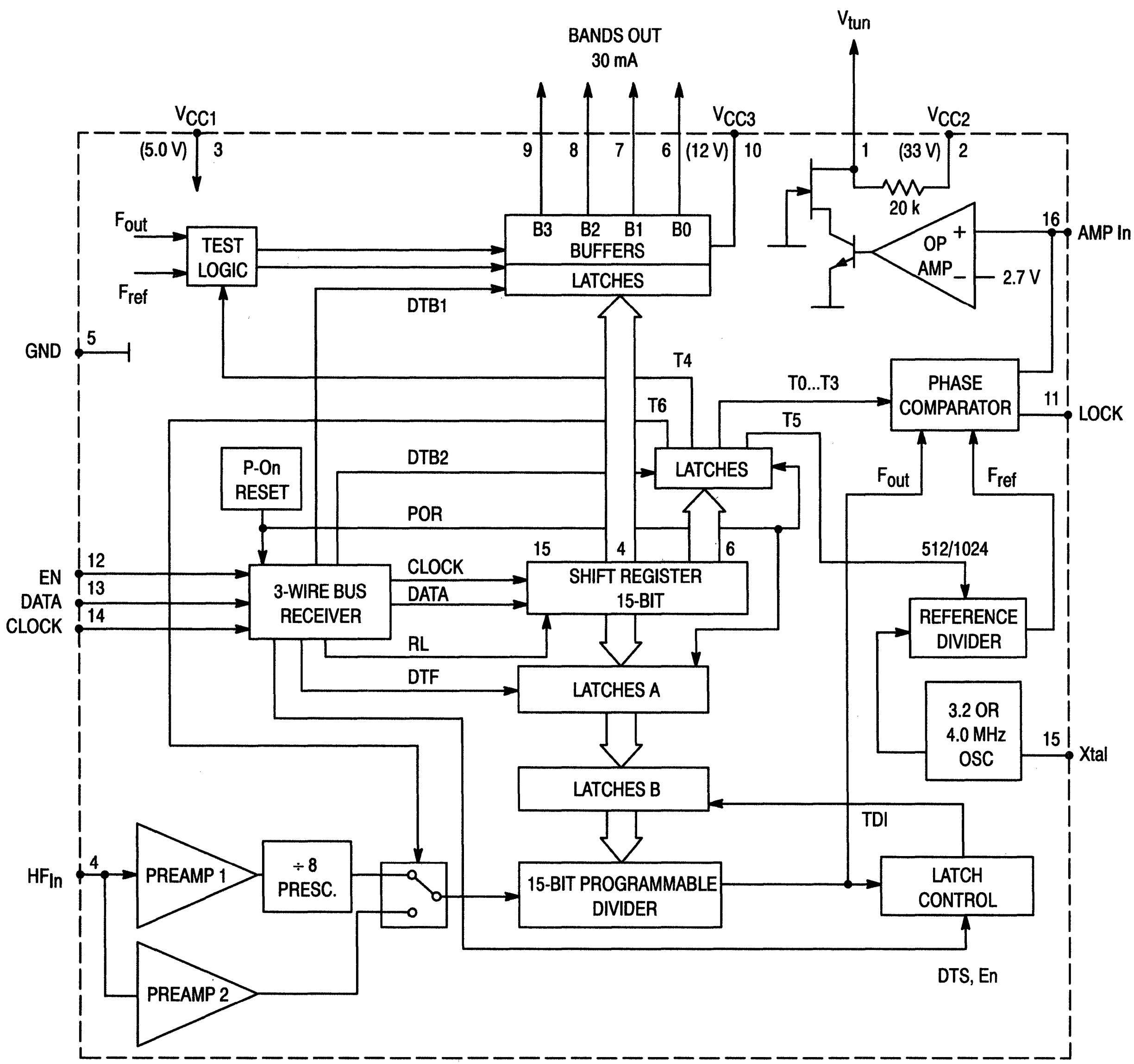


1.3 GHz Tuner PLL With 3-Wire Control

MC44807P/17D
Case 648, 751B

The MC44807/17 is a tuning circuit for TV applications. It contains, on one chip, all the functions required for PLL control of a V_{CO}. This integrated circuit also contains a high frequency prescaler (which can be bypassed by software control) and thus handle frequencies up to 1.3 GHz.

- Complete Single Chip System for MPU Control (3-Wire Bus)
- ÷ 8 Prescaler Accepts Frequencies Up to 1.3 GHz
- 15-Bit Programmable Reference Divider Accepts Frequencies Up to 165 MHz
- Tri-State Phase/Frequency Comparator with Lock Detect Output
- Op Amp for Direct Tuning Voltage Output: 30 V
- Four Integrated Band Buffers for 40 mA (V_{CC1} to 14.4 V)
- Output Options for Reference Frequency and Programmable Divider
- Bus Protocol for 18 or 19-Bit Transmission
- High Input Sensitivity



PLL Tuning Circuit With DACs for Tuner Alignment

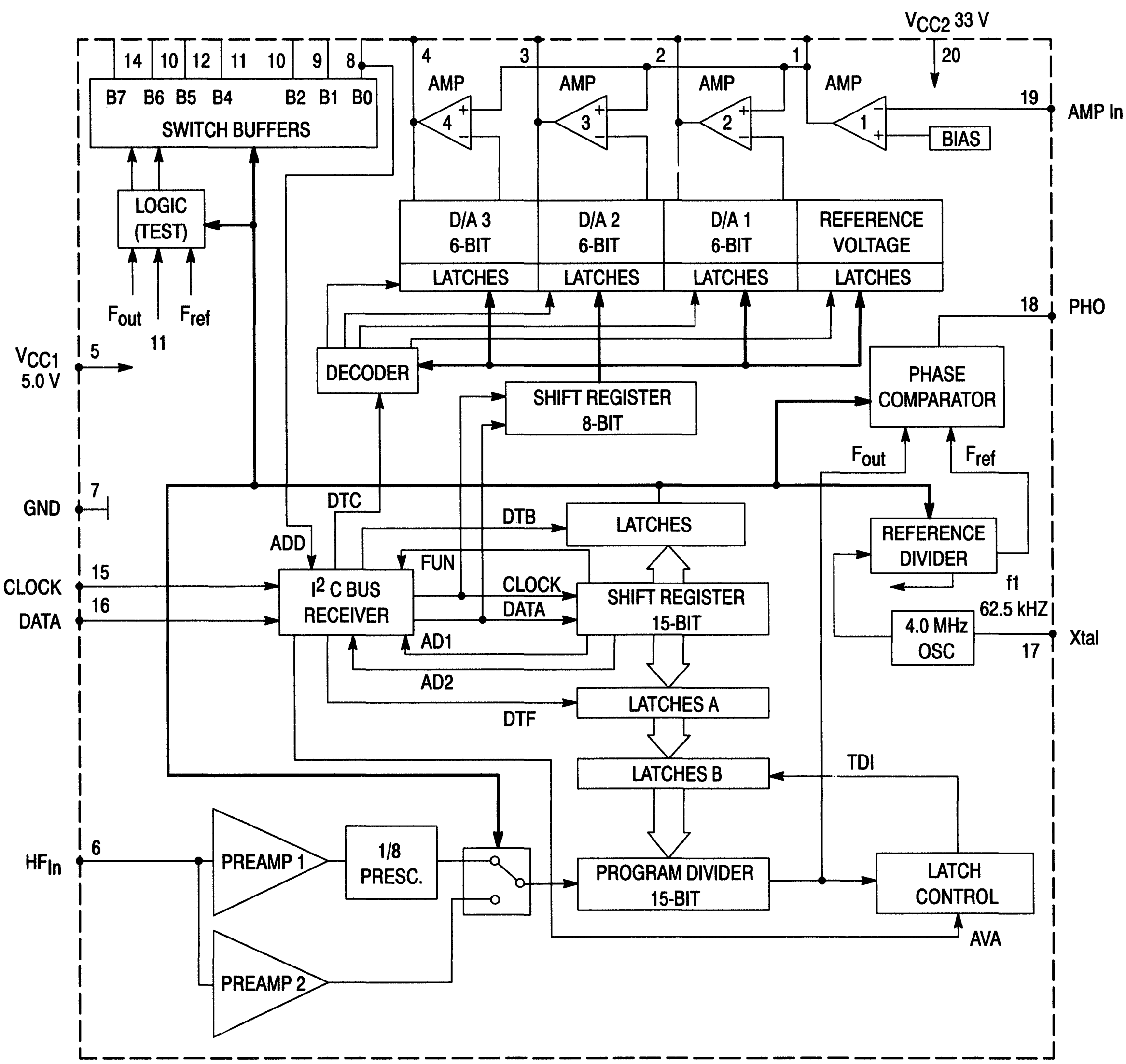
MC44810P
Case 738

The MC44810 is a tuning circuit for TV applications. It contains a PLL section and a DAC section and is MPU controlled through the I^2C bus.

The PLL section contains all the functions required to control the V_{CO} of a TV tuner. It generates the tuning voltage and the additional control signals. The PLL section is functionally equivalent to the MC44802A.

The DAC section generates three varactor voltages in order to feed all of the tuner varactors with their individually optimized control voltages (automatic tuner adjustment).

- Complete Single Chip System for MPU Control (I^2C Bus)
- Tri-State Phase/Frequency Comparator
- Selectable ÷ 8 Prescaler Accepts Frequencies Up to 1.3 GHz
- 15-Bit Programmable Reference Divider Accepts Frequencies Up to 165 MHz
- Op Amp for Direct Tuning Voltage Output: 30 V
- Seven High Current Buffers: 10 mA, 12 V
- Output Options for 62.5 kHz, Reference Frequency and Programmable Divider
- Software Compatible with the MC44802A
- Three 6-Bit DACs for Automatic Tuner Adjustment Allowing Use of Non-Matched Varactors
- 2 Chip Addresses for the PLL Section and 2 Different Chip Addresses for the DAC Section

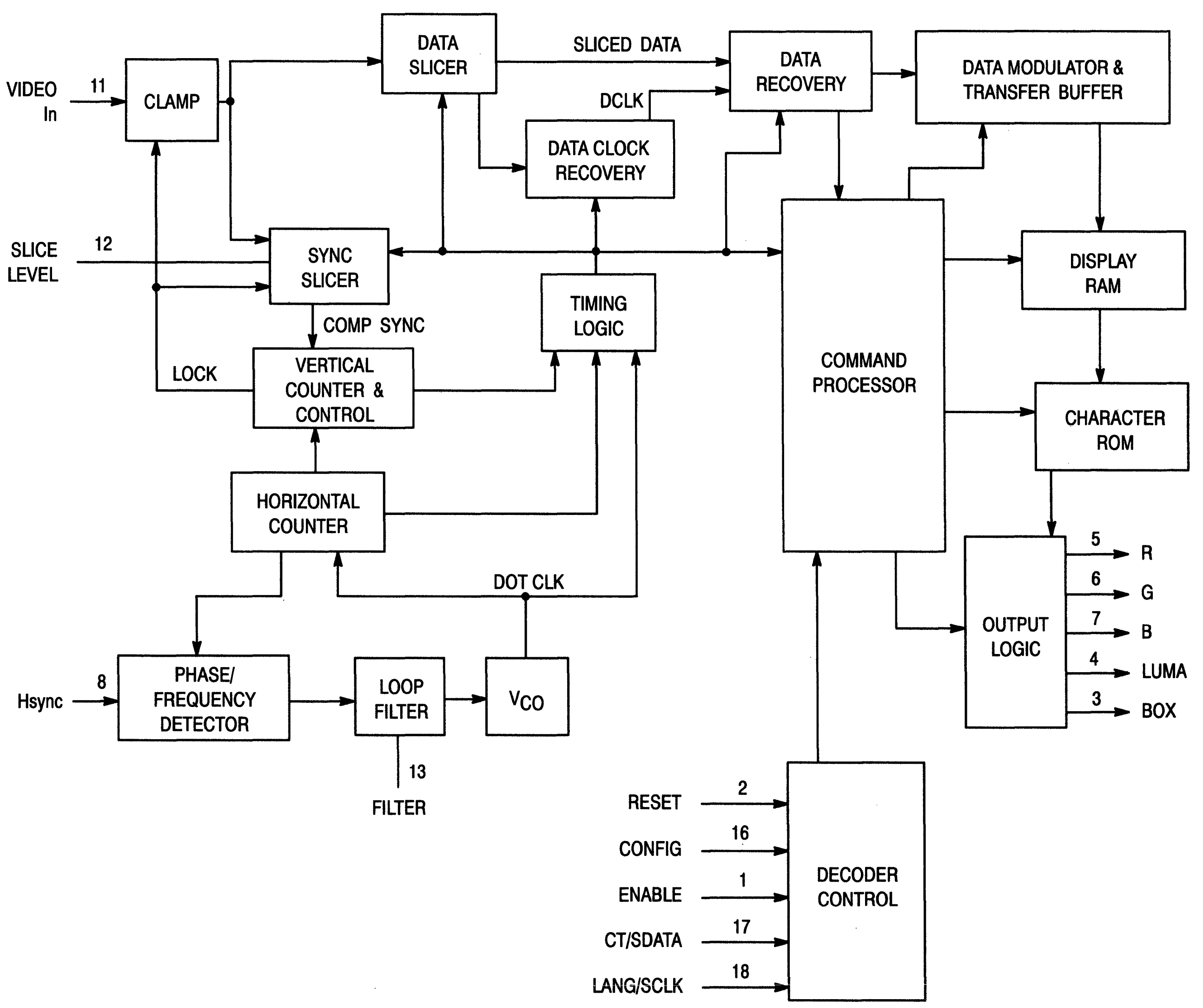


Closed-Caption Decoder

MC144143P
Case 707

The MC144143 is a Line 21 closed-caption decoder for use in television receivers or set top decoders conforming to the NTSC broadcast standard. Capability for processing and displaying all of the latest standard Line 21 closed-caption format transmissions is included. The device requires a closed-caption encoded composite video signal, a horizontal sync signal, and an external keyer to produce captioned video. RGB outputs are provided, along with a luminance and a box signal, allowing simple interface to both color and black and white receivers.

- Conforms to the SCC Report and Order as Amended by the Petition for Reconsideration on Gen. Doc. 91-1
- Supports Four Different Data Channels, Time Multiplexed within the Line 21 Data Stream: Captions Utilizing Languages 1 & 2, Plus Text Utilizing Languages 1 & 2
- Output Logic Provides Hardware Underline Control and Italics Slant Generation
- Single Supply Operating Voltage Range: 4.75 to 5.25 V
- Composite Video Input Range: 0.7 to 1.4 Vp-p
- Horizontal Sync Input Polarity can be either Positive or Negative
- Internal Timing/Sync Signals Derived from On-Chip V_{CO}

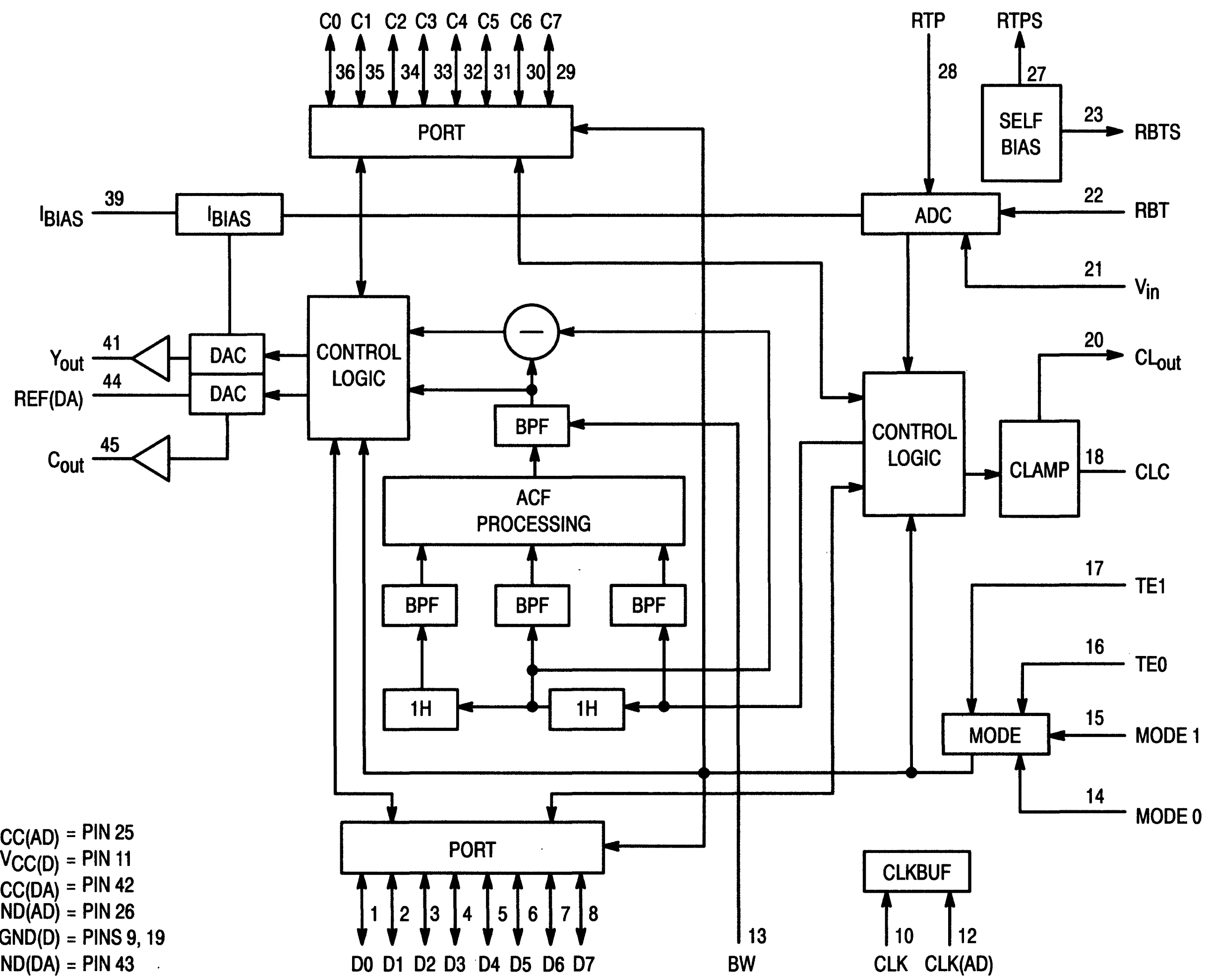


Advanced NTSC Comb Filter

MC141621FU
Case 898

The MC141621 is an advanced NTSC comb filter for VCR and TV applications. It separates the luminance (Y) and chrominance (C) signals from the NTSC composite video signal by using digital signal processing techniques. This filter allows a video signal input of an extended frequency bandwidth by using a 4.0 F_{SC} clock. In addition, the filter minimizes dot crawl and cross color effects. The built-in A/D and D/A converters allow easy connections to analog video circuits.

- Built-in High Speed 8-Bit A/D Converter
- Two Line Memories (1820 Bytes)
- Advanced Combing Process
- Two 8-Bit D/A Converters
- Built-in Clamp Circuit
- On-Chip Reference Voltage Regulator for ADC
- Digital Interface Mode



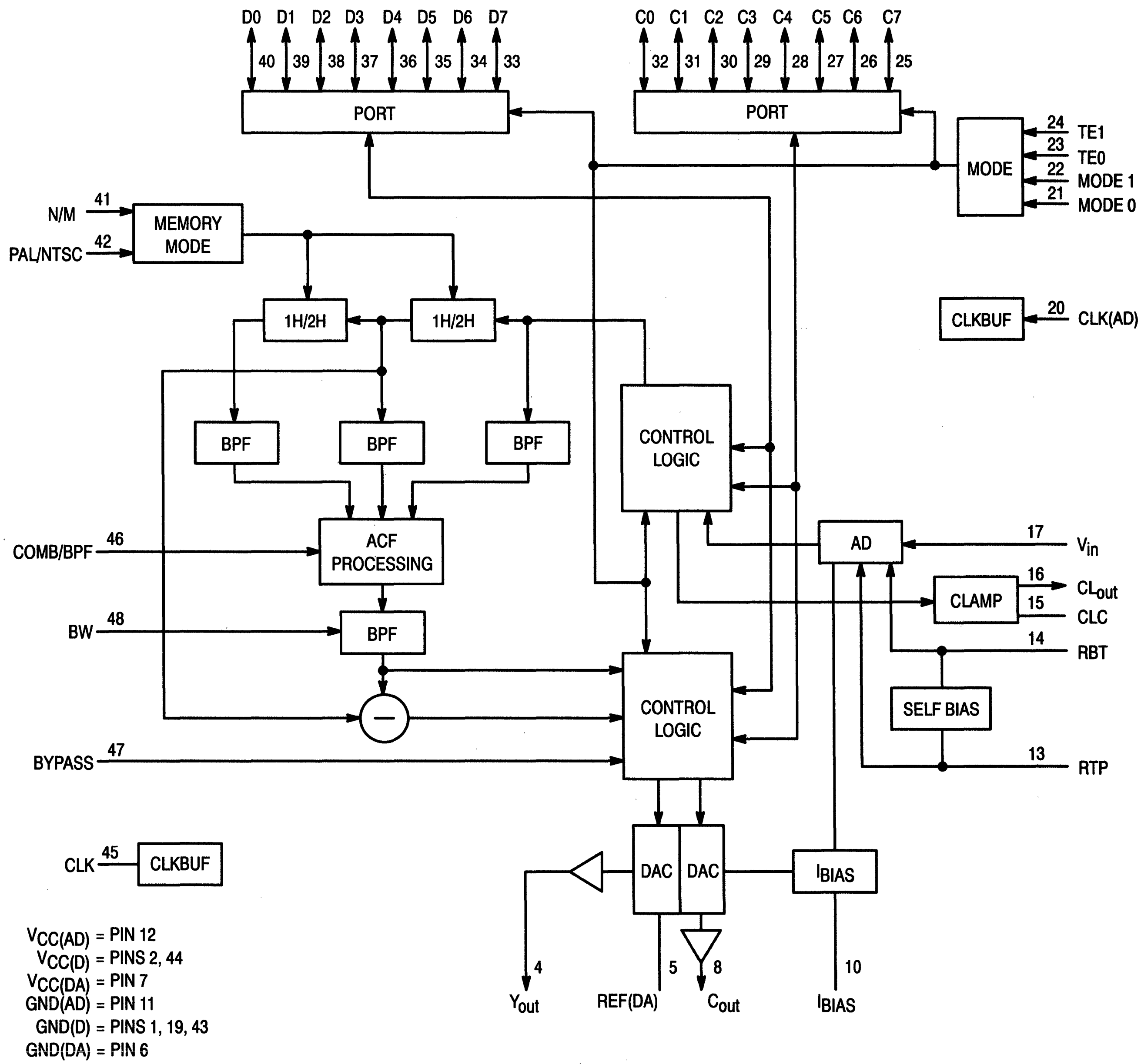
$V_{CC(AD)}$ = PIN 25
$V_{CC(D)}$ = PIN 11
$V_{CC(DA)}$ = PIN 42
GND(AD) = PIN 26
GND(D) = PINS 9, 19
GND(DA) = PIN 43

Advanced PAL/NTSC Comb Filter

MC141625AFU, FU
Case 898

The MC141625 is an advanced PAL/NTSC comb filter for VCR and TV applications. It separates the luminance (Y) and chrominance (C) signals from the PAL or NTSC composite video signal by using digital signal processing techniques. This filter allows a video signal input of an extended frequency bandwidth and minimizes dot crawl and cross color effects. The built-in A/D and D/A converters allow easy connections to analog video circuits.

- Fast 8-Bit A/D Converter
- Four Line Memories (4540 Bytes)
- Advanced Combing Process
- Two 8-Bit D/A Converters
- Built-in Clamp Circuit
- On-Chip Reference Voltage Regulator for ADC
- Digital Interface Mode
- PAL/NTSC Mode



Dual Video Amplifiers

MC14576B/77BF, P
Case 626, 904

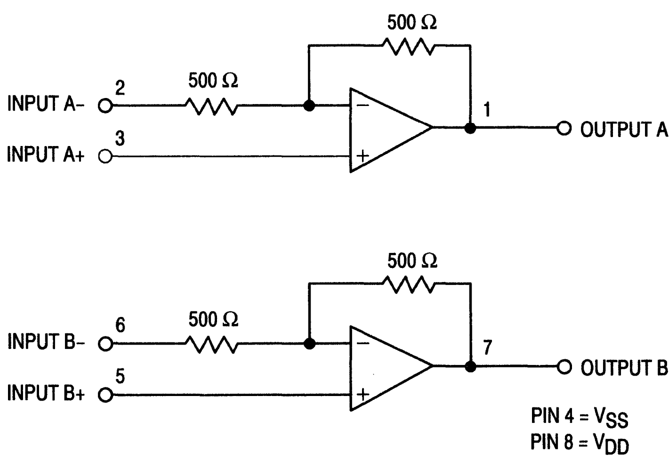
The MC14576B/77B devices each contain two amplifiers manufactured in CMOS process. Each amplifier also employs two lateral NPN bipolar transistors.

The MC14576B contains two internally compensated operational amplifiers. On-chip gain setting resistors result in a noninverting voltage gain of 6.0 dB, ±1.0 dB at 4.43 MHz for each amp. Each noninverting input of the MC14576B appears as mostly a capacitive load of approximately 10 pF.

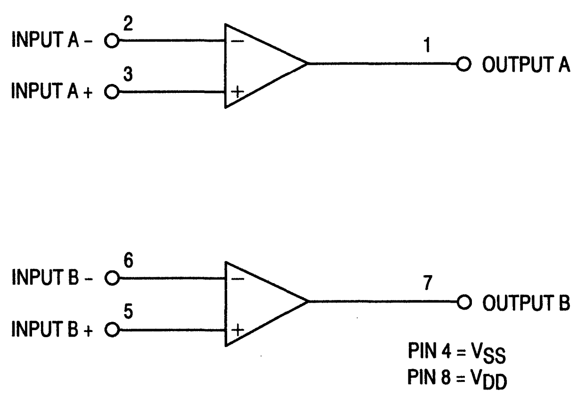
The MC14577B also contains two internally compensated operational amplifiers. However, the gain for each amplifier is adjustable with external components. All inputs of the MC14577B appear mostly as capacitive loads of approximately 10 pF.

- Direct Drive of 150 Ω Loads
- May Be Used with Single or Dual Supplies
- Guaranteed Bandwidth of 10 MHz

MC14576A



MC14577A



Video Circuits (continued)

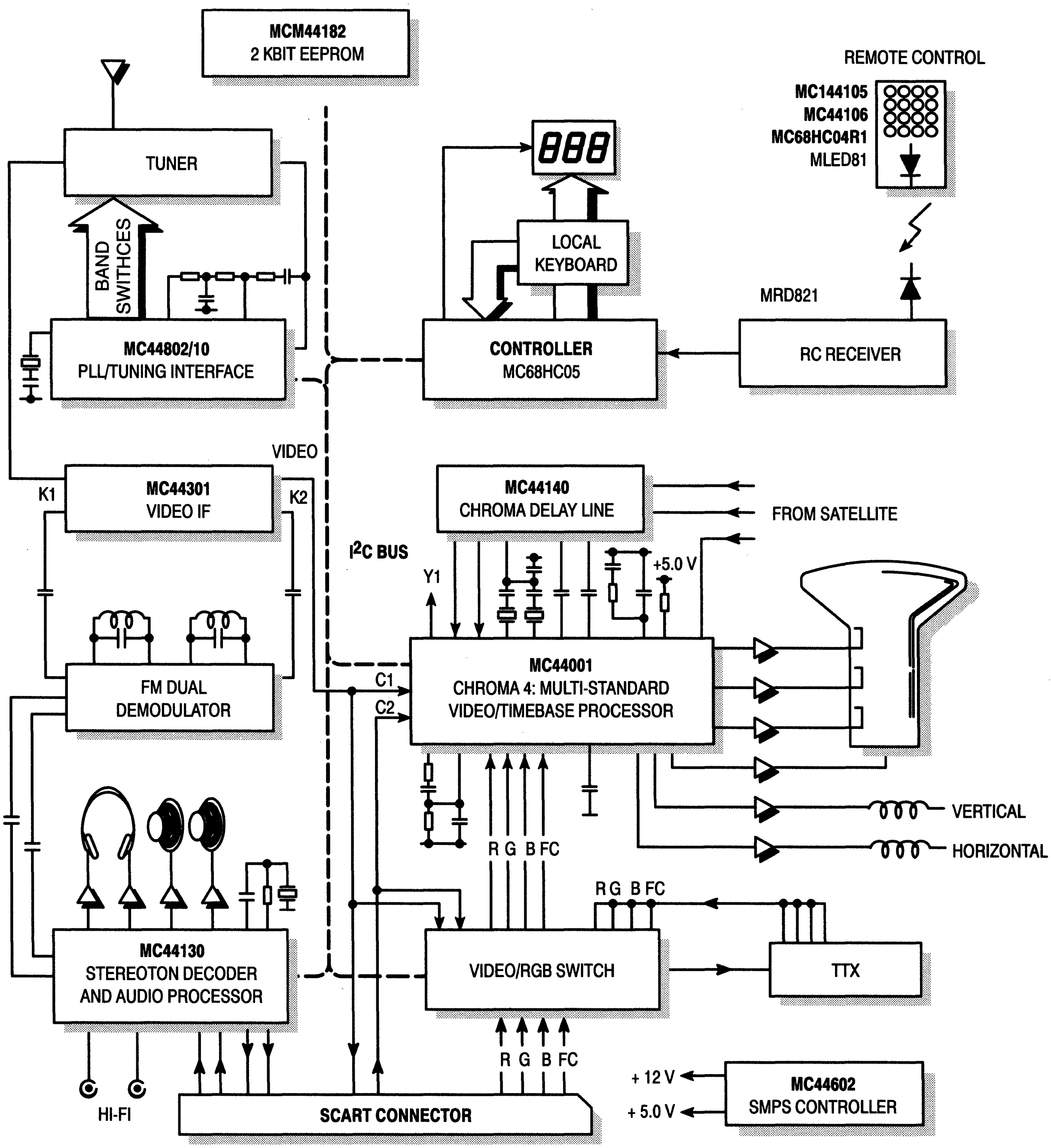


Figure 6. Chroma 4 Family Block Diagram

Remote Control Circuits

MC3373P Amplifier/Detector (Bipolar)
Case 626

MC14497 Transmitter (CMOS)
Case 707

The MC3373 remote control receiver is specifically designed for infrared link systems where high sensitivity and good noise immunity are critical. The MC3373 incorporates a high gain detector diode preamp driving an envelope detector and data wave shaper for accurate data recovery. Provision is also made to use an external L-C tank circuit at the carrier frequency, normally 30 to 60 kHz, for extended range low noise systems. Applications include TV remote control, short range data links (up to several hundred feet), door openers and security systems. The MC14497 is an ideal companion transmitter, where a simple DTMF like key-pad control is desired. The Motorola Discrete Opto Division also has several high sensitivity detectors and emitters which match up well to the MC3373 system.

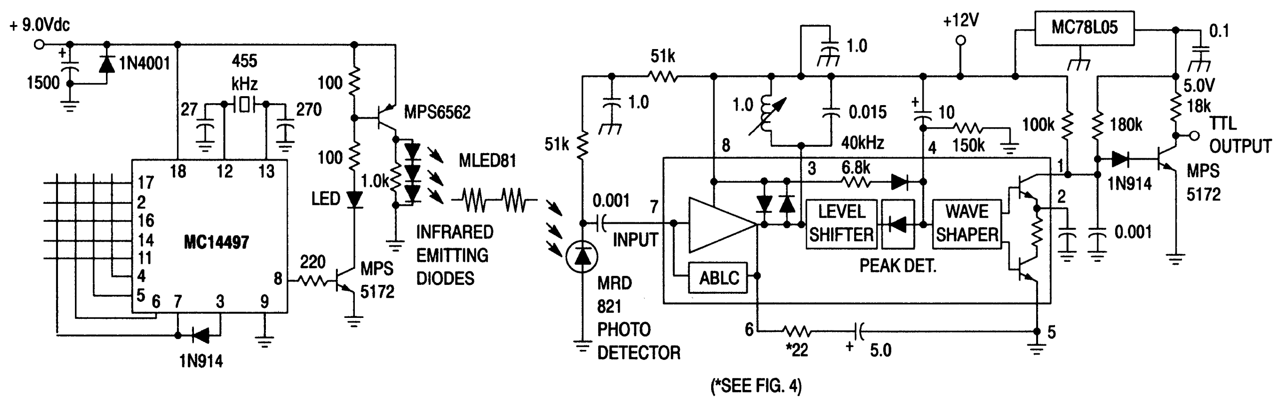


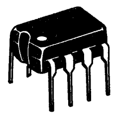
Figure 7. Remote Control Application 40 kHz Carrier

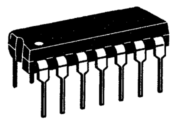
Table 61. CMOS Remote Control Functions

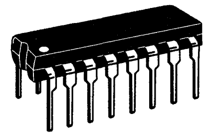
Function	Number of Address Lines	Maximum Number of Address Codes	Number of Data Bits	Operation	Device	Suffix/Case
Addressable UART	7	128	7/8	Full-Duplex	MC14469	P/711, FN/777
Transmitter	0	0	6	Simplex	MC14497	P/707
Encoder	Depends on Decoder(1)	Depends on Decoder(1)	Depends on Decoder(1)	Simplex	MC145026	P/648, D/751B
Decoder	5	243	4	Simplex	MC145027	P/648, DW/751G
	9	19,683	0	Simplex	MC145028	
Encoder/Decoder	9	512	0	Half-Duplex	MC145030	P/738, DW/751D
	15	32,768	0	Half-Duplex	MC145033	DW/751F
Encoder	13 or 17	131,072	4	Simplex	MC145034	
Decoder	13 or 17	131,072	4	Simplex	MC145035	

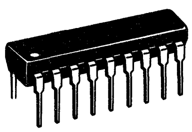
(1)See MC145027, MC145028

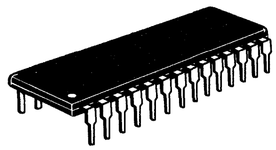
Consumer Electronic Circuits Package Overview

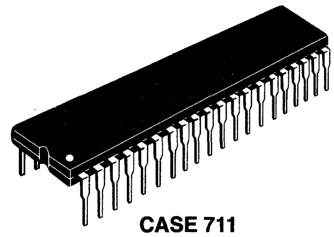

CASE 626
PLASTIC
F, P SUFFIX

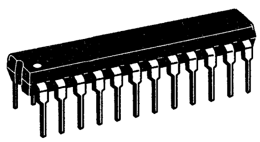

CASE 646
PLASTIC
P SUFFIX

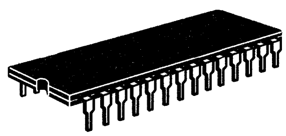

CASE 648, 648C
PLASTIC
P SUFFIX

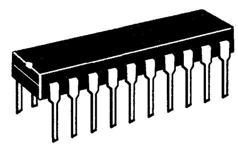

CASE 707
PLASTIC
P SUFFIX

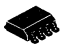

CASE 710
PLASTIC
P SUFFIX


CASE 711
PLASTIC
P SUFFIX

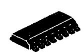

CASE 724
PLASTIC
P SUFFIX

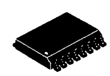

CASE 733
CERAMIC
L SUFFIX

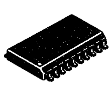

CASE 738
PLASTIC
P SUFFIX

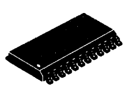

CASE 751
PLASTIC
D SUFFIX

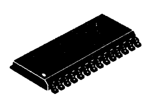

CASE 751A
PLASTIC
D SUFFIX

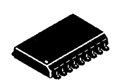

CASE 751B
PLASTIC
D SUFFIX

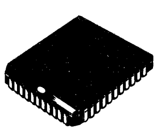

CASE 751C
PLASTIC
DW SUFFIX

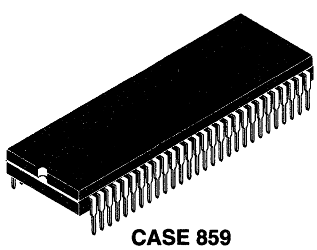

CASE 751D
PLASTIC
DW SUFFIX

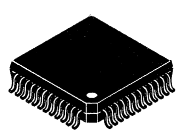

CASE 751E
PLASTIC
DW SUFFIX

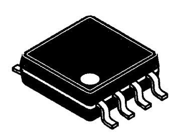

CASE 751F
PLASTIC
DW SUFFIX


CASE 751G
PLASTIC
DW SUFFIX


CASE 777
PLASTIC
FN SUFFIX


CASE 859
PLASTIC
B SUFFIX


CASE 898
PLASTIC
FU SUFFIX


CASE 904
PLASTIC
F SUFFIX

Automotive Electronic Circuits

In Brief . . .

Motorola Linear has established itself as a global leader in custom integrated circuits for the automotive market. With multiple design centers located on four continents, global process and assembly sites, and strategically located supply centers, Motorola serves the global automotive market needs. These products are key elements in the rapidly growing engine control, body, navigation, entertainment, and communication electronics portions of modern automobiles. Though Motorola is most active in supplying automotive custom designs, many of yesterday's proprietary custom devices become standard products of today available to the broad base manufactures who support this industry. Today, based on new technologies, Motorola offers a wide array of standard products ranging from rugged high current "smart" fuel injector drivers which control and protect the fuel management system, through rigors of the underhood environment, to the latest SMARTMOS™ switches and series transient protectors. Several devices are targeted to support microprocessor housekeeping and data line protection. A wide range of packaging is available from die, flip-chip, and SOICs for high density layouts, to low thermal resistance multi-pin, single-in-line types for high power control ICs.

Page

Automotive Electronic Circuits

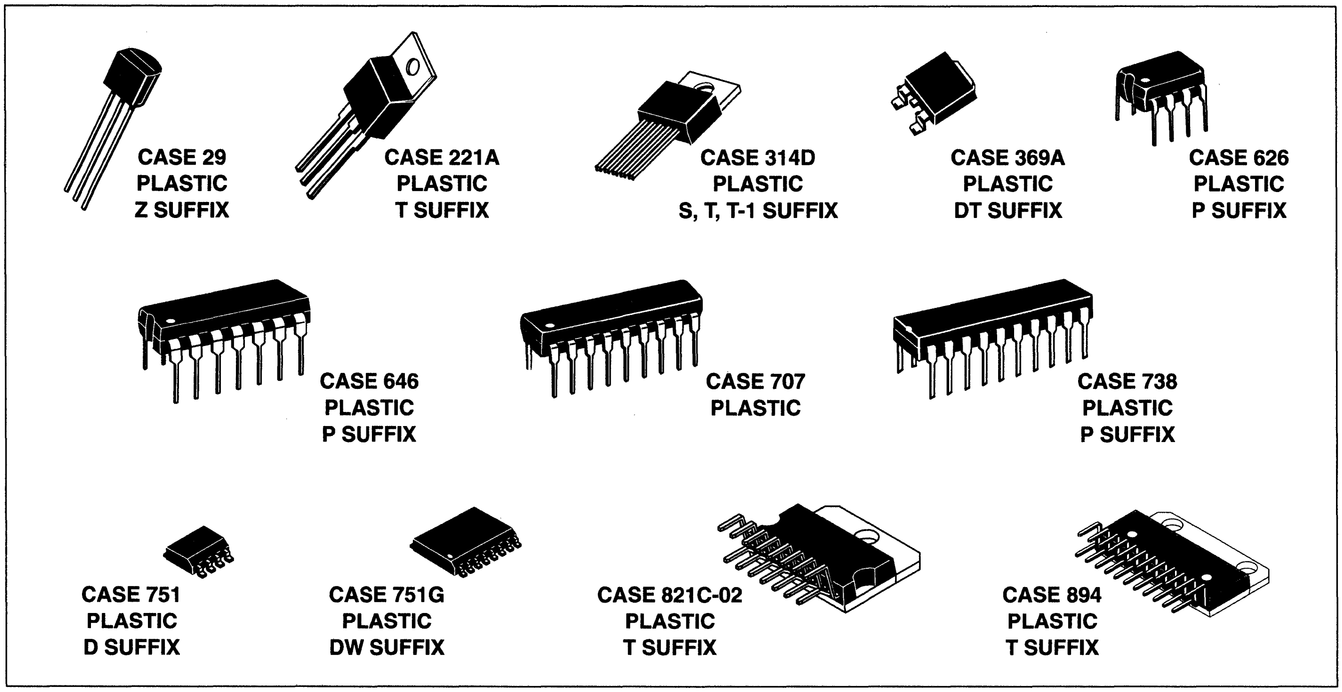


Table 62. Voltage Regulators

Function	Features	Suffix/ Case	Device
Low Dropout Voltage Regulator	Positive fixed and adjustable output voltage regulators which maintain regulation with very low input to output voltage differential.	Z/29, T/221A, T/314D, DT/369A	LM2931,C
Low Dropout Dual Regulator	Positive low voltage differential regulator which features dual 5.0 V outputs, with currents in excess of 750 mA (switched) and 10 mA standby, and quiescent current less than 3.0 mA.	T/314D	LM2935
Automotive Voltage Regulator	Provides load response control, duty cycle limiting, under/overvoltage and phase detection, high side MOSFET field control, voltage regulation in 12 V alternator systems.	DW/751D	MC33092
Low Dropout Voltage Regulator	Positive 5.0 V, 500 mA regulator having on-chip power-up-reset circuit with programmable delay, current limit, and thermal shutdown.	T/314	MC33267

Table 63. Electronic Ignition

Function	Features	Suffix/ Case	Device
Electronic Ignition Circuit	Used in high energy variable dwell electronic ignition systems with variable reluctance sensors. Dwell and spark energy are externally adjustable.	P/626, D/751	MC3334
Flip-Chip Electronic Ignition Circuit	Same as MC3334 — Mirror image die for inverted "bumped" mounting to substrate	Flip-Chip	MCCF3334
Flip-Chip Electronic Ignition Control Chip	Used in high energy electronic ignition systems requiring differential Hall Sensor control. "Bumped" die for inverted mounting to substrate.	Flip-Chip	MCCF33093
Flip-Chip Electronic Ignition Control Circuit	Used in high energy electronic ignition systems requiring single Hall Sensor control. "Bumped" die for inverted mounting to substrate.	Flip-Chip	MCCF33094
Flip-Chip Electronic Ignition Control Circuit	Used in high energy electronic ignition systems requiring single Hall Sensor control. Dwell feedback for coil variation. "Bumped" die for inverted mounting to substrate.	Flip-Chip	MCCF79076

Table 64. Special Functions

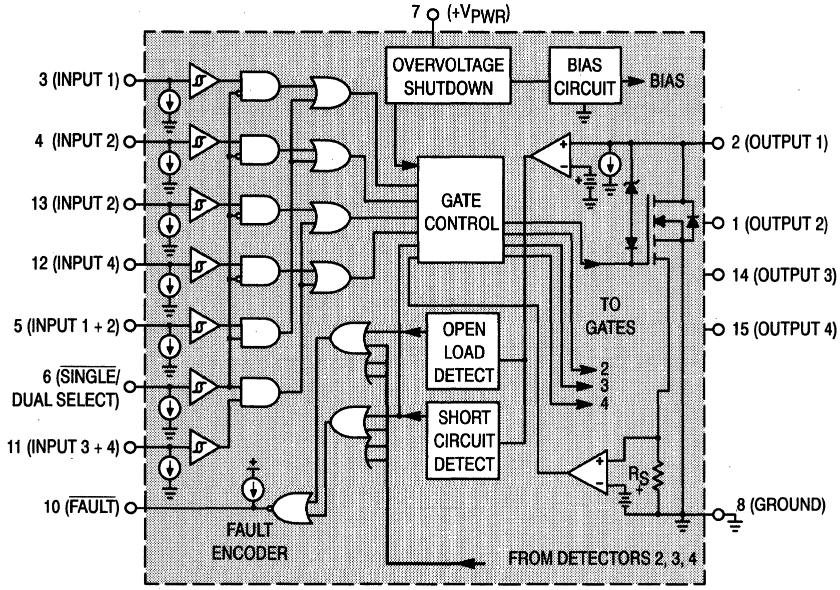
Function	Features	Suffix/ Case	Device
Low Side Protected Switch	Single automotive low side switch having CMOS compatible input, 1.0 A maximum rating, with overcurrent, overvoltage, and thermal protection.	T/221, T-1/314D, DW/751G	MC3392
High Side Driver Switch	Drives loads from positive side of power supply and protects against high-voltage transients.	T/314D	MC3399
High Side TMOS Driver	Designed to drive and protect N-channel power MOSFETs used in high side switching applications. Has internal charge pump, externally programmed timer, and fault reporting.	P/626, D/751	MC33091
MI-Bus Interface Stepper Motor Controller	High noise immunity serial communication using MI-Bus protocol to control relay drivers and motors in harsh environments. Four phase signals drive two phase motors in either half or full-step modes.	DW/751G	MC33192
Quad Fuel Injector Driver	Four low side switches with parallel CMOS compatible input control, $\leq$ 7.0 mA quiescent current, 0.25 Ω $r_{ds(on)}$ at 25°C independent outputs with 3.0 A current limiting and internal 65 V clamps.	T/821C-02	MC33293
Quad Fuel Injector Driver	Four low side switches with parallel CMOS compatible input control, $\leq$ 5.0 mA quiescent current, 0.7 Ω $r_{ds(on)}$ at 25°C independent outputs with 3.0 A current limiting and internal 65 V clamps.	T/821C-02	MC33295
Octal Serial Output Switch	Eight low side switches having 8-bit serial CMOS compatible input control, serial fault reporting, $\leq$ 4.0 mA quiescent current, independent 0.45 Ω $r_{ds(on)}$ at 25°C outputs with 3.0 A minimum current limiting and internal 55 V clamps.	P/738	MC33298
Integral Alternator Regulator	Control device used in conjunction with an MCCF33096 Darlington companion device to monitor and control the field current in alternator charging systems. “Bumped” die for inverted mounting to substrate.	Flip-Chip	MCCF33095
Darlington Drive Chip	Darlington companion device for MC33095 used to control the field current in alternator charging systems. “Bumped” die for inverted mounting to substrate.	Flip-Chip	MCCF33096
Peripheral Clamping Array	Protects up to six MPU I/O lines against voltage transients.	D/751	TCF6000
Automotive Direction Indicator	Detects defective lamps and protects against overvoltage and short circuit hazards in automotive turn-signal applications. Replaces UAA1041 with improved noise immunity.	P/626, D/751	UAA1041B

Quad Fuel Injector Driver

MC33293T

T_J = –40° to +150°C, Case 821C

The MC33293T is a monolithic quad low-side switching device having CMOS logic, bipolar/ CMOS analog circuitry, and DMOS power FETs. All inputs are CMOS compatible. Each independent output is internally clamped to 65 V, current limited to ≥ 3.0 A, and has an $r_{ds(on)}$ of ≤ 0.25 Ω with V_{PWR} ≥ 9.0 V and may be paralleled to lower $r_{ds(on)}$. $\overline{\text{Fault}}$ output reports existence of open loads (outputs On or Off), shorted loads, and over temperature condition of outputs. A shorted load condition will shut off only the specific output involved while allowing other outputs to operate normally. An overvoltage condition will shut off all outputs for the overvoltage duration. A single/dual mode select pin allows either independent input/output operation or paired output operation.

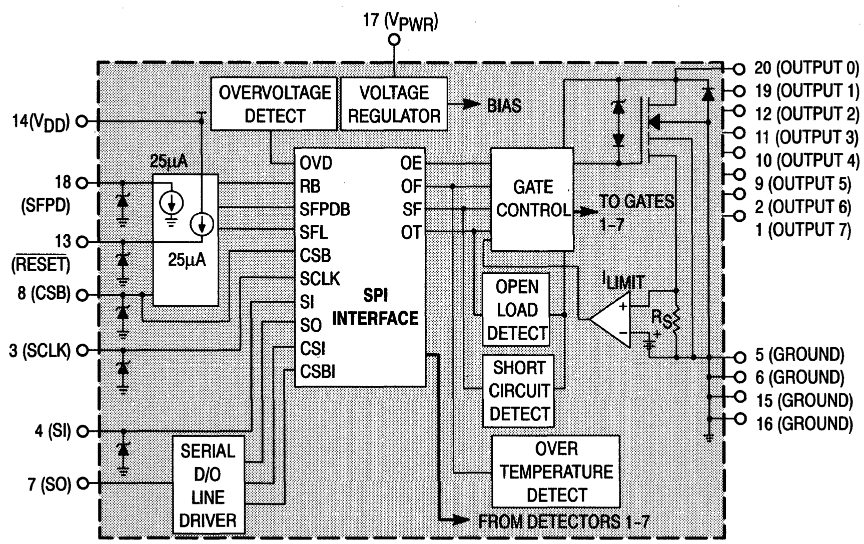


Octal Serial Switch

MC33298P

T_J = –40° to +150°C, Case 738

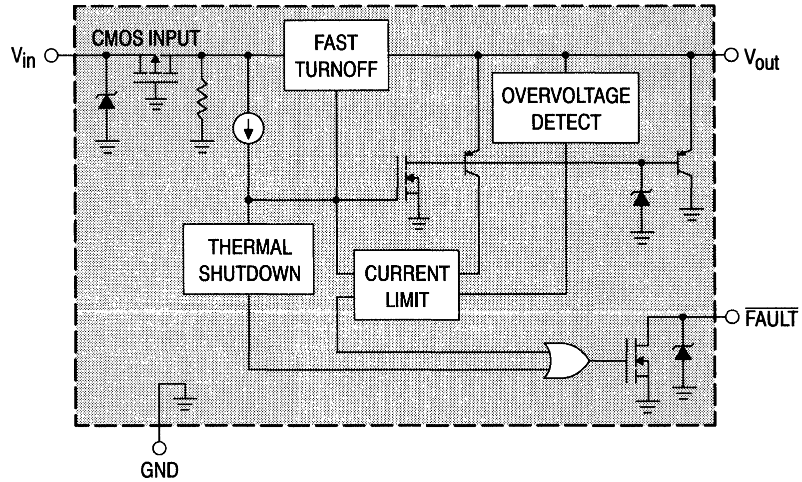
The MC33298P is a monolithic eight output low-side switch with 8-bit serial input control. Incorporates CMOS logic, bipolar/ CMOS analog circuitry, and DMOS power FETs. All inputs are CMOS compatible. It is designed to interface to a microcontroller and switch inductive or incandescent loads. Each independent output is internally clamped to 55 V, current limited to ≥ 3.0 A, and has an $r_{ds(on)}$ of ≤ 0.45 Ω with V_{PWR} ≥ 9.0 V. This device has low standby current, cascadable fault status reporting, output diagnostics, and shutdown for each output.



Low Side Protected Switch

MC3392T, T-1,DW
T_J = –40° to +150°C,
Case 221A, 314D, 751G

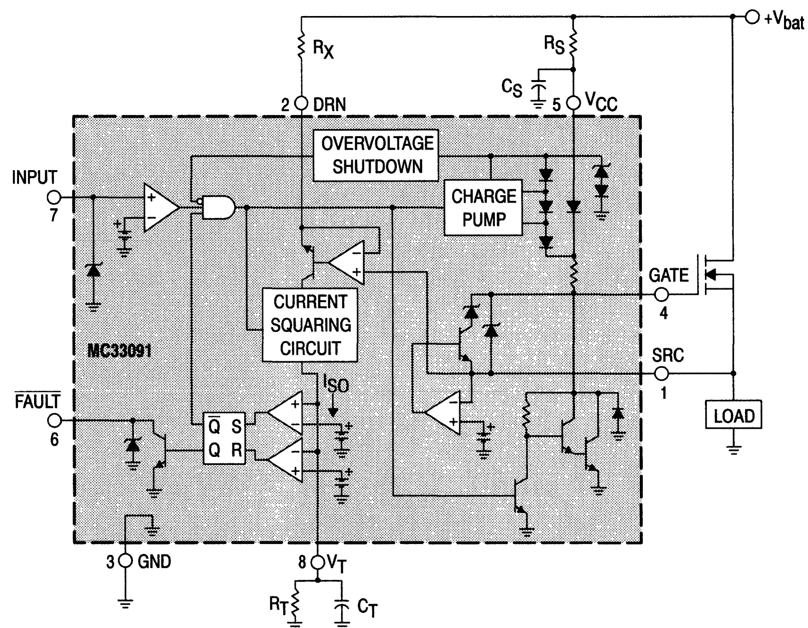
Single low side protected switch with fault reporting capability. Input is CMOS compatible. Output is short circuit protected to 1.0 A minimum with a unique current fold-back feature. Device has internal output clamp for driving inductive loads with over current, overvoltage, and thermal protection. When driving a moderate load, the MC3392 performs as an extremely high gain, low saturation Darlington transistor having a CMOS input characteristic with added protection features. In some applications, the three terminal version can replace industry standard TIP100/101 NPN power Darlington transistors.



High Side TMOS Driver

MC33091P, D
T_J = –40° to +150°C, Case 626, 751

Offers an economical solution to drive and protect N-channel power TMOS devices used in high side switching configurations. Unique device monitors load resulting V_{DS}. TMOS voltage to produce a proportional current used to drive an externally programmed over current timer circuit to protect the TMOS device from shorted load conditions. Timer can be programmed to accommodate driving incandescent loads. Few external components required to drive a wide variety of N-channel TMOS devices. A Fault output is made available through the use of an open collector NPN transistor requiring a single pull-up resistor for operation. Input is CMOS compatible. Device uses ≤ 3.0 μA standby current and has an internal charge pump requiring no external components for operation.

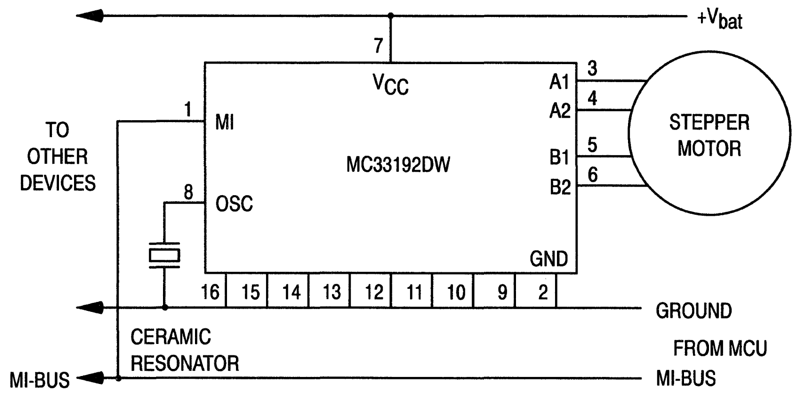


MI-Bus Interface Stepper Motor Controller

MC33192DW

T_J = –40° to +100°C, Case 751G

Intended to control loads in harsh automotive environments using a serial communication bus. Can provide satisfactory real time control of up to eight stepper motors using MI-Bus protocol. Use of MI-Bus offers a noise immune system solution for difficult applications involving relays and motors. The stepper motor controller provides four phase signals to drive two phase motors in either half of full-step modes. Designed to interface to a microprocessor with minimal amount of wiring, affording an economical and versatile system.

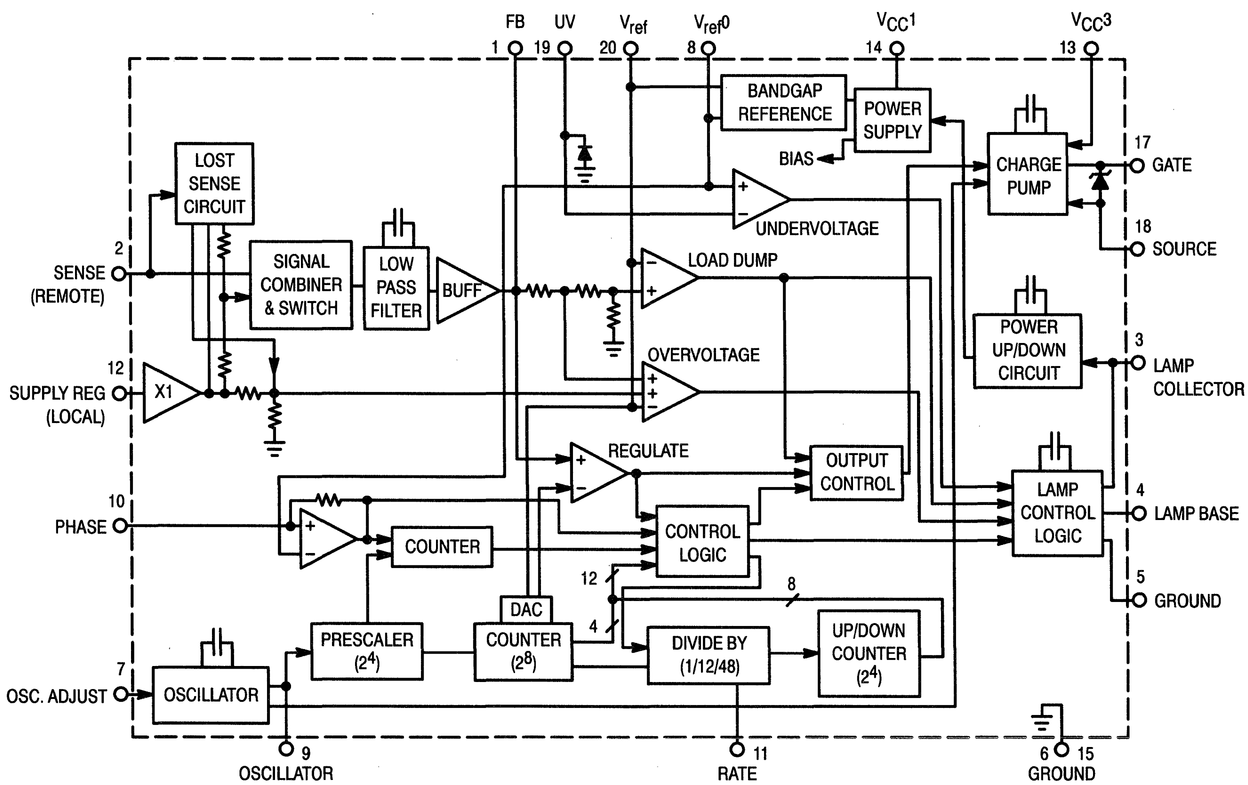


Alternator Voltage Regulator

MC33092DW

T_J = –40° to +125°C, Case 751D

Provides voltage regulation and load response control in diode rectified 12 V alternator charging systems. Provides externally programmed load response control of the alternator output current to eliminate engine speed hunting and vibration due to sudden electrical loads. Monitors and compares the system battery voltage to an externally programmed set point value and pulse width modulates an N-channel MOSFET transistor to control the average alternator field current. In addition, has duty cycle limiting, under/overvoltage and phase detection (broken belt) protective features.



Other Linear Circuits

In Brief . . .

A variety of other analog circuits are provided for special applications with both bipolar and CMOS technologies. These circuits range from the industry standard analog timing circuits and multipliers to specialized CMOS smoke detectors. These products provide key functions in a wide range of applications, including data transmission, commercial smoke detectors, and various industrial controls.

Timing Circuits

These highly stable timers are capable of producing accurate time delays or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the free-running frequency and the duty cycle are both accurately controlled with two external resistors and one capacitor. The output structure can source or sink up to 200 mA or drive TTL circuits. Timing intervals from microseconds through hours can be obtained. Additional terminals are provided for triggering or resetting if desired.

Singles

MC1455P1,U,D

T_A = 0° to +70°C, Case 626, 693, 751

MC1455BP1

T_A = –40° to +85°C, Case 626

Duals

MC3456L,P

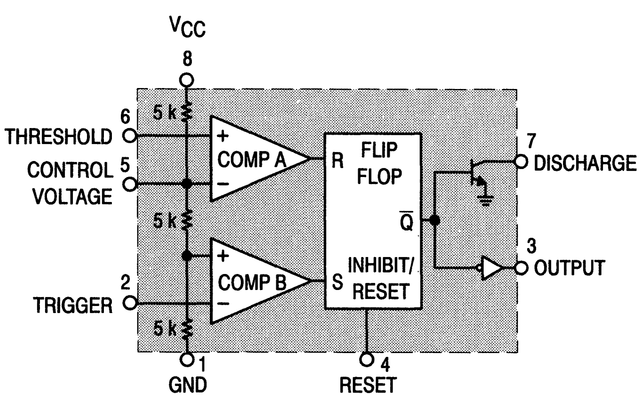
T_A = 0° to +70°C, Case 632, 646

NE556A,N

T_A = 0° to +70°C, Case 646

NE556D

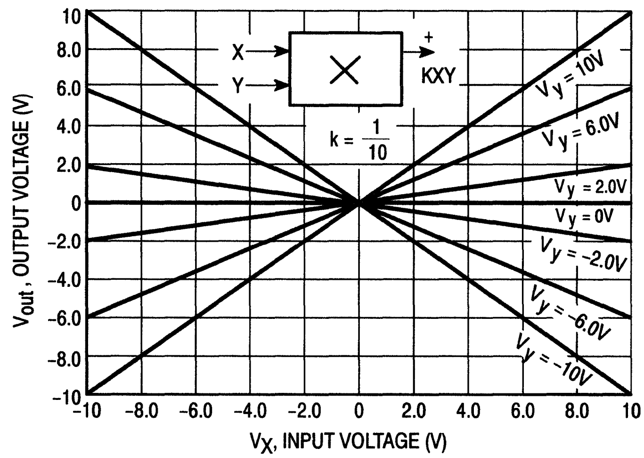
T_A = 0° to +70°C, Case 751



Multipliers

Linear Four-Quadrant Multipliers

Multipliers are designed for use where the output voltage is a linear product of two input voltages. Typical applications include: multiply, divide, square, root-mean-square, phase detector, frequency doubler, balanced modulator/demodulator, electronic gain control.



MC1594L

T_A = –55° to +125°C, Case 620

MC1494L

T_A = 0° to +70°C, Case 620

The MC1594/MC1494 is a variable transconductance multiplier with internal level-shift circuitry and voltage regulator. Scale factor, input offsets and output offset are completely adjustable with the use of four external potentiometers. Two complementary regulated voltages are provided to simplify offset adjustment and improve power supply rejection.

MC1595L

T_A = –55° to +125° C, Case 632

MC1495L

T_A = 0° to +70° C, Case 632

These devices are designed for uses where the output is a linear product of two input voltages. Maximum versatility is assured by allowing the user to select the level shift method. Typical applications include: multiply, divide(1), square root(1), mean square(1), phase detector, frequency doubler, balanced modulator/demodulator, and electronic gain control.

(1)When used with an operational amplifier.

Smoke Detectors (CMOS)

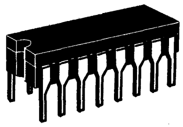
These smoke detector ICs require a minimum number of external components. When smoke is sensed, or a low battery voltage is detected, an alarm is sounded via an external piezoelectric transducer. All devices are designed to comply with UL specifications.

Table 65. Smoke Detectors (CMOS)

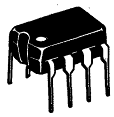
Function	Recommended Power Source	Unique Feature	Low Battery Detector	Piezoelectric Horn Driver	Complies with UL217 and UL268	Device Number	Suffix/ Case
Ionization-Type Smoke Detector	Battery	High Input Impedance FET Comparator	✓	✓	✓	MC14467-1	P1/626
	Line		—	—	✓	MC14578	P/648
Ionization-Type Smoke Detector with Interconnect	Battery		✓	✓	✓	MC14468	
	Line		—	✓	✓	MC14470	
Photoelectric-Type Smoke Detector with Interconnect	Battery	Photo Amplifier	✓	✓	✓	MC145010	P/648 DW/751G
	Line		(1)	✓	✓	MC145011	

(1)Low-supply detector

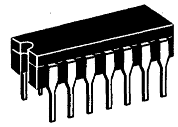
Other Linear Circuits Package Overview



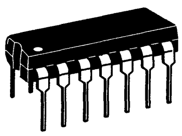
CASE 620
CERAMIC
L SUFFIX



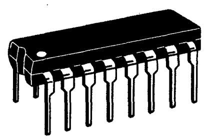
CASE 626
PLASTIC
P1 SUFFIX



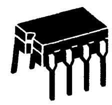
CASE 632
CERAMIC
L SUFFIX



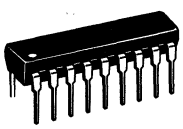
CASE 646
PLASTIC
P SUFFIX



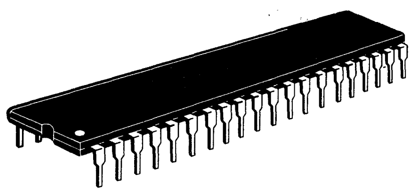
CASE 648
PLASTIC
P SUFFIX



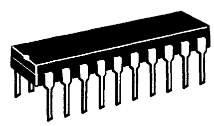
CASE 693
CERAMIC
U SUFFIX



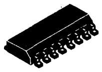
CASE 707
PLASTIC
P SUFFIX



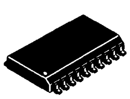
CASE 711
PLASTIC
P SUFFIX



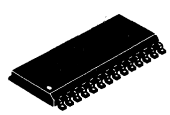
CASE 738
PLASTIC
P SUFFIX



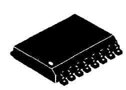
CASE 751B
PLASTIC
D SUFFIX



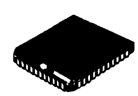
CASE 751D
PLASTIC
DW SUFFIX



CASE 751F
PLASTIC
DW SUFFIX



CASE 751G
PLASTIC
DW SUFFIX



CASE 777
PLASTIC (PLCC)
FN SUFFIX

Surface Mount Technology

In Brief . . .

Surface Mount Technology is now being utilized to offer answers to many problems that have been created in the use of Insertion Technology.

Limitations have been reached with insertion packages and PC board technology. Surface Mount Technology offers the opportunity to continue to advance state-of-the-art designs that cannot be accomplished with Insertion Technology.

Surface Mount packages allow more optimum device performance with the smaller Surface Mount configuration. Internal lead lengths, parasitic capacitance and inductance that placed limitations on chip performance, has been reduced.

The lower profile of Surface Mount packages allows more boards to be utilized in a given amount of space. They are stacked closer together and utilize less total volume than insertion populated PC boards.

Printed circuit costs are lowered with the reduction of the number of board layers required. The elimination or reduction of the number of plated-through-holes in the board, contribute significantly to lower PC board prices.

Surface Mount assembly does not require the preparation of components that are common on insertion technology lines. Surface Mount components are set directly to the assembly line, eliminating an intermediate step.

Automatic placement equipment is available that can place Surface Mount components at the rate of a few thousand per hour to hundreds of thousands of components per hour.

Surface Mount Technology is cost effective, allowing the manufacturer the opportunity to produce smaller units and offer increased functions with the same size product.

Page

Linear and Interface

Table 66. Bipolar

All the major bipolar analog families are now represented in surface mount packaging. Standard SOIC and PLCC packages are augmented by SOP-8 and DPAK for Linear regulators. In addition, tape and reel shipping to the updated EIA-481A is now on line for the industry's largest array of operational amplifiers, regulators, interface, data conversion, consumer, telecom and automotive Linear ICs.

Device	Function	Package
CA3146D	Transistor Array	SO-14
DAC-08CD, ED	High-Speed 8-Bit Multiplying D-to-A Converter	SO-16
LF351D	Single JFET Operational Amplifier	SO-8
LF353D	Dual JFET Operational Amplifiers	SO-8
LF411CD	Single/Dual JFET Operational Amplifier	SO-8
LF412CD	Dual JFET Operational Amplifiers	SO-8
LF441CD	Single JFET Low Power Operational Amplifier	SO-8
LF442CD	Dual JFET Low Power Operational Amplifiers	SO-8
LF444CD	Quad JFET Low Power Operational Amplifiers	SO-14
LM201AD	General Purpose Adjustable Operational Amplifier	SO-8
LM211D	High Performance Voltage Comparator	SO-8
LM224D	Quad Low Power Operational Amplifiers	SO-14
LM239D,AD	Quad Single Supply Comparators	SO-14
LM258D	Dual Low Power Operational Amplifiers	SO-8
LM285D-1.2	Micropower Voltage Reference Diode	SO-8
LM285D-2.5	Micropower Voltage Reference Diode	SO-8
LM293D	Dual Comparators	SO-8
LM301AD	General Purpose Adjustable Operational Amplifier	SO-8
LM311D	High Performance Voltage Comparator	SO-8
LM317LD	Positive Adjustable 100 mA Voltage Regulator	SOP-8
LM317MDT	Positive Adjustable 500 mA Voltage Regulator	DPAK
LM324D,AD	Quad Low Power Operational Amplifiers	SO-14
LM339D,AD	Quad Single Supply Comparators	SO-14
LM348D	Quad MC1741 Operational Amplifiers	SO-14
LM358D	Dual Low Power Operational Amplifiers	SO-8
LM385D-1.2	Micropower Voltage Reference Diode	SO-8
LM385D-2.5	Micropower Voltage Reference Diode	SO-8
LM393D	Dual Comparators	SO-8
LM833D	Dual Audio Amplifiers	SO-8
LM2901D	Quad Single Supply Comparators	SO-14
LM2902D	Quad Low Power Operational Amplifiers	SO-14
LM2903D	Dual Comparators	SO-8
LM2904D	Dual Low Power Operational Amplifiers	SO-8
LM2931AD-5.0,D-5.0	Low Dropout Voltage Regulator	SOP-8
LM2931CD	Adjustable Low Dropout Voltage Regulator	SOP-8
LM3900D	Quad Single Supply Operational Amplifiers	SO-14
MC1350D	IF Amplifier	SO-8
MC1357D	FM IC with Quadrature Detector	SO-14
MC1377DW	Color Television RGB to PAL/NTSC Encoder	SO-20L
MC1378FN	Video Overlay Synchronizer	PLCC-44
MC1382DW	Multimode Monitor TTL To Analog Video	SO-24L
MC1403D	Precision Low Voltage Reference	SO-8
MC1413D	Peripheral Driver Array	SO-16
MC1436D,CD	High Voltage Operational Amplifier	SO-8
MC1455D	Timing Circuit	SO-8
MC1458D,CD	Dual Operational Amplifiers	SO-8
MC14C88BD	Quad EIA-232-D/EIA-562 Drivers	SO-14
MC1488D	Quad EIA-232-D Drivers	SO-14

Table 66. Bipolar (continued)

Device	Function	Package
MC14C89ABD,BD	Quad EIA-232-D/EIA-562 Receivers	SO-14
MC1489D	Quad EIA-232-D Receivers	SO-14
MC1495D	Four-Quadrant Multiplier	SO-14
MC1496D	Balanced Modulator/Demodulator	SO-14
MC1723CD	Adjustable Positive or Negative Voltage Regulator	SO-14
MC1741CD	General Purpose Operational Amplifier	SO-8
MC1747CD	Dual MC1741 Operational Amplifiers	SO-14
MC1776CD	Programmable Operational Amplifier	SO-8
MC26LS31D	Quad EIA-422/23 Drivers	SO-16
MC26LS32D	Quad EIA-422 Receivers	SO-16
MC26S10D	Quad Bus Transceiver	SO-16
MC2831AD	FM Transmitter	SO-16
MC3303D	Quad Differential-Input Operational Amplifier	SO-14
MC3335DW	Basic Dual Conversion Receiver	SO-20L
MC3346D	General Purpose Transistor Array	SO-14
MC3356DW	FSK Receiver	SO-20L
MC3359DW	Low Power Narrowband FM IF Amplifier	SO-20L
MC3361AD	Low Voltage Narrowband FM IF Amplifier	SO-16
MC3362DW	Dual Conversion Receivers	SO-28L
MC3363DW	Dual Conversion Receivers	SO-28L
MC3367DW	Low Voltage VHF Receiver	SO-28L
MC3371D	Low Voltage FM Receiver with RSSI, LC Quadrature Detector	SO-16
MC3372D	Low Voltage FM Receiver with RSSI, Ceramic Quadrature Detector	SO-16
MC3391DW	Low Side Protected Switch	SOP-8+8L
MC3401D	Quad Operational Amplifiers	SO-14
MC3403D	Quad Differential-Input Operational Amplifier	SO-14
MC3418DW	CVSD	SO-16L
MC3423D	Overvoltage Sensing Circuit	SO-8
MC3448AD	Quad GPIB Transceivers	SO-16
MC3450D	Quad Line Receivers	SO-16
MC3452D	Quad Line Receivers	SO-16
MC3456D	Dual Timing Circuit	SO-14
MC3458D	Dual Low Power Operational Amplifiers	SO-8
MC3486D	Quad EIA-422/23 Receivers	SO-16
MC3487D	Quad EIA-422 Drivers	SO-16
MC4558CD	Dual High Frequency Operational Amplifiers	SO-8
MC4741CD	Quad MC1741 Operational Amplifiers	SO-14
MC78L05ACD	Positive Voltage Regulator, 5 V, 100 mA	SOP-8
MC78L08ACD	Positive Voltage Regulator, 8 V, 100 mA	SOP-8
MC78L12ACD	Positive Voltage Regulator, 12 V, 100 mA	SOP-8
MC78L15ACD	Positive Voltage Regulator, 15 V, 100 mA	SOP-8
MC78M05CDT	Positive Voltage Regulator, 5 V, 500 mA	DPAK
MC78M08CDT	Positive Voltage Regulator, 8 V, 500 mA	DPAK
MC78M12CDT	Positive Voltage Regulator, 12 V, 500 mA	DPAK
MC78M15CDT	Positive Voltage Regulator, 15 V, 500 mA	DPAK
MC79L05ACD	3-Terminal Negative Fixed Voltage Regulator, –5 V, 100 mA	SOP-8
MC79L12ACD	3-Terminal Negative Fixed Voltage Regulator, –12 V, 100 mA	SOP-8
MC79L15ACD	3-Terminal Negative Fixed Voltage Regulator, –15 V, 100 mA	SOP-8
MC79M05CDT	3-Terminal Negative Fixed Voltage Regulator, –5 V, 500 mA	DPAK
MC79M12CDT	3-Terminal Negative Fixed Voltage Regulator, –12 V, 500 mA	DPAK
MC79M15CDT	3-Terminal Negative Fixed Voltage Regulator, –15 V, 500 mA	DPAK
MC10319DW	8-Bit A/D Flash Converter	SO-24L
MC10321DW	7-Bit A/D Flash Converter	SO-20L
MC13022DW(1)	Medium Voltage AM Stereo C-QUAM® Decoder	SO-28L

(1)To be introduced.

Table 66. Bipolar (continued)

Device	Function	Package
MC13024DW	Low Voltage C-QUAM® Receiver	SO-24L
MC13055D	VHF LAN Receiver — FSK	SO-16
MC13060D	1 Watt Audio Amplifier	SOP-8
MC33023DW,FN	High Speed (1.0 MHz) Single-Ended PWM Controller	SO-16L, PLCC-20
MC33025DW,FN	High Speed (1.0 MHz) Double-Ended PWM Controller	SO-16L, PLCC-20
MC33033DW	Brushless DC Motor Controller	SO-20L
MC33035DW	Brushless DC Motor Controller	SO-24L
MC33039D	Closed Loop Brushless Motor Adaptor (5 V ± 5% Supply)	SO-8
MC33060AD	Precision Switchmode Pulse Width Modulator	SO-14
MC33064D-5	Undervoltage Sensing Circuit	SO-8
MC33065DW	Dual Current Mode PWM Controller	SO-16L
MC33065DW-H	Dual Current Mode PWM Controller (Off-Line)	SO-16L
MC33065DW-L	Dual Current Mode PWM Controller (DC-to-DC Converters)	SO-16L
MC33066DW	Resonant Mode (ZCS) Controller	SO-16L
MC33067DW	Resonant Mode (ZVS) Controller	SO-16L
MC33071D,AD	Single, High Speed Single Supply Operational Amplifiers	SO-8
MC33072D,AD	Dual, High Speed Single Supply Operational Amplifiers	SO-8
MC33074D,AD	Quad, High Speed Single Supply Operational Amplifiers	SO-14
MC33076D	Dual High Output Current Operational Amplifiers	SO-8
MC33077D	Dual, Low Noise High Frequency Operational Amplifiers	SO-8
MC33078D	Dual Audio, Low Noise Operational Amplifiers	SO-8
MC33079D	Low Power, Single Supply Operational Amplifier	SO-14
MC33091D	High Side TMOS Driver	SO-8
MC33102D	Sleep-Mode™ 2-State, μProcessor Operational Amplifier	SO-8
MC33110D	Low Voltage Compander	SO-14
MC33120FN	SLIC II	PLCC-28
MC33121FN	Low Voltage Subscriber Loop Interface Circuit	PLCC-28
MC33129D	High Performance Current Mode Controller	SO-14
MC33151D	Dual Inverting MOSFET Drivers	SO-8
MC33152D	Dual Noninverting MOSFET Drivers	SO-8
MC33161D	Universal Voltage Monitor	SO-8
MC33164D-3	Micropower Undervoltage Sensing Circuit (3 V ± 5% Supply)	SO-8
MC33164D-5	Micropower Undervoltage Sensing Circuit (5 V ± 10% Supply)	SO-8
MC33171D	Single, Low Power, Single Supply Operational Amplifier	SO-8
MC33172D	Dual, Low Power, Single Supply Operational Amplifiers	SO-8
MC33174D	Quad, Low Power, Single Supply Operational Amplifiers	SO-14
MC33178D	Dual Precision Operational Amplifiers	SO-8
MC33179D	Quad Precision Operational Amplifiers	SO-14
MC33218DW	Voice-Switched Speakerphone with μProcessor Interface	SO-24L
MC33261D	Power Factor Controller	SO-8
MC33272D	Dual Precision Bipolar Operational Amplifiers	SO-8
MC33274D	Quad Precision Bipolar Operational Amplifiers	SO-14
MC33282D	Dual Precision Low Input JFET Operational Amplifiers (Trim-in-the-Package)	SO-8
MC33284D	Quad Precision JFET Operational Amplifiers (Trim-in-the-Package)	SO-14
MC34001D,BD	Single JFET Input Operational Amplifier	SO-8
MC34002D,BD	Dual JFET Input Operational Amplifiers	SO-8
MC34010FN	Electronic Telephone Circuit	PLCC-44
MC34012-1D	Telephone Tone Ringer	SO-8
MC34012-2D	Telephone Tone Ringer	SO-8
MC34012-3D	Telephone Tone Ringer	SO-8
MC34014DW	Telephone Speech Network with Dialer Interface	SO-20L
MC34017-1D	Telephone Tone Dialer	SO-8
MC34017-2D	Telephone Tone Dialer	SO-8
MC34017-3D	Telephone Tone Dialer	SO-8
MC34018DW	Voice Switched Speakerphone Circuit	SO-28L
MC34023DW,FN	High Speed (1.0 MHz) Single-Ended PWM Controller	SO-16L, PLCC-20

Table 66. Bipolar (continued)

Device	Function	Package
MC34025DW,FN	High Speed (1.0 MHz) Double-Ended PWM Controller	SO-16L, PLCC-20
MC34050D	EIA-422/23 Transceivers	SO-16
MC34051D	EIA-422/23 Transceivers	SO-16
MC34060AD	Switchmode Pulse Width Modulation Control Circuit	SO-14
MC34063AD	Precision DC-to-DC Converter Control Circuit	SO-8
MC34064D-5	Undervoltage Sensing Circuit (5 V ± 5% Supply)	SO-8
MC34065DW	Dual Current Mode PWM Controller	SO-16L
MC34065DW-H	Dual Current Mode PWM Controller (Off-Line)	SO-16L
MC34065DW-L	Dual Current Mode PWM Controller (DC-to-DC Converter)	SO-16L
MC34066DW	Resonant Mode (ZCS) Controller	SO-16L
MC34067DW	Resonant Mode (ZVS) Controller	SO-16L
MC34071D,AD	Single, High Speed, Single Supply Operational Amplifier	SO-8
MC34072D,AD	Dual, High Speed, Single Supply Operational Amplifiers	SO-8
MC34074D,AD	Quad, High Performance, Single Supply Operational Amplifiers	SO-14
MC34080D	High Speed Decompensated ($A_{VCL} \geq 2$) JFET Input Operational Amplifier	SO-8
MC34081D	High Speed JFET Input Operational Amplifier	SO-8
MC34084DW,ADW	Quad High Speed, JFET Operational Amplifier	SO-16L
MC34085DW,ADW	Quad High Speed, JFET Operational Amplifier	SO-16L
MC34114DW	Speech Network II	SO-18L
MC34115DW	CVSD	SO-16L
MC34118DW	Speakerphone II	SO-28L
MC34119D	Telephone Speaker Amplifier	SO-8
MC34129D	Power Supply Controller	SO-14
MC34151D	Dual Inverting MOSFET Drivers	SO-8
MC34152D	Dual Noninverting MOSFET Drivers	SO-8
MC34161D	Universal Voltage Monitor	SO-8
MC34164D-3	Micropower Undervoltage Sensing Circuit (3 V ± 5% Supply)	SO-8
MC34164D-5	Micropower Undervoltage Sensing Circuit (5 V ± 10% Supply)	SO-8
MC34181D	Single, Low Power, High Speed JFET Operational Amplifier	SO-8
MC34182D	Dual, Low Power, High Speed JFET Operational Amplifiers	SO-8
MC34184D	Quad, Low Power, High Speed JFET Operational Amplifiers	SO-14
MC34217D	Adjustable Toner Ringer	SO-8
MC34261D	Power Factor Controller	SO-8
MC44301DW	High Performance Video IF	SO-28L
MC75172BDW	Quad EIA-485 Line Drivers w/3-State Outputs	SO-20L
MC75174BDW	Quad EIA-485 Line Drivers w/3-State Outputs	SO-20L
NE556D	Dual Timing Circuit	SO-14
TL064CD	Quad JFET Low Power Operational Amplifiers	SO-14
TL071CD,ACD	Single, Low Noise JFET Input Operational Amplifier	SO-8
TL072CD,ACD	Dual, Low Noise JFET Input Operational Amplifiers	SO-8
TL081CD,ACD	Single, JFET Input Operational Amplifier	SO-8
TL082CD,ACD	Dual, JFET Input Operational Amplifiers	SO-8
TL431ACD,AID,CD,ID	Programmable Precision Reference	SOP-8
UAA1041D	Automotive Direction Indicator	SO-8
UC2842AD, BD, BD1	Off-Line Current Mode PWM Controller	SO-14, SO-8
UC2843AD, BD, BD1	Current Mode PWM Controller	SO-14, SO-8
UC2844D, BD, BD1	Off-Line Current Mode PWM Controller (DC ≤ 50%)	SO-14, SO-8
UC2845D, BD, BD1	Current Mode PWM Controller (DC ≤ 50%)	SO-14, SO-8
UC3842AD, BD, BD1	Off-Line Current Mode PWM Controller	SO-14, SO-8
UC3843AD, BD, BD1	Current Mode PWM Controller	SO-14, SO-8
UC3844D, BD, BD1	Off-Line Current Mode PWM Controller (DC ≤ 50%)	SO-14, SO-8
UC3845D, BD, BD1	Current Mode PWM Controller (DC ≤ 50%)	SO-14, SO-8

Table 67. MOS Digital-Analog

Device	Function	Package
A/D and D/A Converters		
MC14433DW	3-1/2 Digit A/D Converter	SO-24L
MC14442FN	11-Channel 8-Bit A/D Converter with Parallel Interface	PLCC-28
MC14443DW	6-Channel A/D Converter Subsystem	SO-16L
MC14447DW	6-Channel A/D Converter Subsystem	SO-16L
MC44250FN	Triple 8-Bit Video A/D Converter	PLCC-44
MC144110DW	Hex D/A Converter with Serial Interface	SO-20L
MC144111DW	Quad D/A Converter with Serial Interface	SO-16L
MC145040FN1(2)	11-Channel, 8-Bit A/D Converter with Serial Interface	PLCC-20
MC145040FN2(2)	11-Channel, 8-Bit A/D Converter with Serial Interface	PLCC-20
MC145041FN1(2)	11-Channel, 8-Bit A/D Converter with Serial Interface	PLCC-20
MC145041FN2(2)	11-Channel, 8-Bit A/D Converter with Serial Interface	PLCC-20
MC145050DW	11-Channel, 10-Bit A/D Converter with Serial Interface	SO-20L
MC145051DW	11-Channel, 10-Bit A/D Converter with Serial Interface	SO-20L
MC145053D	11-Channel, 10-Bit A/D Converter with Serial Interface	SO-14
Display Drivers		
MC14489DW	Multi-Character LED Display/Lamp Driver	SO-20L
MC14495DW1(2)	Hex-to-7 Segment Latch/Decoder ROM/Driver	SO-16L
MC14499DW	7-Segment LED Display Decoder/Driver with Serial Interface	SO-20L
MC145000FN	48-Segment Multiplexed LCD Driver (Master)	PLCC-28
MC145001FN	44-Segment Multiplexed LCD Driver (Slave)	PLCC-28
MC145453FN	33-Segment LCD Driver with Serial Interface	PLCC-44
Operational Amplifiers/Comparators		
MC14573D	Quad Programmable Operational Amplifier	SO-16
MC14574D	Quad Programmable Comparator	SO-16
MC14575D	Dual Programmable Operational Amplifier and Dual Comparator	SO-16
MC14576BF	Dual Video Amplifier	SO-8 (EIAJ)
MC14577BF	Dual Video Amplifier	SO-8 (EIAJ)
MC14578D	Micro-Power Comparator Plus Voltage Follower	SO-16
Phase-Locked Loop Frequency Synthesizers		
MC145106FN	PLL Frequency Synthesizer	PLCC-20
MC145145DW1	4-Bit Data Bus Input PLL Frequency Synthesizer	SO-20L
MC145146DW1	4-Bit Data Bus Input PLL Frequency Synthesizer	SO-20L
MC145149DW	Serial Input Dual PLL Frequency Synthesizer	SO-20L
MC145151DW2	Parallel Input PLL Frequency Synthesizer	SO-28L
MC145151FN2	Parallel Input PLL Frequency Synthesizer	PLCC-28
MC145152DW2	Parallel Input PLL Frequency Synthesizer	SO-28L
MC145152FN2	Parallel Input PLL Frequency Synthesizer	PLCC-28
MC145155FN2	Serial Input PLL Frequency Synthesizer	PLCC-20
MC145155DW2	Serial Input PLL Frequency Synthesizer	SO-20L
MC145156FN2	Serial Input PLL Frequency Synthesizer	PLCC-20
MC145156DW2	Serial Input PLL Frequency Synthesizer	SO-20L
MC145157FN2	Serial Input PLL Frequency Synthesizer	PLCC-20
MC145157DW2	Serial Input PLL Frequency Synthesizer	SO-16L
MC145158FN2	Serial Input PLL Frequency Synthesizer	PLCC-20
MC145158DW2	Serial Input PLL Frequency Synthesizer	SO-16L
MC145159DW1	Serial Input PLL Frequency Synthesizer with Analog Phase Detector	SO-20L
MC145159FN(3)	Serial Input PLL Frequency Synthesizer with Analog Phase Detector	PLCC-20
MC145160DW	Dual PLL for Cordless Telephones	SO-20L
MC145161DW	Dual PLL for Cordless Telephones	SO-16L
MC145166DW	Dual PLL for Cordless Telephones	SO-16L
MC145167DW	Dual PLL for Cordless Telephones	SO-16L
MC145168DW	Dual PLL for Cordless Telephones	SO-16L
MC145170D	Serial Interface PLL Frequency Synthesizer	SO-16

(2)The digit 1 or 2 after the package designator is not a part of the package definition, but describes electrical capability of the device
(3)Electrical variations may require a numerical suffix after the package suffix. Contact your Motorola representative for details.

Table 67. MOS Digital-Analog (continued)

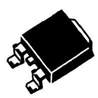
Device	Function	Package
Remote Control Functions		
MC14469FN	Addressable Asynchronous Receiver/Transmitter	PLCC-44
MC14497	PCM Remote Control Transmitter	(4)
MC145026D	Remote Control Encoder	SO-16
MC145027DW	Remote Control Decoder	SO-16L
MC145028DW	Remote Control Decoder	SO-16L
MC145030DW	Remote Control Encoder/Decoder	SO-20
MC145033DW	Remote Control Encoder/Decoder	SO-28L
MC145034DW	Remote Control Encoder	SO-28L
MC145035DW	Remote Control Decoder	SO-28L
Smoke Detectors		
MC14467	Low-Cost Smoke Detector	(4)
MC14468	Interconnectable Smoke Detector	(4)
MC145010DW	Photoelectric Smoke Detector with I/O	SO-16L
MC145011DW	Photoelectric Smoke Detector with I/O	SO-16L
Telecommunications Devices		
MC14410DW	2-of-8 Tone Encoder	SO-16L
MC14411DW	Bit Rate Generator	SO-24L
MC142100DW	Crosspoint Switch with Control Memory (4 × 4 × 1)	SO-16L
MC142103	Transcoder HDB31 AMI to NRZ	(4)
MC143403D	Quad Line Driver (Op Amp)	SO-14
MC145403DW	EIA-232/V.28 CMOS Driver/Receiver	SO-20L
MC145404DW	EIA-232/V.28 CMOS Driver/Receiver	SO-20L
MC145405DW	EIA-232/V.28 CMOS Driver/Receiver	SO-20L
MC145406DW	EIA-232/V.28 CMOS Driver/Receiver	SO-16L
MC145407DW	EIA-232/V.28 CMOS Driver/Receiver, 5.0 V Only	SO-20L
MC145408DW	EIA-232/V.28 CMOS Driver/Receiver	SO-20L
MC145412	Pulse/Tone Repertory Dialer (Nine 18-Digit Memory)	(4)
MC145416DW	Pulse/Tone Repertory Dialer (13 18-Digit Memory)	SO-20L
MC145421DW	UDLT II Master	SO-24L
MC145422DW	UDLT Master	SO-24L
MC145425DW	UDLT II Slave	SO-24L
MC145426DW	UDLT Slave	SO-24L
MC145428DW	Data Set Interface Circuit	SO-20L
MC145436DW	DTMF Decoder	SO-16L
MC145439	Transcoder B8ZS, B6ZS, HDB3 to NRZ	(4)
MC145442DW	300-Baud CCITT V.21 Single-Chip Modem	SO-20L
MC145443DW	300-Baud Bell 103 Single-Chip Modem	SO-20L
MC145447DW	Calling Line I.D. Receiver with Ring Detector	SO-16L
MC145472FE	ISDN U-Interface Transceiver	CQFP-68L
MC145472FU	ISDN U-Interface Transceiver	PQFP-68L
MC145475DW	ISDN S/T Transceiver	SO-28L
MC145480DW	+5.0 V PCM Codec/Filter	SO-20L
MC145488	Dual Data Link Controller	(4)
MC145502	PCM Codec/Filter	(4)
MC145503DW	PCM Codec/Filter	SO-16L
MC145505DW	PCM Codec/Filter	SO-16L
MC145532DW	ADPCM Transcoder	SO-16L
MC145540DW	ADPCM Codec	SO-28L
MC145554DW	PCM Codec/Filter (TP3054 Compatible)	SO-16L
MC145557DW	PCM Codec/Filter (TP3057 Compatible)	SO-16L

(4)Introduction of this device in surface mount packages is dependent on market demand.

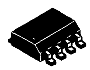
Table 67. MOS Digital-Analog (continued)

Device	Function	Package
MC145564DW	PCM Codec/Filter (TP3064 Compatible)	SO-20L
MC145567DW	PCM Codec/Filter (TP3067 Compatible)	SO-20L
MC145705DW	EIA-232/V.28 CMOS Driver/Receiver, 5.0 V Only	SO-20L
MC145706DW	EIA-232/V.28 CMOS Driver/Receiver, 5.0 V Only	SO-20L
MC145707DW	EIA-232/V.28 CMOS Driver/Receiver, 5.0 V Only	SO-20L

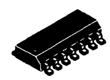
Surface Mount Technology Package Overview



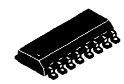
CASE 369A
PLASTIC
DPAK
DT SUFFIX



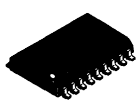
CASE 751
PLASTIC
SO-8, SOP-8
D. D1 SUFFIX



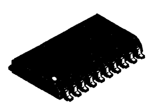
CASE 751A
PLASTIC
SO-14
D SUFFIX



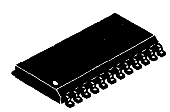
CASE 751B
PLASTIC
SO-16
D SUFFIX



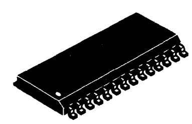
CASE 751C
PLASTIC
SO-18L
DW SUFFIX



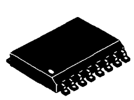
CASE 751D
PLASTIC
SO-20L
DW SUFFIX



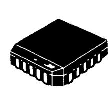
CASE 751E
PLASTIC
SO-24L
DW SUFFIX



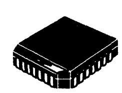
CASE 751F
PLASTIC
SO-28L
DW SUFFIX



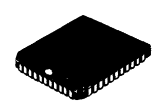
CASE 751G
PLASTIC
SO-8+8L, SO-16L
DW SUFFIX



CASE 775
PLASTIC
PLCC-20
FN SUFFIX



CASE 776
PLASTIC
PLCC-28
FN SUFFIX



CASE 777
PLASTIC
PLCC-44
FN SUFFIX

Analog MPQ Table

Table 68. Tape/Reel and Ammo Pack

Package Type	Package Code	MPQ
PLCC		
Case 775	0802	1000/reel
Case 776	0804	500/reel
Case 777	0801	500/reel
Case 778	0805	450/reel
Case 779	0803	250/reel
Case 780	0806	250/reel
SOIC		
Case 751	0095	2500/reel
Case 751A	0096	2500/reel
Case 751B	0097	2500/reel
Case 751G	2003	1000/reel
Case 751C	2004	1000/reel
Case 751D	2005	1000/reel
Case 751E	2008	1000/reel
Case 751F	2009	1000/reel
TO-92		
Case 29	0031	2000/reel
Case 29	0031	2000/Ammo Pack

Tape and Reel
Logic and Analog Technologies, and MOS Integrated Circuits

Motorola has now added the convenience of Tape and Reel packaging for our growing family of standard Integrated Circuit products. Three reel sizes are available, for all but the largest types, to support the requirements of both first and second generation pick-and-place equipment. The packaging fully conforms to the latest EIA-481A specification. The antistatic embossed tape provides a secure cavity, sealed with a peel-back cover tape.

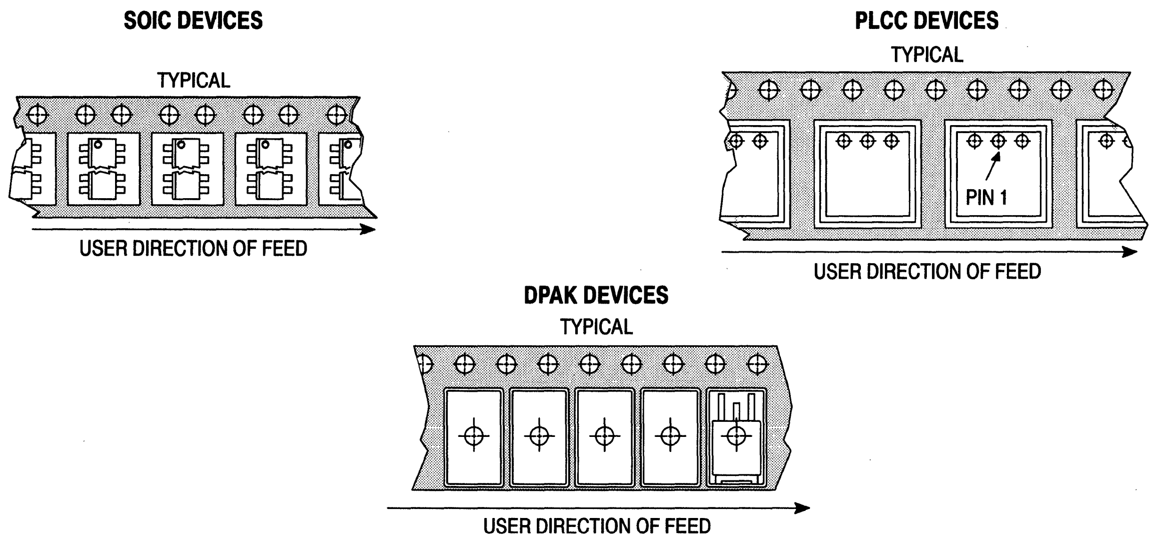


Figure 8. Mechanical Polarization

Table 69.

Package	Tape Width (mm)	Device(1) per Reel	Reel Size (inch)	Device Suffix
SO-8, SOP-8	12	2,500	13	R2
SO-14	16	2,500	13	R2
SO-16	16	2,500	13	R2
SO-16L, SO-8+8L WIDE	16	1,000	13	R2
SO-20L WIDE	24	1,000	13	R2
SO-24L WIDE	24	1,000	13	R2
SO-28L WIDE	24	1,000	13	R2
SO-28L WIDE	32	1,000	13	R3
PLCC-20	16	1,000	13	R2
PLCC-28	24	500	13	R2
PLCC-44	32	500	13	R2
PLCC-52	32	500	13	R2
PLCC-68	44	250	13	R2
PLCC-84	44	250	13	R2
TO-226AA (TO-92)(2)	18	2,000	13	RA, RB, RE, RM, or RP (Ammo Pack) only
DPAK	16	2,500	13	RK

(1)Minimum order quantity is 1 reel. Distributors/OEM customers may break lots or reels at their option, however broken reels may not be returned.
(2)Integrated circuits in TO-226AA packages are available in Styes A, B and E only, with optional “Ammo Pack” (Suffix RM or RP).
For ordering information please contact your local Motorola Semiconductor Sales Office.

Tape and Reel (continued)

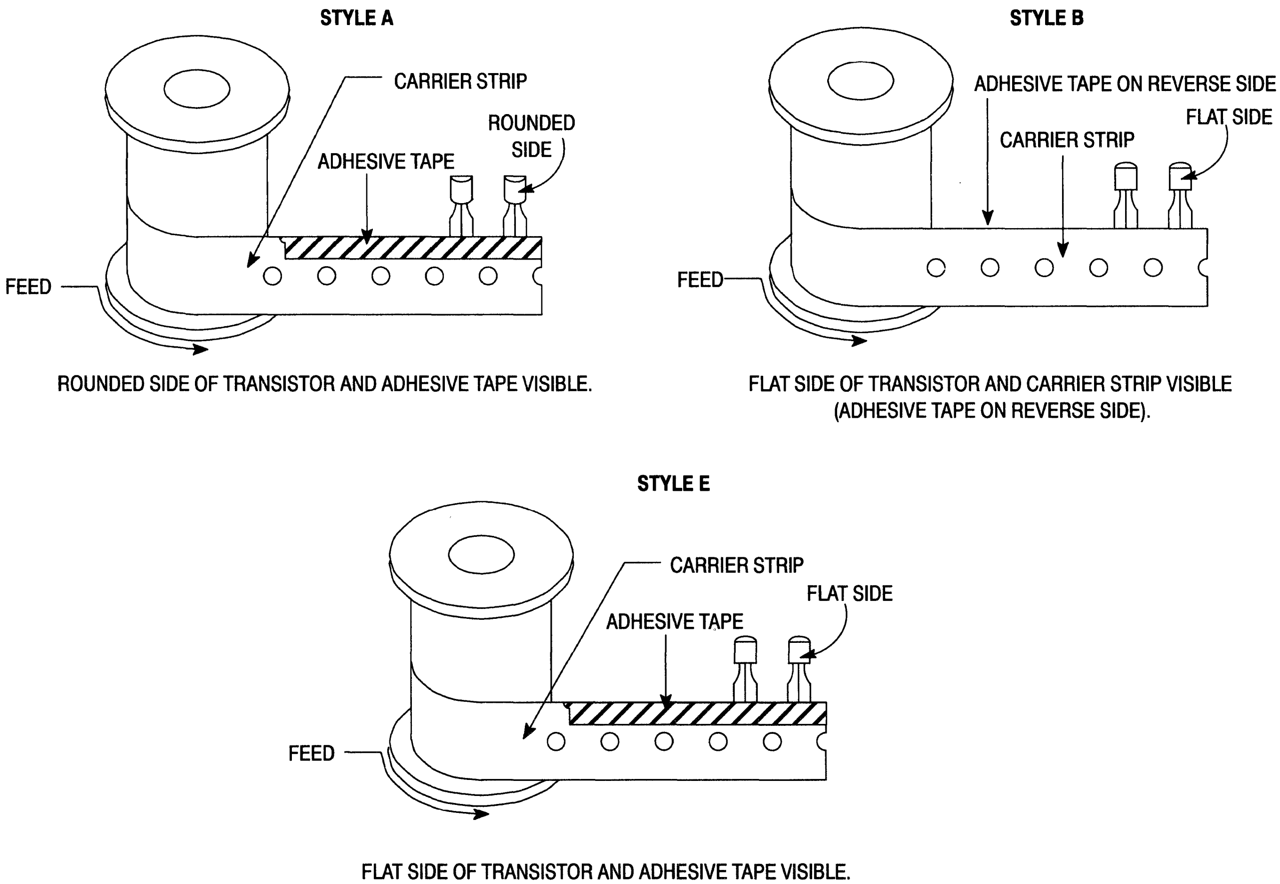


Figure 9. TO-92 Reel Styles

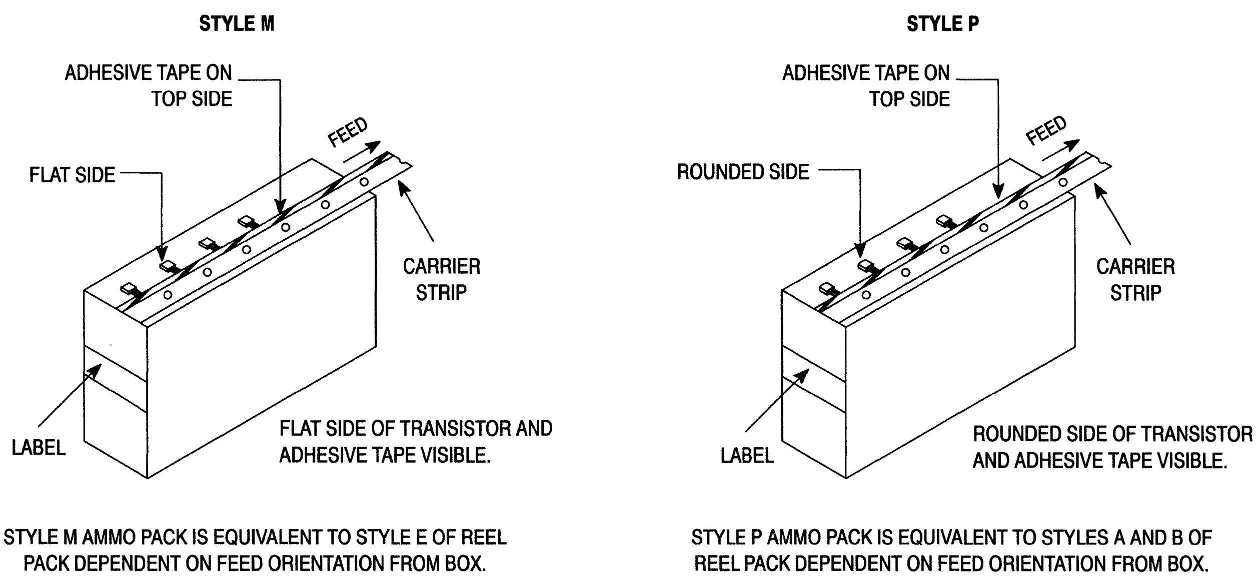


Figure 10. TO-92 Ammo Pack

Discrete Products

In Brief . . .

Many leading semiconductor manufacturers have de-emphasized or eliminated discrete components from their product portfolio. This is not the case with Motorola.At Motorola, continuing major investments in research and development for discrete product categories underscore a commitment to remain the world leader in both the scope and breadth of these product lines.But things are changing significantly and the changes are not limited simply to the expansion of product lines through the enhancement of specification limits.In addition to the improvements with higher performance, faster speed, greater efficiency, lower cost and assembly compatible packaging, Motorola will continue to integrate additional features, provide performance and packaging unique to specific applications, and offer state-of-the-art packaging options.Size reduction continues to be an important factor in system design. This same factor has propelled surface mount packaging into the limelight of semiconductor device change. Recognizing this trend, Motorola discrete components has developed and will continue to develop a broad family of surface mount packages across all product lines.But more important is the changing nature of the entire concept of discrete componentry. Integration in semiconductor components is not new, but increasing integration in products that are classified as "discrete" devices is a recent occurrence. This trend is generating families of more reliable, intelligent semiconductor products. Several examples of product lines that include this type of integration are SMARTDISCRETES, SMALLBLOCK, Sensors and RF products. For example, current RF technology enables a transistor to have thousands of transistors on a single die with built-in resistors and also includes inductors and capacitors in the package to enhance performance characteristics.Thus the field of "discrete products" is changing both in definition and in perspective toward a "multi-function" capability and Motorola will continue to be the manufacturer of choice for all your discrete semiconductor requirements.

Page

5

Small Signal Transistors, FETs and Diodes

In Brief . . .

This section highlights semiconductors that are the most popular and have a history of high usage for the most applications.

It covers a wide range of Small-Signal plastic and metal-can semiconductors.

A large selection of encapsulated plastic transistors, FETs and diodes are available for surface mount and insertion assembly technology. Plastic packages include TO-92 (TO-226AA), 1 Watt TO-92 (TO-226AE), SOT-23, SC-59, and SOT-223. Plastic multiples are available in 14-pin and 16-pin dual in-line packages for insertion applications: SO-8, SO-14, and SO-16 for surface mount applications.

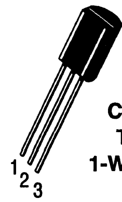
Metal-can packages are available for applications requiring higher power dissipation or having hermetic requirements in TO-18 (TO-206AA) and TO-39 (TO-205AD).

Page

Bipolar Transistors

Plastic-Encapsulated Transistors

Motorola's Small Signal TO-226 plastic transistors encompass hundreds of devices with a wide variety of characteristics for general-purpose, amplifier and switching applications. The popular high-volume package combines proven reliability, performance, economy and convenience to provide the perfect solution for industrial and consumer design problems. All devices are laser marked for ease of identification and shipped in antistatic containers, as part of Motorola's ongoing practice of maintaining the highest standards of quality and reliability.



CASE 29-05
TO-226AE
1-WATT (TO-92)

CASE 29-04
TO-226AA
(TO-92)

Table 1. Plastic-Encapsulated General-Purpose Transistors

These general-purpose transistors are designed for small-signal amplification from dc to low ratio frequencies. They are also useful as oscillators and general-purpose switches. Complementary devices shown where available (Tables 1 through 4).

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C MHz Min	mA	I_C mA Max	h_{FE} @ I_C Min	Max	mA	NF dB Max	Style
Case 29-04 — TO-226AA (TO-92)										
MPS8099	***MPS8599***	80	150	10	500	100	300	1.0	—	1
MPSA06	***MPSA56***	80	100	10	500	100	—	100	—	1
2N4410	—	80	60	10	250	60	400	10	—	1
BC546	BC556	65	150	10	100	120	450	2.0	10	17
BC546A	BC556A	65	150	10	100	120	220	2.0	10	17
BC546B	BC556B	65	150	10	100	180	450	2.0	10	17
MPSA05	MPSA55	60	100	10	500	100	—	100	—	1
	MPS2907A	60	200	50	600	100	300	150	—	1
BC182	BC212	50	200(1)	10	100	120	500	2.0	10	14
BC237B	BC307B	45	150	10	100	200	460	2.0	10	17
BC337	BC327	45	210(1)	10	800	100	630	100	—	17
BC547	BC557	45	150	10	100	120	800	2.0	10	17
BC547A	BC557A	45	150	10	100	120	220	2.0	10	17
BC547B	BC557B	45	150	10	100	180	450	2.0	10	17
BC547C	BC557C	45	150	10	100	380	800	2.0	10	17
MPSA20	MPSA70	40	125	5.0	100	40	400	5.0	—	1
MPS2222A		40	300	20	600	100	300	150	—	1
2N4401	***2N4403***	40	200	20	600	100	300	150	—	1
2N4400	2N4402	40	150	20	600	50	150	150	—	1
MPS6602	***MPS6652***	40	100	50	1000	50	—	500	—	1
2N3903	2N3905	40	200	10	200	50	150	10	6.0	1
2N3904	***2N3906***	40	250	10	200	100	300	10	5.0	1
BC548		30	300(1)	10	100	110	800	2.0	10	17
BC548A		30	300(1)	10	100	120	220	2.0	10	17
BC548B	BC558B	30	300(1)	10	100	200	450	2.0	10	17
BC548C		30	300	10	100	420	800	2.0	10	17
2N4123	2N4125	30	200	10	200	50	150	2.0	6.0	1
2N4124	2N4126	25	250	10	200	120	360	2.0	4.0	1
BC338	BC328	25	210(1)	10	800	100	630	100	—	17

(1) Typical

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Transistors **(continued)**

Table 1. Plastic-Encapsulated General-Purpose Transistors (continued)

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C MHz Min	f_T @ I_C mA	I_C A Max	h_{FE} @ I_C Min	h_{FE} @ I_C Max	h_{FE} @ I_C mA	$V_{CE(sat)}$ @ I_C @ I_B Volts Max	$V_{CE(sat)}$ @ I_C @ I_B mA	$V_{CE(sat)}$ @ I_C @ I_B mA	Style
Case 29-05 — TO-226AE (1-WATT TO-92)												
BDB01D	BDB02D	100	50	200	0.5	40	400	100	0.7	1000	100	1
BDC01D	BDC02D	100	50	200	0.5	40	400	100	0.7	1000	100	14
BDB01C	BDB02C	80	50	200	0.5	40	400	100	0.7	1000	100	1
MPS6717		80	50	200	0.5	80	—	50	0.5	250	10	1
MPSW06	***MPSW56***	80	50	200	0.5	80	—	50	0.4	250	10	1

Table 2. Plastic-Encapsulated Low-Noise and Good h_{FE} Linearity

These devices are designed to use on applications where good h_{FE} linearity and low-noise characteristics are required: Instrumentation, hi-fi preamplifier.

NPN	PNP	$V_{(BR)CEO}$ Volts	h_{FE} @ I_C Min	h_{FE} @ I_C Max	h_{FE} @ I_C mA	V_T(4) mV Typ	NF(5) dB Max	f_T MHz Typ	Style
Case 29-04 — TO-226AA (TO-92)									
—	***2N5087***	50	250	800	0.1	—	2.0	40(2)	1
—	2N5086	50	150	500	0.1	—	3.0	40(2)	1
MPS6428	—	50	250	650	0.1	7.0(7)	3.5(8)	100(2)	1
BC239	—	45	120	800	2.0	9.5	2.0(1)	280	17
BC550B	BC560B	45	180	450	2.0	—	2.5	250	17
BC550C	BC560C	45	380	800	2.0	—	2.5	250	17
MPSA18	—	45	500	—	1.0	6.5(1)	—	160	1
MPS3904	MPS3906	40	100	300	10	—	5.0	200(2)	1
—	MPS4250	40	250	—	10	—	2.0	—	1
BC549B	BC559B	30	200	450	2.0	—	2.5	250	17
BC549C	BC559C	30	380	800	2.0	—	2.5	250	17
2N5088	—	30	350	—	1.0	—	3.0	50	1
2N5089(6)	—	25	450	—	1.0	—	2.0	50	1
MPS6521	MPS6523	25	300	600	2.0	—	3.0	—	1

(1) Typical
(2) Min
(4) V_T: Total Input Noise Voltage (see BC413/BC414 and BC415/BC416 Data Sheets) at R_S = 2.0 kΩ, I_C = 200 μA, V_{CE} = 5.0 Volts.
(5) N_F: Noise Figure at R_S = 2.0 kΩ, I_C = 200 μA, V_{CE} = 5.0 Volts. f = 30 Hz to 15 kHz.
(7) R_S = 10 kΩ, BW = 1.0 Hz, f = 100 MHz
(8) R_S = 500 Ω, BW = 1.0 Hz, f = 10 MHz

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Transistors **(continued)**

Table 3. Plastic-Encapsulated Darlington Transistors

Darlington amplifiers are cascade transistors used in applications requiring very high-gain and input impedance. These devices have monolithic construction.

NPN	PNP	$V_{(BR)CEO}$ Volts	I_C Max	h_{FE} @ I_C Min	Max	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C Min	mA	Style
Case 29-05 — TO-226AE (1-WATT TO-92)												
MPSW45A	—	50	1000	25K	150K	200	1.5	1000	2.0	100	200	1
—	***MPSW64***	30	1000	20K	—	100	1.5	100	0.1	125	10	1
Case 29-04 — TO-226AA (TO-92)												
MPSA29	—	100	500	10K	—	100	1.5	100	0.1	125	10	1
BC373	—	80	1000	10K	160K	100	1.1	250	0.25	100	100	1
MPSA27	MPSA77	60	500	10K	—	100	1.5	100	0.1	—	—	1
BC618	—	55	1000	10K	50K	200	1.1	200	0.2	150	500	17
	MPSA75	40	500	10K	—	100	1.5	100	0.1	—	—	1
2N6427	—	40	500	20K	200K	100	1.5	500	0.5	—	—	1
2N6426	—	40	500	30K	300K	100	1.5	500	0.5	125	10	1
MPSA14	***MPSA64***	30	500	20K	—	100	1.5	100	0.1	125	10	1
MPSA13	MPSA63	30	500	10K	—	100	1.5	100	0.1	125	10	1
BC517	—	30	1000	30K	—	20	1.0	100	0.1	200(1)	10	17

Table 4. Plastic-Encapsulated High-Current Transistors

The following table is a listing of devices that are capable of handling a higher current range for small-signal transistors.

NPN	PNP	$V_{(BR)CEO}$ Volts Min	f_T @ I_C MHz Min	mA	I_C mA Max	h_{FE} @ I_C Min	Max	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	Style
Case 29-05 — TO-226AE (1-WATT TO-92)												
MPS6715	MPS6727	40	—	—	1000	50	—	1000	0.5	1000	100	1
MPSW01A	***MPSW51A***	40	50	50	1000	50	—	1000	0.5/0.7	1000	100	1
Case 29-04 — TO-226AA (TO-92)												
BC489	BC490	80	200/150(1)	50	1000	60	400	100	0.3/0.5	1000	100	17
BC639	BC640	80	60	10	500	40	160	150	0.5	500	50	14
MPS651	***MPS751***	60	75	50	2000	75	—	1000	0.5	2000	200	1
MPS650	MPS750	40	75	50	2000	75	—	1000	0.5	2000	200	1
BC368	BC369	20	65	10	1000	60	—	1000	0.5	1000	100	1

(1) Typical

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Transistors (continued)

Table 5. Plastic-Encapsulated High-Voltage Amplifier Transistors

These high-voltage transistors are designed for driving neon bulbs and indicator tubes, for direct line operation, and for other applications requiring high-voltage capability at relatively low collector current. These devices are listed in order of decreasing breakdown voltage ($V_{(BR)CEO}$).

Device Type	$V_{(BR)CEO}$ Volts Min	I_C Amp Max	h_{FE} @ I_C Min	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C MHz Min	mA	Style
Case 29-05 — TO-226AE (1-WATT TO-92) — NPN										
BDC05	300	0.5	40	25	2.0	20	2.0	60	10	14
MPSW42	300	0.5	40	30	0.5	20	2.0	50	10	1
Case 29-05 — TO-226AE (1-WATT TO-92) — PNP										
MPSW92	300	0.5	25	30	0.5	20	2.0	50	10	1
Case 29-04 — TO-226AA (TO-92) — NPN										
BF844	400	0.3	50	10	0.5	10	1.0	—	—	1
MPSA44	400	0.3	40	100	0.75	50	5.0	—	—	1
2N6517	350	0.5	30	30	0.3	10	1.0	40	10	1
BF393	300	0.5	40	10	0.2	20	2.0	50	10	1
MPSA42	300	0.5	40	10	0.5	20	2.0	50	10	1
2N5551	160	0.6	80	10	0.15	10	1.0	100	10	1
Case 29-04 — TO-226AA (TO-92) — PNP										
BF493S	350	0.5	40	10	20	20	2.0	50	10	1
2N6520	350	0.5	30	30	0.3	10	1.0	40	10	1
MPSA92	300	0.5	40	10	0.5	20	2.0	50	10	1
2N6519	300	0.5	45	30	0.3	10	1.0	40	10	1
2N5401	150	0.6	60	10	0.2	10	1.0	100	10	1

Case 29-04 — TO-226AA (TO-92)

NPN	PNP	$V_{(BR)CEO}$ Volts Min	I_C Amp Cont	h_{FE} @ I_C Min	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C MHz Min	mA	Style
BF420	BF421	300	0.5	50	25	2.0	20	2.0	60	10	14
BF422	BF423	250	0.5	50	25	2.0	20	2.0	60	10	14

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Transistors (continued)

Table 6. Plastic-Encapsulated RF Transistors

The RF transistors are designed for small-signal amplification from RF to VHF/UHF frequencies. They are also used as mixers and oscillators in the same frequency ranges.

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} @ I_C Min	mA	V_{CE} V	f_T MHz Typ	CRE/CRB pF Max	NF dB Typ	f MHz	Style
Case 29-04 — TO-226AA (TO-92) — NPN										
BF224	30	50	30	7.0	10	600	0.28	2.5	100	21
MPSH24	30	50	30	8.0	10	400(2)	0.36	—	—	2
MPSH20	30	100	25	4.0	10	400(2)	0.65	—	—	2
MPSH07A(9)	30	25	20	3.0	10	400(2)	0.3	3.2(3)	100	1
MPS3866	30	400	10	50	5.0	500(2)	—	—	—	1
MPSH11	25	—	60	4.0	10	650(2)	0.9	—	—	2
MPSH10	25	—	60	4.0	10	650(2)	0.65	—	—	2
BF199	25	100	40	7.0	10	750	0.35	2.5	35	21
BF959	20	100	40	20	10	600(2)	0.65	3.0	200	21
MPS6568A	20	50	20	4.0	5.0	375(2)	0.65	3.3(3)	200	2
MPSH17	15	—	25	5.0	10	800(2)	0.9	6.0(3)	200	2
MPS918	15	50	20	8.0	10	600(2)	1.7	6.0(3)	60	1
MPS5179	12	50	25	3.0	1.0	2000(3)	—	5.0(3)	200	1
MPS3563	12	50	20	8.0	10	800	1.7	6.0(3)	60	1
MPS6595	12	50	25	10	5.0	1200(2)	1.3	—	—	1
Case 29-04 — TO-266AA (TO-92) — PNP										
MPSH81	20	50	60	5.0	10	600(2)	0.85	—	—	2
MPSH69	15	50	30	10	10	2000(2)	0.3	—	—	1

Table 7. Plastic-Encapsulated High-Speed Saturated Switching Transistors

Device Type	t_{on} & t_{off} @ I_C ns Max	ns Max	mA	$V_{(BR)CEO}$ Volts Min	h_{FE} @ I_C Min	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C MHz Min	mA	Style
Case 29-04 — TO-226AA (TO-92) — NPN												
2N4264	25	35	10	15	40	10	0.22	10	1.0	300	10	1
2N4265	25	35	10	12	100	10	0.22	10	1.0	300	10	1
MPS3646	18	28	300	15	30	30	0.2	30	3.0	350	30	1
MPS2369A	12	18	10	15	40	10	0.2	10	1.0	—	—	1
Case 29-04 — TO-226AA (TO-92) — PNP												
MPS3640	25	35	50	12	30	10	0.2	10	1.0	500	10	1
MPS4258	15	20	10	12	30	50	0.15	10	1.0	700	10	1
MPS5771	15	20	10	15	35	10	0.18	10	1.0	—	—	1

(2) Min
(3) Max
(9) AGC Capable

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Transistors (continued)

Table 8. Plastic-Encapsulated Choppers

Devices are listed in decreasing $V_{(BR)EBO}$.

Device Type	$V_{(BR)EBO}$ Volts Min	I_C Amp(1) Max	h_{FE} @ I_C Min	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C MHz Min	mA	Style
Case 29-04 — TO-226AA (TO-92) — NPN										
MPSA17	15	100	200	5.0	0.25	10	1.0	80	5.0	1
MPSA16	12	100	200	5.0	0.25	10	1.0	100	5.0	1
Case 29-04 — TO-266AA (TO-92) — PNP										
MPS404A	–25	–150	30	–12	–0.2	–24	1.0	—	—	1

Table 9. Plastic-Encapsulated Telecom Transistors

These devices are special product ranges intended for use in telecom applications.

Device Type	$V_{(BR)CEO}$ Volts	P_D mW 25°C Amb	I_C mA Cont	h_{FE} @ I_C @ V_{CE} Min	Max	mA	Volts	f_T MHz Min	Style
Case 29-04 — TO-226AA (TO-92) — NPN									
P2N2222A	40	625	600	75	—	10	10	300	17
PBF259,S(10)	300	625	500	25	—	1.0	10	40	1
Case 29-04 — TO-226AA (TO-92) — PNP									
P2N2907A	60	625	600	100	—	10	10	200	17
PBF493,S(11)	300	625	500	40	—	1.0	10	40	1

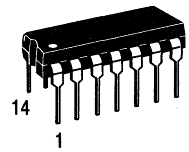
(1) Typical
(10) "S" version, h_{FE} Min 60 @ I_C = 20 mA, V_{CE} = 10 V.
(11) "S" version, h_{FE} Min 40 @ I_C = 0.1 mA, V_{CE} = 1.0 V.

Devices listed in bold, italic are Motorola preferred devices.

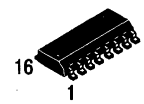
Plastic-Encapsulated Multiple Transistors

The manufacturing trend has been toward printed circuit board design with requirements for smaller packages with more functions. In the case of discrete components the use of the multiple device package helps to reduce board space requirements and assembly costs.

Many of the most popular devices are offered in the standard plastic DIP and surface mount IC packages. This includes small-signal NPN and PNP bipolar transistors, N-channel and P-channel FETs, as well as diode arrays.



CASE 646-06
(TO-116)
STYLE 1



CASE 751B-05
SO-16
STYLE 1

Specification Tables

The following short form specifications include Quad and Dual transistors listed in alphanumeric order. Some columns denote two different types of data indicated by either **bold** or *italic* typeface. See key and headings for proper identification. This applies to Table 1 and 2 of this section only.

KEY

TYPE NO.	ID	Ref. Point P_D Watts One Die Only	Subscript V_{CE} Volts	I_C Amp Max	Unit h_{FE} @ I_C Min	f_T MHz Min	C_{ob} pF Max	**h_{FE1}/h_{FE2}** *t_{on} ns Max*	**ΔV_{BE} mV Max** *t_{off} ns Max*	**G_p dB Min, NF dB Max @ f** *$V_{CE(sat)}$ Volts Max @ I_C/I_B & I_C Unit*

Alphanumeric listing type numbers

Identification Code

First Letter: Polarity
C — both types in multiple device
N — NPN
P — PNP

Second Letter: Use
A — General Purpose Amplifier
E — Low Noise Audio Amplifier
F — Low Noise RF Amplifier
G — General Purpose Amplifier and Switch
H — Tuned RF/IF Amplifier
M — Differential Amplifier
S — High Speed Switch
D — Darlington

Power Dissipation specified at 25°C. Single die rating.
Ref. Point: A — Ambient Temperature
C — Case Temperature

Rated Minimum Collector-Emitter Voltage
Subscript letter identifies base termination listed below in order of preference.
SUBSCRIPT:
0 — V_{CEO}, open

Continuous (DC) Collector Current

Common-emitter DC Current Gain.

Units for test Current:
A — ampere
m — mA
u — µA

Current-Gain-Bandwidth Product

Output Capacitance, common-base. Shown without distinction:
C_{cb} — Collector-Base Capacitance
C_{re} — Common-Emitter Reverse Transfer Capacitance

h_{FE1}/h_{FE2} — Current Gain Ratio
V_{BE} — Differential Base Voltage $|V_{BE1} - V_{BE2}|$.
Differential Amplifiers
t_{on} — turn-on time
t_{off} — turn-off time

G_p — Power Gain
NF — Noise Figure
f — Test Frequency
AUD — 10-15 kHz
Frequency Units:
H — Hertz M — MHz
K — kHz G — GHz

$V_{CE(sat)}$ — Collector-Emitter Saturation Voltage
IC — Test Current
Current Units: u — µA
m — mA
A — Amp

Bipolar Transistors: Plastic-Encapsulated Multiple Transistors **(continued)**

Table 10. Plastic-Encapsulated Multiple Transistors — Quad

The following table is a listing of the most popular multiple devices available in the plastic DIP package. These devices are available in NPN, PNP, and NPN/PNP configurations. (See note.)

DEVICE	ID	P_D Watts One Die Only	V_{CEO} Volts	I_C Amp Max	h_{FE} Min	@ I_C	f_T MHz Min	C_{ob} pF Max	**h_{FE1} / h_{FE2}** / t_{on} ns Max	**ΔV_{BE} mV Max** / t_{off} ns Max	**G_p dB Min** / V_{CE} (sat) Volts Max	**NF dB Max Typ[1]** / @ I_C / I_B	**@ f** / I_C
Case 646-06 — TO-116													
MPQ2222A	NA	0.65	40	0.5	100	150 m	200	8.0	35[1]	285[1]	0.3	10	150 m
MPQ2369	NS	0.5	15	0.5	40	10 m	450	4.0	9.0[1]	15[1]	0.25	10	10 m
MPQ2483	NA	0.625	40	0.05	150	1.0 m	50					**3.0[1]**	**AUD**
MPQ2484	NA	0.625	40	0.05	300	1.0 m	50					**2.0[1]**	**AUD**
MPQ2907A	PA	0.65	60	0.6	100	150 m	200	8.0	45[1]	180[1]	0.4	10	150 m
MPQ3467	PS	0.75	40	1.0	20	500 m	125	25	40	90	0.5	10	500 m
MPQ3725	NS	1.0	40	1.0	25	500 m	250	10	35	60	0.45	10	500 m
MPQ3762	PS	0.75	40	1.5	35	150 m	150	15	50	120	0.55	10	500 m
MPQ3798	PA	0.625	40	0.05	150	0.1 m	60	4.0				**3.0[1]**	**AUD**
MPQ3799	PA	0.625	60	0.05	300	0.1 m	60	4.0				**2.0[1]**	**AUD**
MPQ3904	NG	0.5	40	0.2	75	10 m	250	4.0	37[1]	136[1]	0.2	10	10 m
MPQ3906	PG	0.5	40	0.2	75	10 m	200	4.5	43[1]	155[1]	0.25	10	10 m
MPQ6001	CG	0.65	30	0.5	40	150 m	200	8.0	30[1]	225[1]	0.4	10	150 m
MPQ6002	CG	0.65	30	0.5	100	150 m	200	8.0	30[1]	225[1]	0.4	10	150 m
MPQ6100A	CA	0.5	45	0.05	150	1.0 m	50	4.0				**4.0[1]**	**AUD**
MPQ6426	ND	0.5	30	0.5	10K	100 m	125	8.0	—	—	1.5	10	100 m
MPQ6501	CG	0.65	30	0.5	40	150 m	200	8.0	30[1]	225[1]	0.4	10	150 m
MPQ6502	CG	0.65	30	0.5	100	150 m	200	8.0	30[1]	225[1]	0.4	10	150 m
MPQ6600A1	CA	0.5	45	0.05	150	1.0 m	50	4.0	0.8	20	0.25	10	1.0 m
MPQ6700	CA	0.5	40	0.2	70	10 m	200	4.5			0.25	10	1.0 m
MPQ6842	CA	0.75	40	0.5	70	10 m	300	4.5	45	150	0.15	10	0.5 m
MPQ7043	NA	0.75	250	0.5	25	1.0 m	50	5.0			0.5	10	20 m
MPQ7042	NA	0.75	200	0.5	25	1.0 m	50	5.0			0.5	10	20 m
MPQ7051	CG	0.75	150	0.5	25	1.0 m	50	6.0			0.7	10	20 m
MPQ7093	PA	0.75	250	0.5	25	1.0 m	50	5.0			0.5	10	20 m

Table 11. Plastic-Encapsulated Multiple Transistors — Quad Surface Mount

The following table is a listing of the most popular multiple devices available in the plastic SOIC surface mount package. These devices are available in NPN, PNP, and NPN/PNP configurations.

Device	$V_{(BR)CEO}$	$V_{(BR)CBO}$	h_{FE} @ I_C Min	mA	f_T @ I_C MHz Min	mA
Case 751B-05 — SO-16						
MMPQ2222A	40	75	40	500	200	20
MMPQ2369	15	40	20	100	450	10
MMPQ2907A	50	60	50	500	200	50
MMPQ3467	40	40	20	500	125	50
MMPQ3725	40	60	25	500	250	50
MMPQ3799	60	60	300	0.5	60	1.0
MMPQ3904	40	60	75	10	250	10
MMPQ3906	40	40	75	10	200	10
MMPQ6700[12]	40	40	70	10	200	10

(1) Typical
(12) NPN/PNP
NOTE: Some columns show 2 different types of data indicated by either **bold** or *italic* typefaces. See key and headings.

Devices listed in bold, italic are Motorola preferred devices.

Plastic-Encapsulated Surface Mount Transistors

This section of the selector guide lists the small-signal plastic devices that are available for surface mount applications. These devices are encapsulated with the latest state-of-the-art mold compounds that enhance reliability and exhibit excellent performance in high temperature and high humidity environments. This package offers higher power dissipation capability for small-signal applications.

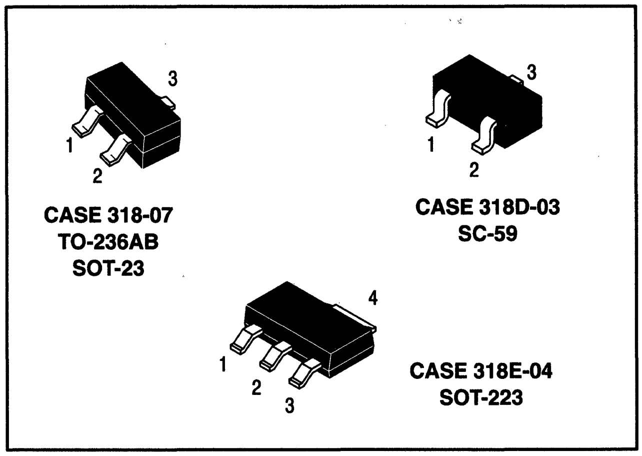


Table 12. Plastic-Encapsulated Surface Mount General-Purpose Transistors

The following tables are a listing of small-signal general-purpose transistors in the SOT-23 and SC-59 surface mount packages. These devices are intended for small-signal amplification for DC, audio, and lower RF frequencies. They also have applications as oscillators and general-purpose, low voltage switches.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	f_T MHz Min
Case 318-07 — TO-236AB (SOT-23) — NPN						
MMBT8099LT1	KB	80	100	300	1.0	150
BC846ALT1	1A	65	110	220	2.0	100
BC846BLT1	1B	65	200	450	2.0	100
BC817-16LT1	6A	45	100	250	100	200
BC817-25LT1	6B	45	160	400	100	200
BC817-40LT1	6C	45	250	600	100	200
BC847ALT1	1E	45	110	220	2.0	100
BC847BLT1	1F	45	200	450	2.0	100
BC847CLT1	1G	45	420	800	2.0	100
MMBT2222ALT1	1P	40	100	300	150	200
MMBT3904LT1	1AM	40	100	300	10	200
MMBT4401LT1	2X	40	100	300	150	250
BC848ALT1	1J	30	110	220	2.0	100
BC848BLT1	1K	30	200	450	2.0	100
BC848CLT1	1L	30	420	800	2.0	100
Case 318-07 — TO-236AB (SOT-23) — PNP						
MMBT8599LT1	2W	80	100	300	1.0	150
BC856ALT1	3A	65	125	250	2.0	100
BC856BLT1	3B	65	220	475	2.0	100
MMBT2907ALT1	2F	60	100	300	150	200
BC807-16LT1	5A	45	100	250	100	200

Devices listed in bold, italic are Motorola preferred devices.

Table 12. Plastic-Encapsulated Surface Mount General-Purpose Transistors (continued)
Pinout: 1-Base, 2-Emitter, 3-Collector
Devices are listed in order of descending breakdown voltage.

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	f_T MHz Min
Case 318-07 — TO-236AB (SOT-23) — PNP						
BC807-25LT1	5B	45	160	400	100	200
BC807-40LT1	5C	45	250	600	100	200
BC857ALT1	3E	45	125	250	2.0	100
BC857BLT1	3F	45	220	475	2.0	100
MMBT3906LT1	2A	40	100	300	10	250
MMBT4403LT1	2T	40	100	300	150	200
BC858ALT1	3J	30	125	250	2.0	100
BC858BLT1	3K	30	220	475	2.0	100
BC858CLT1	3L	30	420	800	2.0	100
Case 318D-03 — SC-59 — NPN						
MSD601-RT1	YR	25	210	340	2.0	150(1)
MSD601-ST1	YS	25	290	460	2.0	150(1)
MSD602-RT1	WR	25	120	240	150	200(1)
MSD1328-RT1	1DR	20	200	350	500	200(1)
Case 318D-03 — SC-59 — PNP						
MSB709-RT1	AR	25	210	340	2.0	100(1)
MSB709-ST1	AS	25	290	460	2.0	100(1)
MSB710-QT1	CQ	25	85	170	150	200(1)
MSB710-RT1	CR	25	120	240	150	200(1)

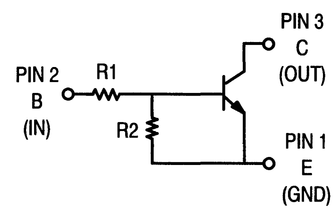


Table 13. Plastic-Encapsulated Surface Mount Bias Resistor Transistors for General Purpose Applications

These devices include bias resistors on the semiconductor chip with the transistor. See the BRT diagram for orientation of resistors.

Device NPN	Device PNP	Marking NPN	Marking PNP	$V_{(BR)CEO}$ Volts (Min)	h_{FE} @ I_C Min	mA	I_C mA Max	R_1 Ohm	R_2 Ohm
Case 318D-03 — SC-59									
MUN2211T1	***MUN2111T1***	8A	6A	50	35	5.0	100	10K	10K
MUN2212T1	***MUN2112T1***	8B	6B	50	60	5.0	100	22K	22K
MUN2213T1	***MUN2113T1***	8C	6C	50	80	5.0	100	47K	47K

(1)Typical

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Surface Mount Transistors **(continued)**

Table 14. Plastic-Encapsulated Surface Mount Switching Transistors

The following tables are a listing of devices intended for high-speed, low saturation voltage, switching applications. These devices have very fast switching times and low output capacitance for optimized switching performance.

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	Switching Time (ns)		$V_{(BR)CEO}$	h_{FE} @ I_C			f_T
		t_{on}	t_{off}		Min	Max	mA	MHz Min
Case 318-07 — TO-236AB (SOT-23) — NPN								
MMBT2369LT1	M1J	12	18	15	20	—	100	—
BSV52LT1	B2	12	18	12	40	120	10	400
Case 318-07 — TO-236AB (SOT-23) — PNP								
MMBT3640LT1	2J	25	35	12	20	—	50	500
Pinout: 1-Emitter, 2-Base, 3-Collector								
Case 318D-03 — SC-59 — NPN								
MSC1621T1	RB	20	40	20	40	180	1.0	200

Table 15. Plastic-Encapsulated Surface Mount VHF/UHF Amplifiers, Mixers, Oscillators

The following table is a listing of devices intended for small-signal RF amplifier applications to VHF/UHF frequencies. These devices may also be used as VHF/UHF oscillators and mixers.

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	$V_{(BR)CEO}$	C_{cb}[13] pF Max	f_T @ I_C GHz Min	mA
Case 318-07 — TO-236AB (SOT-23) — NPN					
MMBTH10LT1	3EM	25	0.7	0.65	4.0
MMBT918LT1	M3B	15	1.7[14]	0.6	4.0
MMBTH24LT1	M3A	30	0.45	0.4	8.0
Case 318-07 — TO-236AB (SOT-23) — PNP					
MMBTH81LT1	3D	20	0.85	0.6	5.0
MMBTH69LT1	M3J	15	0.35[13]	2.0	10
Pinout: 1-Emitter, 2-Base, 3-Collector					
Case 318D-03 — SC-59 — NPN					
MSC2295-BT1	VB	20	1.5[13]	0.15	1.0
MSC2295-CT1	VC	20	1.5[13]	0.15	1.0
MSC2404-CT1	UC	20	1.0[13]	0.45	1.0
MSC3130T1	1S	10	—	1.4	5.0
Case 318D-03 — SC-59 — PNP					
MSA1022-BT1	EB	20	2.0[13]	0.15	1.0
MSA1022-CT1	EC	20	2.0[13]	0.15	1.0

(13) C_{re}
(14) C_{ob}

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Surface Mount Transistors **(continued)**

Table 16. Plastic-Encapsulated Surface Mount Choppers

The following table is a listing of small-signal devices intended for chopper applications where a higher than normal $V_{(BR)CEO}$ is required in the circuit application.

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	$V_{(BR)CEO}$	$V_{BR)EBO}$	h_{FE} @ I_C Min	Max	mA
Case 318-07 — TO-236AB (SOT-23) — PNP						
MMBT404ALT1	2N	35	25	30	400	12

Table 17. Plastic-Encapsulated Surface Mount Darlingtons

The following table is a listing of small-signal devices that have very high h_{FE} and input impedance characteristics. These devices utilize monolithic, cascade transistor construction.

Pinout: 1-Base, 2-Emitter, 3-Collector
Devices are listed in order of descending h_{FE}.

Device	Marking	$V_{(BR)CES}$	$V_{CE(sat)}$ Volts Max	h_{FE} @ I_C Min	Max	mA
Case 318-07 — TO-236AB (SOT-23) — NPN						
MMBTA14LT1	1N	30	1.5	20K	—	100
MMBTA13LT1	1M	30	1.5	10K	—	100
Case 318-07 — TO-236AB (SOT-23) — PNP						
MMBTA64LT1	2V	30	1.5	20K	—	100

Table 18. Plastic-Encapsulated Surface Mount Low-Noise Transistors

The following table is a listing of small-signal devices intended for low noise applications in the audio range. These devices exhibit good linearity and are candidates for hi-fi and instrumentation equipment.

Pinout: 1-Base, 2-Emitter, 3-Collector
Devices are listed in order of ascending NF.

Device	Marking	NF dB Typ	$V_{(BR)CEO}$	h_{FE}@ I_C Min	Max	mA	f_T MHz Min
Case 318-07 — TO-236AB (SOT-23) — NPN							
MMBT5089LT1	1R	2.0(15)	25	400	—	10	50
MMBT2484LT1	1U	3.0(15)	60	—	800	10	—
MMBT6428LT1	1KM	3.0	50	250	—	10	100
MMBT6429LT1	1L	3.0	45	500	—	10	100
Case 318-07 — TO-236AB (SOT-23) — PNP							
MMBT5087LT1	2Q	2.0(15)	50	250	—	10	40

(15)Max

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Surface Mount Transistors **(continued)**

Table 19. Plastic-Encapsulated Surface Mount High-Voltage Transistors

The following table is a listing of small-signal high-voltage devices designed for direct line operation requiring high voltage breakdown and relatively low current capability.

Pinout: 1-Base, 2-Emitter, 3-Collector

Devices are listed in order of descending breakdown voltage.

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	f_T MHz Min
Case 318-07 — TO-236AB (SOT-23) — NPN						
MMBT6517LT1	1Z	350	15	—	100	40
MMBTA42LT1	1D	300	40	—	30	50
MMBT5551LT1	G1	160	30	—	50	100
Case 318-07 — TO-236AB (SOT-23) — PNP						
MMBT6520LT1	2Z	350	15	—	100	40
MMBTA92LT1	2D	300	25	—	30	50
MMBT5401LT1	2L	150	50	—	50	100

Table 20. Plastic-Encapsulated Surface Mount Drivers

The following is a listing of small-signal devices intended for medium voltage driver applications at fairly high current levels.

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	$V_{(BR)CEO}$	h_{FE} @ I_C Min	Max	mA	f_T MHz Min
Case 318-07 — TO-236AB (SOT-23) — NPN						
MMBTA06LT1	1GM	80	100	—	100	100
BSS64LT1	AM	80	20	—	10	50
Case 318-07 — TO-236AB (SOT-23) — PNP						
BSS63LT1	T1	100	30	—	25	50
MMBTA56LT1	2GM	80	100	—	100	50

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Surface Mount Transistors **(continued)**

Table 21. Plastic-Encapsulated Surface Mount RF Transistors

The following table is a listing of small-signal RF transistors intended for low-noise, high-power gain, Class A, AB or C amplifiers. These devices are used as pre-drivers in power amplifier applications.

Pinout: 1-Base, 2-Emitter, 3-Collector

Device	Marking	f_T @ I_C @ V_{CE} GHz Typ	mA	Volts	NF @ I_C @ V_{CE} dB Typ	mA	Volts	MAG @ I_C @ V_{CE} @ f dB Typ	mA	Volts	MHz
Case 318-07 — TO-236AB (SOT-23) — NPN											
MMBR571LT1	7X	8.0	50	5.0	2.0	10	6.0	16.5	5.0	6.0	500
MMBR941LT1	7Y	8.0	15	6.0	2.1	5.0	6.0	8.5	5.0	6.0	2000
MMBR951LT1	7Z	8.0	30	8.0	2.1	5.0	6.0	7.5	5.0	6.0	2000
MMBR911LT1	7P	6.0	30	10	2.0	10	10	17	10	10	500
MMBR930LT1	7C	5.5	30	5.0	1.9	2.0	5.0	11	30	5.0	500
MMBR920LT1	7B	4.5	14	10	2.4	2.0	10	15	2.0	10	500
MMBR901LT1	7A	4.0	15	10	1.9	5.0	6.0	12	5.0	6.0	1000
BFR92LT1	P1	3.4	14	10	3.0	3.0	1.5	—	—	—	500
BFR93LT1	R1	3.4	30	5.0	2.5	2.0	5.0	—	—	—	30
MMBR931LT1	7D	3.0	1.0	1.0	4.3	0.25	1.0	10	0.25	1.0	1000
MMBR5179LT1	7H	1.4	5.0	6.0	4.5	1.5	6.0	15	5.0	6.0	200
MMBR2060LT1	7E	1.0	20	1.0	3.5	1.5	10	13	1.5	10	450
MMBR5031LT1	7G	1.0	5.0	6.0	2.5	1.0	6.0	17	1.0	6.0	450
MMBR2857LT1	7K	1.0	4.0	10	4.5	1.5	6.0	12.5	1.5	6.0	450
BFS17LT1	E1	1.0	2.0	5.0	5.0	2.0	5.0	—	—	—	30
Case 318-07 — TO-236AB (SOT-23) — PNP											
MMBR536LT1	7R	5.5	20	5.0	4.5	10	5.0	14	10	5.0	500
MMBR4957LT1	7F	1.2	2.0	10	3.0	2.0	10	17	2.0	10	450

Table 22. Plastic-Encapsulated Surface Mount Switching Transistors

Pinout: 1-Base, 2-Collector, 3-Emitter, 4-Collector

Device	Marking	t_{on}	t_{off}	$V_{(BR)CEO}$	h_{FE} Min	h_{FE} Max	f_T @ I_C (mA)	f_T Min (MHz)
Case 318E-04 — SOT-223 — NPN								
PZT2222AT1	P1F	35	285	40	100	300	20	300
Case 318E-04 — SOT-223 — PNP								
PZT2907AT1	P2F	45	100	60	100	300	50	200

Table 23. Plastic-Encapsulated Surface Mount Darlingtons

Pinout: 1-Base, 2-Collector, 3-Emitter, 4-Collector

Device	Marking	$V_{(BR)CEO}$	$V_{CE(sat)}$ Max (V)	h_{FE} Min	h_{FE} Max	@ I_C (mA)
Case 318E-04 — SOT-223 — PNP						
PZTA64T1	P2V	30	1.5	20k	—	100

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Plastic-Encapsulated Surface Mount Transistors (continued)

Table 24. Plastic-Encapsulated Surface Mount High-Voltage Transistors

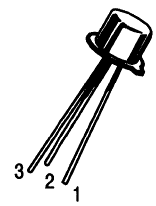
Pinout: 1-Base, 2-Collector, 3-Emitter, 4-Collector

Device	Marking	$V_{(BR)CEO}$	h_{FE} Min	h_{FE} Max	f_T @ I_C (mA)	f_T Min (MHz)
Case 318E-04 — SOT-223 — NPN						
PZTA42T1	P1D	300	40	—	10	50
BF720T1	BF720	250	50	—	10	60
Case 318E-04 — SOT-223 — PNP						
PZTA92T1	P2D	300	40	—	10	50
BF721T1	BF721	250	50	—	10	60
PZTA96T1	ZTA96	450	50	150	10	50
BSP16T1	BSP16	300	30	150	10	15

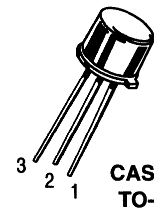
Devices listed in bold, italic are Motorola preferred devices.

Metal-Can Transistors

Metal-can packages are intended for use in industrial applications where harsh environmental conditions are encountered. These packages enhance reliability of the end products due to their resistance to varying humidity and extreme temperature ranges.



CASE 22-03
TO-206AA
(TO-18)
STYLE 1



CASE 79-04
TO-205AD
(TO-39)
STYLE 1

Table 25. Metal-Can General-Purpose Transistors

These transistors are designed for DC to VHF amplifier applications, general-purpose switching applications, and complementary circuitry. Devices are listed in decreasing order of $V_{(BR)CEO}$ within each package group.

Device Type	$V_{(BR)CEO}$ Volts Min	f_T @ I_C MHz Min	mA	I_C mA Max	h_{FE} @ I_C Min	Max	mA
Case 22-03 — TO-206AA (TO-18) — NPN							
2N720A	80	50	50	150	40	120	150
2N3700	80	80	50	1000	50	—	500
BC107	45	150	10	200	110	450	2.0
BC107A	45	150	10	200	110	220	2.0
BC107B	45	150	10	200	200	450	2.0
BCY59-IX	45	125	10	200	250	460	2.0
BCY59-VIII	45	125	10	200	180	310	2.0
2N2222A	40	300	20	800	100	300	150
2N3947	40	300	10	200	100	300	10
BCY58-VIII	32	125	10	200	180	310	2.0
BC109C	25	150	10	200	420	800	2.0
Case 22-03 — TO-206AA (TO-18) — PNP							
2N2906A	60	200	50	600	40	120	150
2N2907A	60	200	50	600	100	300	150
2N3251A	60	300	10	200	100	300	10
BC177B	45	200	10	200	180	460	2.0
BCY79-IX	45	180	10	200	250	460	2.0
BCY79-VIII	45	180	10	200	180	310	2.0
Case 79-04 — TO-205AD (TO-39) — NPN							
2N3019	80	100	50	1000	100	300	150
2N3020	80	80	50	1000	40	120	150
2N1893	80	50	50	500	40	120	150
2N2219A	40	300	20	800	100	300	150
2N2218A	40	250	20	800	40	120	150
Case 79-04 — TO-205AD (TO-39) — PNP							
MM5007	100	30	50	2000	50	250	250
2N4033	80	—	—	1000	25	—	1000
2N4036	65	60	50	1000	40	140	150
2N2904A	60	200	50	600	40	120	150
2N2905A	60	200	50	600	100	300	150
2N4032	60	—	—	1000	40	—	1000

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Metal-Can Transistors (continued)

Table 26. Metal-Can High-Gain/Low-Noise Transistors

These transistors are characterized for high-gain and low-noise applications. Devices are listed in decreasing order of NF.

Device Type	NF Wideband dB Typ Max	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} @ I_C Min	Max	µA mA	f_T @ I_C MHz Min	mA
Case 22-03 — TO-206AA (TO-18) — NPN								
2N2484	8.0(1)	60	50	100	500	10	15	0.05
2N930A	3.0	45	30	—	600	10	45	0.5
2N930	3.0	45	30	—	600	10	30	0.5
Case 22-03 — TO-206AA (TO-18) — PNP								
2N3964	4.0	45	200	250	600	1.0(24)	50	0.5
2N3799	2.5	60	50	300	900	500	30	0.5

Table 27. Metal-Can High-Voltage/High-Current Transistors

The following table lists Motorola standard devices that have high collector-emitter breakdown voltage. Devices are listed in decreasing order of $V_{(BR)CEO}$ within each package type.

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} @ I_C Min	mA	$V_{CE(sat)}$ @ I_C & I_B Volts Max	mA	mA	f_T @ I_C MHz Min	mA
Case 22-03 — TO-206AA (TO-18) — NPN									
2N6431	300	50	50	30	0.5	20	2.0	50	10
BSS73	300	500	40	30	1.0	50	5.0	50	20
Case 22-03 — TO-206AA (TO-18) — PNP									
2N6433	300	500	30	30	0.5	20	20	50	10
BSS76	300	500	35	30	0.5	50	5.0	50	20
2N3497	120	100	40	10	0.35	10	1.0	150	20
Case 79-04 — TO-205AD (TO-39) — NPN									
2N5058	300	150	35	30	1.0	30	3.0	30	10
BF259	300	100	25	30	1.0	30	6.0	110(1)	30
2N4927	250	50	20	30	2.0	30	3.0	30	10
2N3500	150	300	40	150	0.4	150	15	150	20
2N3501	150	300	100	150	0.4	150	15	150	20
2N3499	100	500	100	150	0.6	300	30	150	20
MM3007	100	2500	50	250	0.35	150	15	50	50
Case 79-04 — TO-205AD (TO-39) — PNP									
2N4931	250	50	20	30	5.0	10	1.0	20	20
2N3636	175	1000	50	50	0.5	50	5.0	150	30
2N3637	175	1000	100	50	0.5	50	5.0	200	30
MM5007	100	2000	50	250	0.5	150	15	30	50

(1)Typical
(24)$T_A = 25°C$

Devices listed in bold, italic are Motorola preferred devices.

Bipolar Transistors: Metal-Can Transistors **(continued)**

Table 28. Metal-Can Switching Transistors

The following devices are intended for use in general-purpose switching and amplifier applications. Within each package group shown, the devices are listed in order of decreasing turn-on time (t_{on}).

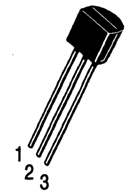
Device Type	t_{on} & t_{off} @ I_C ns Max	ns Max	mA	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} @ I_C Min	mA	$V_{CE(sat)}$ @ I_C @ I_B Volts Max	mA	mA	f_T MHz Min	I_C mA
Case 22-03 — TO-206AA (TO-18) — NPN												
2N4014	35	60	500	40	1000	35	500	0.52	500	50	300	50
2N2369A	12	18	10	15	200	40	10	0.2	10	1.0	500	10
BSX20	7.0	21	100	15	500	20	10	0.25	10	1.0	500	10
Case 22-03 — TO-206AA (TO-18) — PNP												
2N2894	60	90	30	12	200	40	30	0.2	30	3.0	400	30
2N869A	50	80	30	18	200	40	30	0.2	30	3.0	400	10
2N3546	40	30	50	12	200	25	50	0.25	50	5.0	700	10
MM4209	15	20	10	15	50	35	10	0.6	50	5.0	850	10
Case 79-04 — TO-205AD (TO-39) — NPN												
MM3725	35	60	500	40	2000	35	500	0.52	500	50	300	50
Case 79-04 — TO-205AD (TO-39) — PNP												
2N3467	40	90	500	40	1000	40	500	0.5	500	50	175	50
2N3468	40	90	500	50	1000	25	500	0.6	500	50	150	50
2N3762	11.5	105	1000	40	1500	30	1000	0.9	1000	100	180	50

Devices listed in bold, italic are Motorola preferred devices.

Field-Effect Transistors

JFETs

JFETs operate in the depletion mode. They are available in both P- and N-channel and are offered in both Through-hole and Surface Mount packages. Applications include general-purpose amplifiers, switches and choppers, and RF amplifiers and mixers. These devices are economical and very rugged. The drain and source are interchangeable on many typical FETs.



CASE 29-04
TO-226AA
(TO-92)

Table 29. JFET Low-Frequency/Low-Noise

The following table is a listing of small-signal JFETs intended for low-noise applications in the audio range. These devices exhibit good linearity and are candidates for hi-fi and instrumentation equipment.

Device	$R_e \lvert Y_{fs} \rvert$ mmho Min	@ f kHz	$R_e \lvert Y_{os} \rvert$ µmho Max	@ f kHz	C_{iss} pF Max	C_{rss} pF Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	$V_{GS(off)}$ Volts Min	$V_{GS(off)}$ Volts Max	I_{DSS} mA Min	I_{DSS} mA Max	Style
Case 29-04 — TO-226AA (TO-92) — N-Channel												
J202	—	—	—	—	—	—	40	0.8	4.0	0.9	4.5	5
2N5458	1.5	1.0	50	1.0	7.0	3.0	25	1.0	7.0	2.0	9.0	5
J203	—	—	—	—	—	—	40	2.0	10	4.0	20	5
MPF3821	1.5	1.0	10	1.0	6.0	3.0	50	—	4.0	0.5	2.5	5
2N5457	1.0	1.0	50	1.0	7.0	3.0	25	0.5	6.0	1.0	5.0	5
2N5459	2.0	1.0	50	1.0	7.0	3.0	25	2.0	8.0	4.0	16	5
MPF3822	3.0	1.0	20	1.0	6.0	3.0	50	—	6.0	2.0	10	5
Case 29-04 — TO-226AA (TO-92) — P-Channel												
2N5460	1.0	1.0	75	1.0	7.0	2.0	40	0.75	6.0	1.0	5.0	7
2N5461	1.5	1.0	75	1.0	7.0	2.0	40	1.0	7.5	2.0	9.0	7
2N5462	2.0	1.0	75	1.0	7.0	2.0	40	1.8	9.0	4.0	16	7

Table 30. JFET High-Frequency Amplifiers

The following is a listing of small-signal JFETs that are intended for hi-frequency applications. These are candidates for VHF/UHF oscillators, mixers and front-end amplifiers.

Device	$R_e \lvert Y_{fs} \rvert$ mmho Min	@ f MHz	$R_e \lvert Y_{os} \rvert$ µmho Max	@ f MHz	C_{iss} pF Max	C_{rss} pF Max	NF @ R_G = 1K dB Max	NF @ R_G = 1K f MHz	$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	$V_{GS(off)}$ Volts Min	$V_{GS(off)}$ Volts Max	I_{DSS} mA Min	I_{DSS} mA Max	Style
Case 29-04 — TO-226AA (TO-92) — N-Channel														
2N5669	1.6	100	100	100	7.0	3.0	2.5	100	25	1.0	6.0	4.0	10	5
MPF102	1.6	100	200	100	7.0	3.0	—	—	25	—	8.0	2.0	20	5
2N5668	1.0	100	50	100	7.0	3.0	2.5	100	25	0.2	4.0	1.0	5.0	5
2N5484	2.5	100	75	100	5.0	1.0	3.0	100	25	0.3	3.0	1.0	5.0	5
2N5670	2.5	100	150	100	7.0	3.0	2.5	100	25	2.0	8.0	8.0	20	5
2N5485	3.0	400	100	400	5.0	1.0	4.0	400	25	0.5	4.0	4.0	10	5
2N5486	3.5	400	100	400	5.0	1.0	4.0	400	25	2.0	6.0	8.0	20	5
J300	4.5	0.001	200	0.001	5.5	1.7	—	—	25	1.0	6.0	6.0	30	5
J308	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	1.0	6.5	12	60	5
J309	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	1.0	4.0	12	30	5
J310	12(1)	100	250(1)	100	7.5	2.5	1.5(1)	100	25	2.0	6.5	24	60	5

(1)Typical

Devices listed in bold, italic are Motorola preferred devices.

Field-Effect Transistors: JFETs (continued)

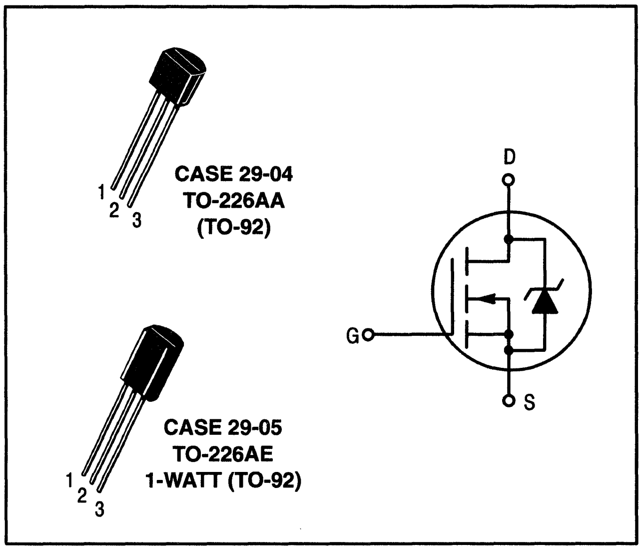
Table 31. JFET Switches and Choppers

The following is a listing of JFETs intended for switching and chopper applications.

Device	$R_{DS(on)}$ @ I_D Ω Max	mA	$V_{GS(off)}$ Volts Min	Max	I_{DSS} mA Min	Max	$V_{(BR)GSS}$ $V_{(BR)GDO}$ Volts Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max	Style
Case 29-04 — TO-226AA (TO-92) — N-Channel												
MPF4856	25	—	4.0	10	50	—	40	18	8.0	9.0	25	5
MPF4859	25	—	4.0	10	50	—	30	18	8.0	9.0	25	5
2N5638	30	1.0	—	(12)(1)	50	—	30	10	4.0	9.0	15	5
J111	30	—	3.0	10	20	—	35	28	5.0	—	—	5
MPF4857	40	—	2.0	6.0	20	100	40	18	8.0	10	50	5
MPF4860	40	—	2.0	6.0	20	100	30	18	8.0	10	50	5
J112	50	—	1.0	5.0	5.0	—	35	28	5.0	—	—	5
MPF4392	60	—	—	—	25	75	30	10	3.5	15	35	5
2N5639	60	1.0	—	(8.0)(1)	25	—	30	10	4.0	—	—	5
MPF4858	60	—	0.8	4.0	8.0	80	40	18	8.0	20	100	5
MPF4861	60	—	0.8	4.0	8.0	80	30	18	8.0	20	100	5
MPF4393	100	—	—	(12)(1)	5.0	30	30	10	3.5	15	55	5
2N5640	100	1.0	—	(6.0)(1)	5.0	—	30	10	4.0	18	45	5
J113	100	—	0.5	3.0	2.0	—	35	28	5.0	—	—	5
2N5555	150	—	—	1.0(16)	15	—	25	5.0	1.2	10	25	5
BF246	—	—	0.6	14	30	250	25	—	—	—	—	22
BF246A	35(1)	1.0	0.6	14	30	80	25	—	—	—	—	22
BF246B	50(1)	1.0	0.6	14	60	140	25	—	—	—	—	22
BF246C	65(1)	1.0	0.6	14	110	250	25	—	—	—	—	22
J109	12	—	2.0	6.0	40	—	25	—	—	—	—	5
J110	18	—	0.5	4.0	10	—	25	—	—	—	—	5
Case 29-04 — TO-226AA (TO-92) — P-Channel												
MPF970	100	1.0	5.0	12	15	100	30	12	5.0	8.0	25	5
MPF971	250	1.0	1.0	7.0	2.0	50	30	12	5.0	10	120	5
J174	85	—	5.0	10	2.0	100	30	—	—	—	—	30
J175	125	—	3.0	6.0	7.0	60	30	—	—	—	—	30
J176	250	—	1.0	4.0	2.0	25	30	—	—	—	—	30
J177	300	—	0.8	2.5	1.5	20	30	—	—	—	—	30

(1)Typical
(16)$V_{GS(f)}$

Devices listed in bold, italic are Motorola preferred devices.



MOSFETs

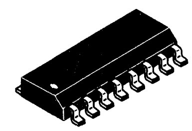
Table 32. TMOS Switches and Choppers

The following is a listing of small-signal TMOS devices that are intended for switching and chopper applications. These devices offer low $R_{DS(on)}$ characteristics.

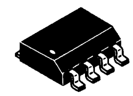
Device	$R_{DS(on)}$ @ I_D Ω Max	A	$V_{GS(th)}$ Volts Min	Max	$V_{(BR)DSS}$ Volts Min	C_{iss} pF Max	C_{rss} pF Max	t_{on} ns Max	t_{off} ns Max	Style
Case 29-05 — TO-226AE (1-WATT TO-92) — N-Channel										
MPF930	1.4	1.0	1.0	3.5	35	70(1)	20(1)	15	15	22
MPF960	1.7	1.0	1.0	3.5	60	70(1)	20(1)	15	15	22
MPF6659	1.8	1.0	0.8	2.0	35	30(1)	4(1)	5.0	5.0	22
MPF990	2.0	1.0	1.0	3.5	90	70(1)	20(1)	15	15	22
MPF6660	3.0	1.0	0.8	2.0	60	30(1)	4(1)	5.0	5.0	22
MPF6661	4.0	1.0	0.8	2.0	90	30(1)	4(1)	5.0	5.0	22
MPF910	5.0	0.5	0.3	2.5	60	—	—	—	—	22
VN10LM	5.0	0.5	0.8	2.5	60	60	5.0	10	10	22
MPF89	6.0	0.30	1.0	2.7	200	70(1)	3(1)	6(1)	12(1)	7
Case 29-04 — TO-226AA (TO-92) — N-Channel										
VN0300L	1.2	1.0	0.8	2.5	60	100	25	30	30	22
2N7000	5.0	0.5	0.8	3.0	60	60	5.0	10	10	22
BS170	5.0	0.2	0.8	3.0	60	25(1)	3.0(1)	10	10	30
VN0610LL	5.0	0.5	0.8	2.5	60	60	5.0	10	10	22
VN1706L	6.0	0.5	0.8	2.0	170	125	20	8.0	18	22
VN2406L	6.0	0.5	0.8	2.0	240	125	20	8.0	23	22
BSS89	6.0	0.30	1.0	2.7	200	72(1)	3.0(1)	6.0(1)	12(1)	7
BS107A	6.4	0.25	1.0	3.0	200	60(1)	6.0(1)	15	15	30
2N7008	7.5	0.5	1.0	2.5	60	50	5.0	20	20	22
VN2222LL	7.5	0.5	0.6	2.5	60	60	5.0	10	10	22
VN2410L	10	0.5	0.8	2.0	240	125	20	8.0	23	22
BS107	14	0.2	1.0	3.0	200	60(1)	6.0(1)	15	15	30

(1)Typical

Devices listed in bold, italic are Motorola preferred devices.



CASE 751B-05
SO-16
STYLE 7



CASE 751-04
SO-8
STYLE 11

MOSFETs

Medium Power TMOS FETs

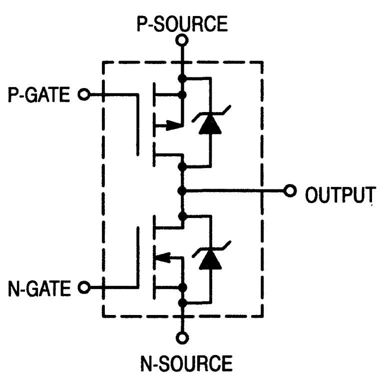
Multiple Chip TMOS Products in SOIC Surface Mount Packages

Multiple chip surface mount TMOS MOSFETs in SOIC packages simplify circuit design through component count and board space reduction. These devices are designed for use in bridge circuits in low voltage, motor control applications such as disk drives, tape drives, optical drives, printers and plotters and they can also be used for driving relays and solenoids. Both devices feature low $R_{DS(on)}$ and a specially designed leadframe for maximum power dissipation. These devices fit the standard SO-8 and SO-16 footprints.

Table 33. Multiple Chip Products in SOIC

Part Number	V_{DSS} (Volts) Min	P-Channel $R_{DS(on)}$ Ohms	N-Channel $R_{DS(on)}$ Ohms	I_D (cont) Amps	P_D(24) (Watts) Max	Description
MMDF2C05E	50	0.3	0.3	2.0	2.0(26)	Complementary Half-Bridge
MMDF2N02E	20	—	0.1	2.2	1.5(25)	Dual N-Channel

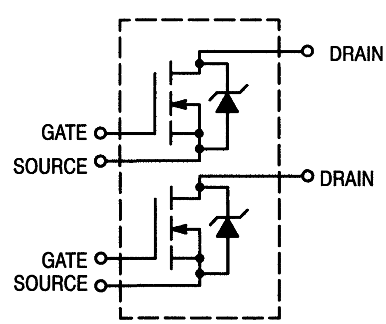
(24)$T_A = 25°C$
(25)Power rating with both die "on" when mounted on FR-4 glass epoxy printed circuit board with the recommended footprint
(26)P or N Channel device only



MMDF2C05E
Half-Bridge

Use MMDF2C05ER1 to order the 7 inch/500 unit reel.
Use MMDF2C05ER2 to order the 13 inch/2500 unit reel.

Tape Size = 16 mm



MMDF2N02E
Dual N-Channel

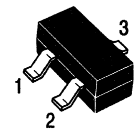
Use MMDF2N02ER1 to order the 7 inch/500 unit reel.
Use MMDF2N02ER2 to order the 13 inch/2500 unit reel.

Tape Size = 12 mm

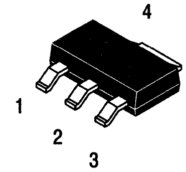
Devices listed in bold, italic are Motorola preferred devices.

Surface Mount FETs

This section contains the FET plastic packages available for surface mount applications. Most of these devices are the most popular metal-can and insertion type parts carried over to the new surface mount packages.



CASE 318-07
TO-236AB
SOT-23



CASE 318E-04
SOT-223

Table 34. JFET Surface Mount RF

The following is a list of surface mount FETs which are intended for VHF/UHF RF amplifier applications.

Pinout: 1-Drain, 2-Source, 3-Gate

Device	Marking	NF dB Typ	NF f MHz	Y_{fs} @ V_{DS} mmhos Min	Y_{fs} @ V_{DS} mmhos Max	Y_{fs} @ V_{DS} Volts	$V_{(BR)GSS}$	Style
Case 318-07 — TO-236AB (SOT-23) — N-Channel								
MMBFJ309LT1	6U	1.5	450	10	20	10	25	10
MMBFJ310LT1	6T	1.5	450	8.0	18	10	25	10
MMBFU310LT1	M6C	1.5	450	10	18	10	25	10
MMBF4416LT1	M6A	2(3)	100	4.5	7.5	15	30	10
MMBF5484LT1	M6B	2.0	100	3.0	6.0	15	25	10
MMBF5486LT1	6H	2.0	100	4.0	8.0	15	25	10

Table 35. JFET Surface Mount General-Purpose

The following table is a listing of surface mount small-signal general purpose FETs. These devices are intended for small-signal amplification for DC, audio, and lower RF frequencies. They also have applications as oscillators and general-purpose, low-voltage switches.

Pinout: 1-Drain, 2-Source, 3-Gate

Device	Marking	$V_{(BR)GSS}$	Y_{fs} @ V_{DS} mmhos Min	Y_{fs} @ V_{DS} mmhos Max	Y_{fs} @ V_{DS} Volts	I_{DSS} mA Min	I_{DSS} mA Max	Style
Case 318-07 — TO-236AB (SOT-23) — N-Channel								
MMBF5457LT1	6D	25	1.0	5.0	15	1.0	5.0	10
MMBF5459LT1	6L	25	2.0	6.0	15	4.0	16	10
Case 318-07 — TO-236AB (SOT-23) — P-Channel								
MMBF5460LT1	M6E	40	1.0	4.0	15	1.0	5.0	10

(3)Max

Devices listed in bold, italic are Motorola preferred devices.

Field-Effect Transistors: Surface Mount FETs **(continued)**

Table 36. JFET Surface Mount Choppers/Switches

The following is a listing of small-signal surface mount JFET devices intended for switching and chopper applications.

Pinout: 1-Drain, 2-Source, 3-Gate

Device	Marking	$R_{DS(on)}$ Ohms Max	t_{off} ns Max	$V_{(BR)GSS}$	$V_{GS(off)}$ Volts Min	$V_{GS(off)}$ Volts Max	I_{DSS} mA Min	I_{DSS} mA Max	Style
Case 318-07 — TO-236AB (SOT-23) — N-Channel									
MMBF4856LT1	AAA	25	25	40	4.0	10	50	—	10
MMBF4391LT1	6J	30	20	30	4.0	10	50	150	10
MMBF4860LT1	6F	40	50	30	2.0	6.0	20	100	10
MMBF4392LT1	6K	60	35	30	2.0	5.0	25	75	10
MMBF4393LT1	6G	100	50	30	0.5	3.0	5.0	30	10
Case 318-07 — TO-236AB (SOT-23) — P-Channel									
MMBFJ175LT1	6W	125	—	–30	3.0	6.0	7.0	60	10
MMBFJ177LT1	6Y	300	—	–30	0.8	2.5	1.5	20	10

Table 37. TMOS FETs

The following is a listing of small-signal surface mount TMOS FETs which exhibit low $R_{DS(on)}$ characteristics.

Pinout: 1-Gate, 2-Source, 3-Drain

Device	Marking	$R_{DS(on)}$ @ I_D Ohm	$R_{DS(on)}$ @ I_D mA	V_{DSS}	$V_{GS(th)}$ Volts Min	$V_{GS(th)}$ Volts Max	Switching Time t_{on} ns	Switching Time t_{off} ns	Style
Case 318-07 — TO-236AB (SOT-23) — N-Channel									
MMBF170LT1	6Z	5.0	200	60	0.8	3.0	10	10	21
BSS123LT1	SA	6.0	100	100	0.8	2.8	20	40	21
2N7002LT1	702	7.5	500	60	1.0	2.5	20	20	21

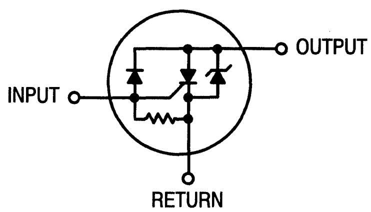
Pinout: 1-Gate, 2-Drain, 3-Source, 4-Drain

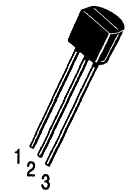
Device	Marking	$R_{DS(on)}$ Ohm	$R_{DS(on)}$ mA	V_{DSS}	$V_{GS(th)}$ Volts Min	$V_{GS(th)}$ Volts Max	Switching Time t_{on} ns	Switching Time t_{off} ns	Style
Case 318E-04 — SOT-223 — N-Channel									
MMFT3055ET1	3055E	0.15	850	60	2.0	4.5	—	—	3
MMFT2N02ELT1	2N02L	0.15	1000	20	1.0	2.0	—	—	3
MMFT3055ELT1	3055L	0.18	750	60	1.0	2.0	—	—	3
MMFT1N10ET1	1N10	0.25	500	100	2.0	4.5	—	—	3
MMFT2955ET1	2955E	0.3	600	60	2.0	4.5	—	—	3
MMFT960T1	FT960	1.7	1000	60	1.0	3.5	15	15	3
MMFT3166T1	T3166	2	500	60	1.6	3.5	—	—	3
MMFT6661T1	T6661	4.0	1000	90	0.8	2.0	5.0	5.0	3
MMFT107T1	FT107	14	200	200	1.0	3.0	15	15	3
MMFT2406T1	T2406	10	200	240	0.8	2.0	—	—	3

Devices listed in bold, italic are Motorola preferred devices.

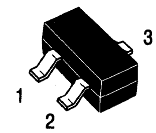
SMALLBLOCK™ Products

This new series of MOSFET turn-off devices offers an economical way to reduce the turn-off time of power MOSFETs. Additionally, they clamp the MOSFET gate voltage to a safe level. The use of a MOSFET turn-off device lowers component count, reduces system cost and board space, and optimizes the switching performance of the MOSFET. Applications for these devices include PWM circuits in switchmode power supplies, DC-DC converters and motor controls for brush and brushless motors.

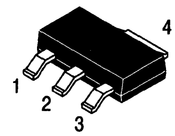




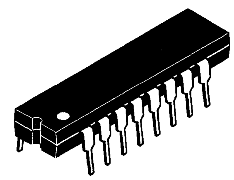
CASE 29-05
(TO-226AE)
TO-92
STYLE 33



CASE 318-07
(TO-236AB)
SOT-23
STYLE 22



CASE 318E-04
(TO-261AA)
SOT-223
STYLE 6



CASE 738B-03

Table 38. MOSFET Turn-Off Devices

The following table is a listing of MOSFET turn-off devices used for reduced turn-off of power MOSFETs.

Device	Marking	V_{in} @ 2 mA Min	V_{in} @ 2 mA Max	V_{out} @ 2 mA Min	V_{out} @ 2 mA Max	t_{off} (1000 pF) Typ
Case 29-04 — TO-226AA (TO-92) Pinout: 1-Return, 2-Input, 3-Output						
MDC1000A	MDC1000	9.5	12	9	11.5	15 ns
MDC1005A	MDC1005	5.5	6.5	5	6.3	22 ns
Case 318-07 — TO-236AB (SOT-23) Pinout: 1-Return, 3-Output, 2-Input						
MDC1000BLT1	C10	9.5	12.5	9	12	15 ns
MDC1005BLT1	C05	5.5	6.8	5	6.3	22 ns
Case 318E-04 — TO-261AA (SOT-223) Pinout: 1-Return, 2-Input, 3-Output, 4-Input						
MDC1000CT1	C1000	9.5	12.5	9	12	15 ns

Device	Marking	V_{in} @ 10 mA Min	V_{in} @ 10 mA Max	V_{out} @ 10 mA Min	V_{out} @ 10 mA Max	t_{off} (1000 pF) Typ
Case 29-05 — TO-226AE (TO-92) Pinout: 1-Return, 2-Input, 3-Output						
MDC1100A	MDC1100	9.5	12	9	11.5	15 ns
MDC1115A	MDC1115	15	17.5	14.5	17.5	20 ns
Case 318E-04 — TO-261AA (SOT-223) Pinout: 1-Return, 2-Input, 3-Output, 4-Input						
MDC1100CT1	C1100	9.5	12	9	11.5	15 ns
MDC1115CT1	C1115	15	17.5	14.5	17.5	20 ns

Devices listed in bold, italic are Motorola preferred devices.

SMALLBLOCK Products (continued)

Table 39. Constant Current Source

Device	Marking	I_{out} @ 3 V		I_{out} @ 35 V		Line Regulation	
		Min	Max	Min	Max	Min	Max
Case 29-04 TO-226AA (TO-92) Pinout: 1-Input, 2-Output							
MDC4010A	MDC4010	9	11	9	11	– 0.5%	5%
Case 318E-04 TO-261AA (SOT-223) Pinout: 1-Input, 2-Output, 3-NC, 4-Output							
MDC4010CT1	C4010	9	11	9	11	– 0.5%	5%

Table 40. High Voltage Level Shifter

Device	Marking	(BV)CEO Min	(BV)CBO Min	h_{FE} @ 2 mA/5 V Min	I_e, Q1-Q3 Continuous	I_e, Q4-Q6 Continuous
Case 738B-03 Pinout: 1-NC, 2-Anode, 3-Emitter, Q6, 4-Emitter Q5, 5-Emitter Q4, 6-Emitter Q3, 7-Emitter Q2, 8-Emitter Q1, 9-Cathode, Common Base, 10-NC, 11-Collector Q7, 12-Collector Q1, 13-Collector Q2, 14-Collector Q3, 15-NC, 16-Collector Q4, 17-NC, 18-Collector Q5, 19-NC, 20-Collector Q6.						
MDC2125	MDC2125	250	250	5	2mA	50 mA

Devices listed in bold, italic are Motorola preferred devices.

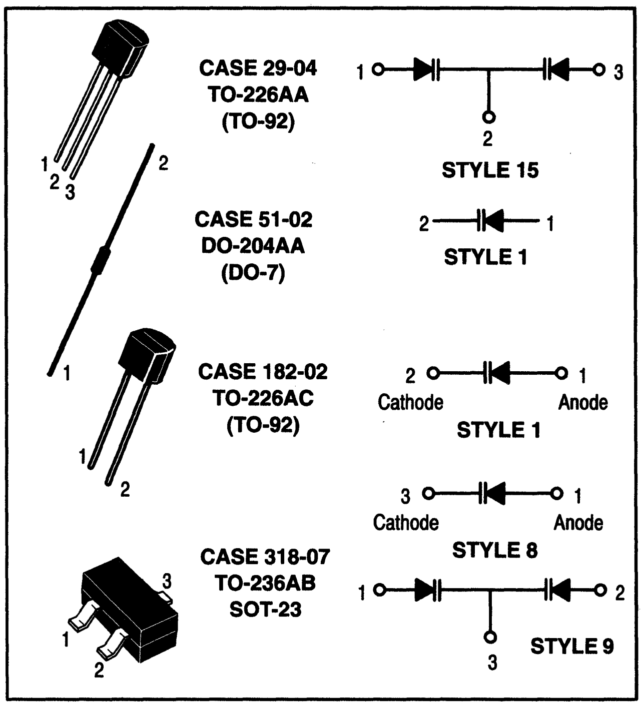
Tuning and Switching Diodes

Tuning Diodes — Abrupt Junction

Motorola supplies voltage-variable capacitance diodes serving the entire range of frequencies from HF through UHF. Used in RF receivers and transmitters, they have a variety of applications, including:

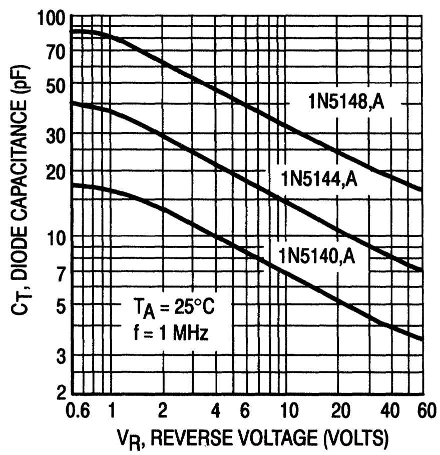
- Phase-locked loop tuning systems
- Local oscillator tuning
- Tuned RF preselectors
- RF filters
- RF phase shifters
- RF amplifiers
- Automatic frequency control
- Video filters and delay lines
- Harmonic generators
- FM modulators

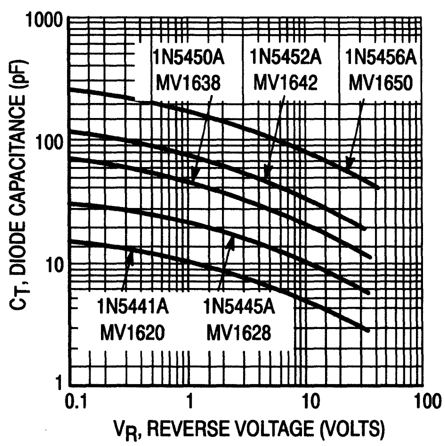
Two families of devices are available: Abrupt Junction and Hyper Abrupt Junction. The Abrupt Junction family includes devices suitable for virtually all tuned-circuit and narrow-range tuning applications throughout the spectrum.



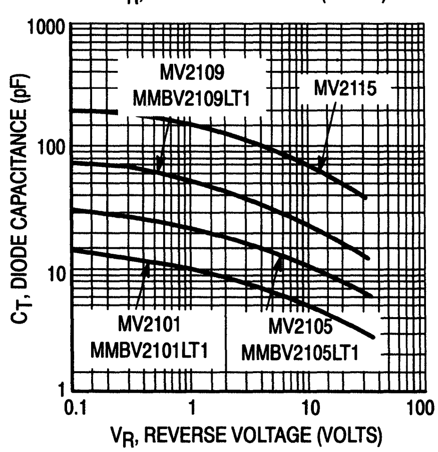
Typical Characteristics

Diode Capacitance versus Reverse Voltage

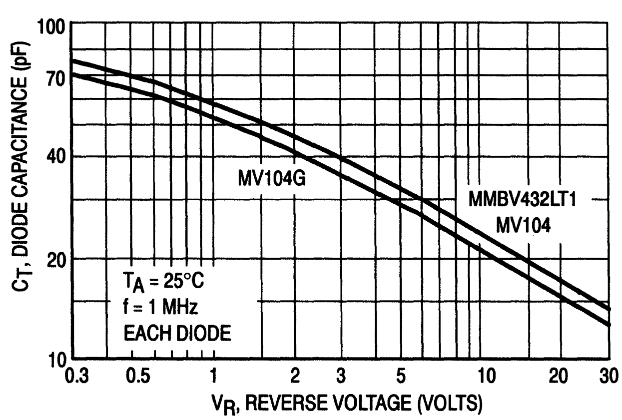




(See Tables 1 Thru 3)



(See Tables 4 and 5)



(See Table 6)

Tuning and Switching Diodes: Tuning Diodes — Abrupt Junction (continued)

Table 41. General-Purpose Glass Abrupt Tuning Diodes High Q Capacitance Ratio @ 4.0 Volts/60 Volts

The following is a listing of axial leaded, general-purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

Device(19)	C_T @ V_R = 4.0 V, 1.0 MHz pF Min	pF Nominal	pF Max	$V_{(BR)R}$ Volts	Cap Ratio C4/C60 Min	Q 4.0 V, 50 MHz Min
Case 51-02 — DO-204AA (DO-7)						
1N5139	6.1	6.8	7.5	60	2.7	350
1N5140	9.0	10	11	60	2.8	300
1N5141	10.8	12	13.2	60	2.8	300
1N5142	13.5	15	16.5	60	2.8	250
1N5143	16.2	18	19.8	60	2.8	250
1N5144	19.8	22	24.2	60	3.2	200
1N5145	24.3	27	29.7	60	3.2	200
1N5146	29.7	33	36.3	60	3.2	200
1N5147	35.1	39	42.9	60	3.2	200
1N5148	42.3	47	51.7	60	3.2	200

Table 42. General-Purpose Glass Abrupt Tuning Diodes High Q Capacitance Ratio @ 2.0 Volts/30 Volts

The following is a listing of axial leaded, general-purpose, abrupt tuning diodes. These devices exhibit very high Q characteristics.

Device(20)	C_T @ V_R = 4.0 V, 1.0 MHz pF Min	pF Nominal	pF Max	$V_{R(BR)R}$ Volts	Cap Ratio C2/C30 Min	Q 4.0 V, 50 MHz Min
Case 51-02 — DO-204AA (DO-7)						
1N5441A	6.1	6.8	7.5	30	2.5	450
1N5443A	9.0	10	11	30	2.6	400
1N5444A	10.8	12	13.2	30	2.6	400
1N5445A	13.5	15	16.5	30	2.6	400
1N5446A	16.2	18	19.8	30	2.6	350
1N5448A	19.8	22	24.2	30	2.6	350
1N5449A	24.3	27	29.7	30	2.6	350
1N5450A	29.7	33	36.3	30	2.6	350
1N5451A	35.1	39	42.9	30	2.6	300
1N5452A	42.3	47	51.7	30	2.6	250
1N5453A	50.4	56	61.6	30	2.6	200
1N5455A	73.8	82	90.2	30	2.7	175
1N5456A	90	100	110	30	2.7	175

(19)Suffix A = 5.0%
(20)Suffix B = 5.0%

Tuning and Switching Diodes: Tuning Diodes — Abrupt Junction (continued)

Table 43. General-Purpose Glass Abrupt Tuning Diodes
Capacitance Ratio @ 2.0 Volts/20 Volts

The following is a listing of axial leaded, general-purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

Device	C_T @ V_R = 4.0 V, 1.0 MHz pF Min	pF Nominal	pF Max	$V_{(BR)R}$ Volts	Cap Ratio C2/C20 Min	Q 4.0 V, 50 MHz Typ
Case 51-02 — DO-204AA (DO-7)						
MV1620	6.1	6.8	7.5	20	2.0	300
MV1624	9.0	10	11	20	2.0	300
MV1626	10.8	12	13.2	20	2.0	300
MV1628	13.5	15	16.5	20	2.0	250
MV1630	16.2	18	19.8	20	2.0	250
NV1634	19.8	22	24.2	20	2.0	250
MV1636	24.3	27	29.7	20	2.0	200
MV1638	29.7	33	36.3	20	2.0	200
MV1640	35.1	39	42.9	20	2.0	200
MV1642	42.3	47	51.7	20	2.0	200
MV1644	50.4	56	61.6	20	2.0	150
MV1648	73.8	82	90.2	20	2.0	150
MV1650	90	100	110	20	2.0	150

Table 44. General-Purpose Plastic Abrupt Tuning Diodes
Capacitance Ratio @ 2.0 Volts/30 Volts

The following is a listing of plastic package, general-purpose, abrupt tuning diodes. These devices exhibit high Q characteristics.

Device	C_T @ V_R = 4.0 V, 1.0 MHz pF Min	pF Nominal	pF Max	$V_{R(BR)R}$ Volts	Cap Ratio C4/C30 Min	Q 4.0 V, 50 MHz Typ
Case 182-02 — TO-226AC (TO-92) — 2-Lead						
MV2101	6.1	6.8	7.5	30	2.5	400
MV2103	9.0	10	11	30	2.5	350
MV2104	10.8	12	13.2	30	2.5	350
MV2105	13.5	15	16.5	30	2.5	350
MV2107	19.8	22	24.2	30	2.5	300
MV2108	24.3	27	29.7	30	2.5	250
MV2109	29.7	33	36.3	30	2.5	200
MV2111	42.3	47	51.7	30	2.5	150
MV2113	61.2	68	74.8	30	2.5	150
MV2114	73.8	82	90.2	30	2.5	100
MV2115	90	100	110	30	2.6	100

Devices listed in bold, italic are Motorola preferred devices.

Tuning and Switching Diodes: Tuning Diodes — Abrupt Junction (continued)

Table 45. Surface Mount Abrupt Tuning Diodes Capacitance Ratio @ 2.0 Volts/30 Volts

The following is a listing of surface mount abrupt junction tuning diodes intended for general-purpose variable capacitance circuit applications.

Device	C_T @ V_R = 4.0 V, 1.0 MHz pF Min	pF Nominal	pF Max	$V_{R(BR)R}$ Volts	Cap Ratio C2/C30 Min	Q 4.0 V, 50 MHz Typ
Case 318-07 — DO-236AB (SOT-23)						
MMBV2101LT1	6.1	6.8	7.5	30	2.5	400
MMBV2103LT1	9.0	10	11	30	2.5	350
MMBV2104LT1	10.8	12	13.2	30	2.5	350
MMBV2105LT1	13.5	15	16.5	30	2.5	350
MMBV2107LT1	19.8	22	24.2	30	2.5	300
MMBV2108LT1	24.3	27	29.7	30	2.5	250
MMBV2109LT1	29.7	33	36.3	30	2.5	200

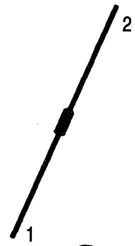
Table 46. Abrupt Tuning Diodes for FM Radio — Dual

The following is a listing of abrupt tuning diodes that are available as dual units in a single package.

Device	C_T @ V_R(22) pF Min	pF Max	Volts	Cap Ratio C3/C30 Min	Q 3.0 V, 50 MHz Min	$V_{(BR)R}$ Volts	Device Marking	Style
Case 29-04 — TO-226AA (TO-92)								
MV104	37	42	3.0	2.5	100	32	—	15
Case 318-07 — TO-236AB (SOT-23)								
MMBV432LT1	43	48.1	2.0	1.5(21)	100	14	M4B	9

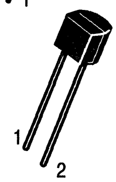
(21)C2/C8
(22)Each Diode

Devices listed in bold, italic are Motorola preferred devices.



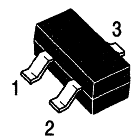
CASE 51-02
DO-204AA
(DO-7)

STYLE 1



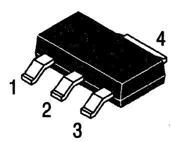
CASE 182-02
TO-226AC
(TO-92)

STYLE 1



CASE 318-07
TO-236AB
SOT-23

STYLE 8



CASE 318E-04
SOT-223

STYLE 2

Tuning Diodes — Hyper-Abrupt Junction

The Hyper Abrupt family exhibits higher capacitance, and a much larger capacitance ratio. It is particularly well suited for wider-range applications such as AM/FM radio and TV tuning.

Typical Characteristics

Diode Capacitance versus Reverse Voltage

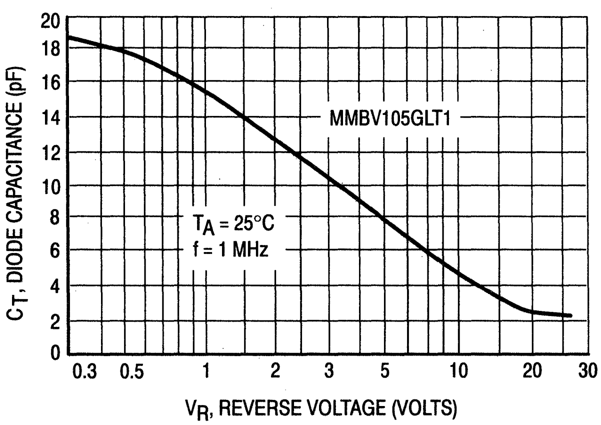


Figure 1. Diode Capacitance

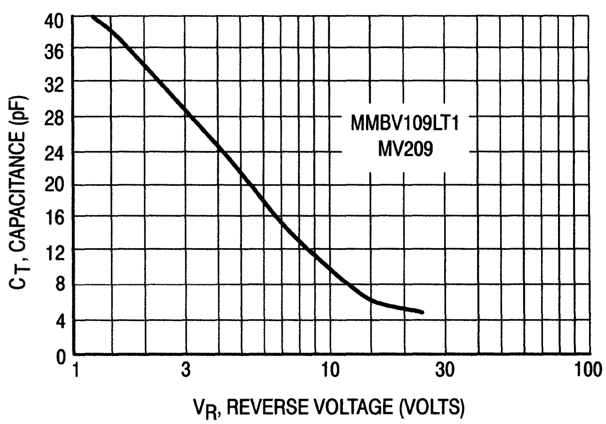


Figure 2. Diode Capacitance

Tuning and Switching Diodes: Tuning Diodes — Hyper-Abrupt Juntion (continued)

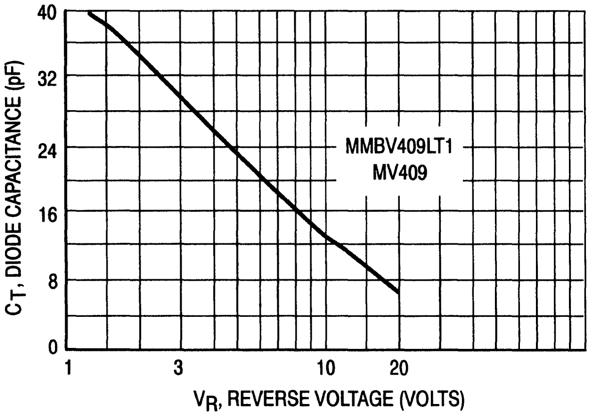


Figure 3. Diode Capacitance

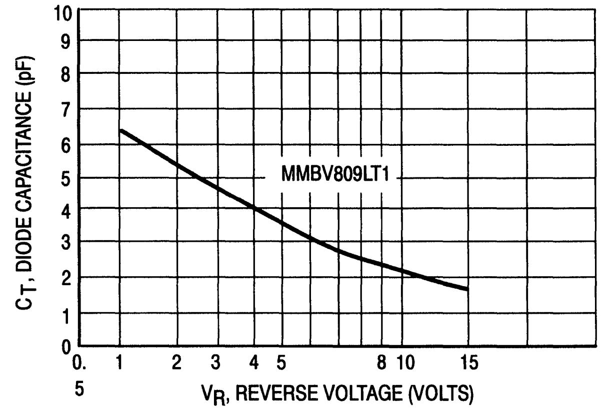


Figure 4. Diode Capacitance

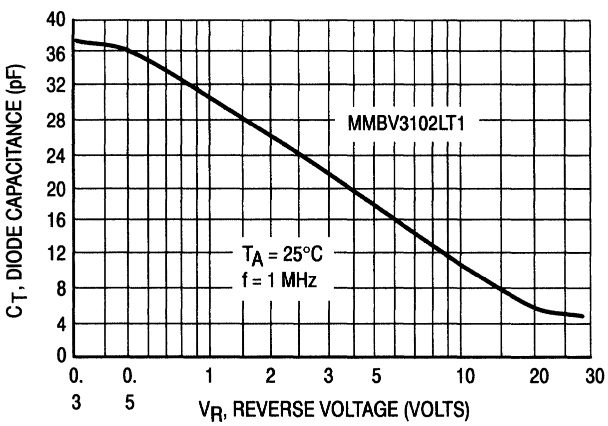


Figure 5. Diode Capacitance

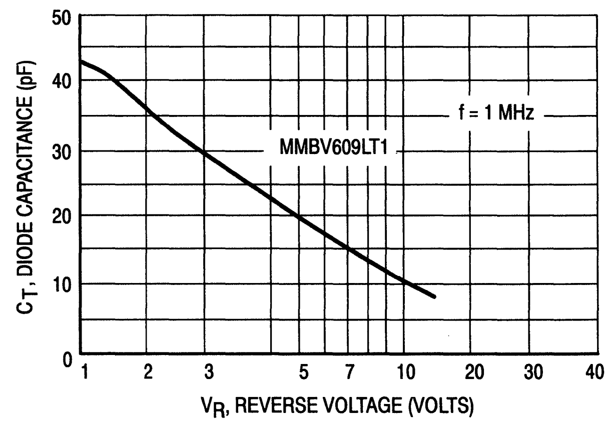


Figure 6. Diode Capacitance Each Die

MVAM108

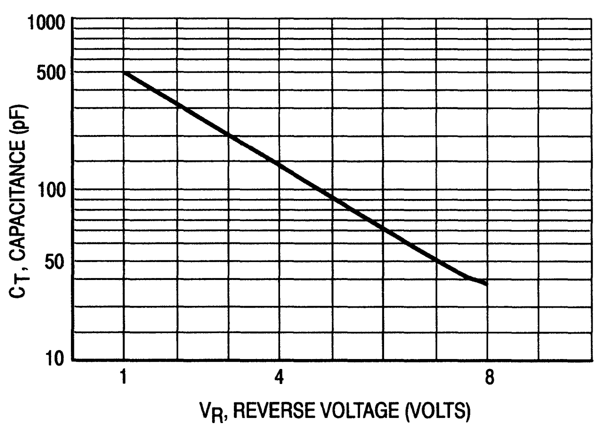


Figure 7. Capacitance versus Reverse Voltage

MVAM109/MV7005T1

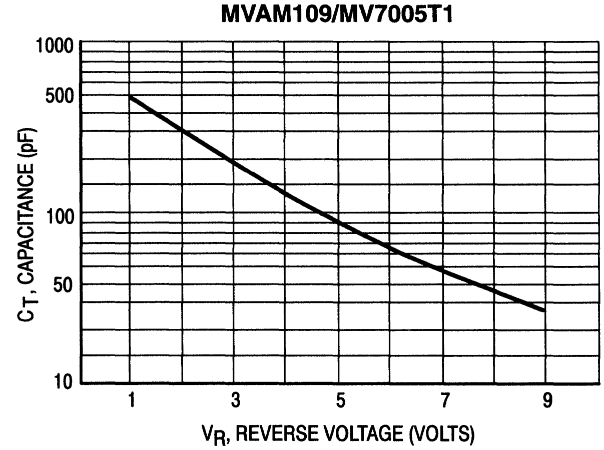


Figure 8. Capacitance versus Reverse Voltage

Tuning and Switching Diodes: Tuning Diodes — Hyper-Abrupt Juntion (continued)

MVAM115

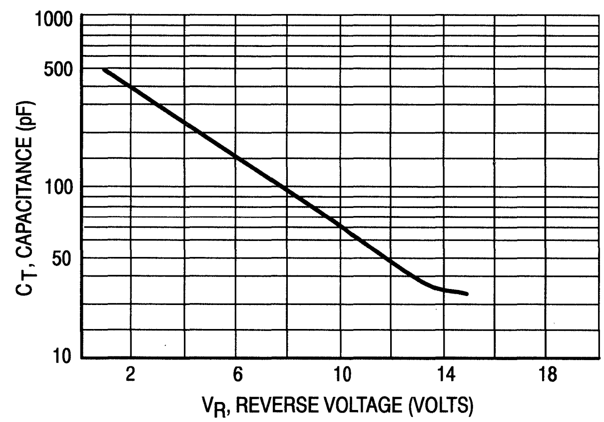


Figure 9. Capacitance versus Reverse Voltage

MVAM125

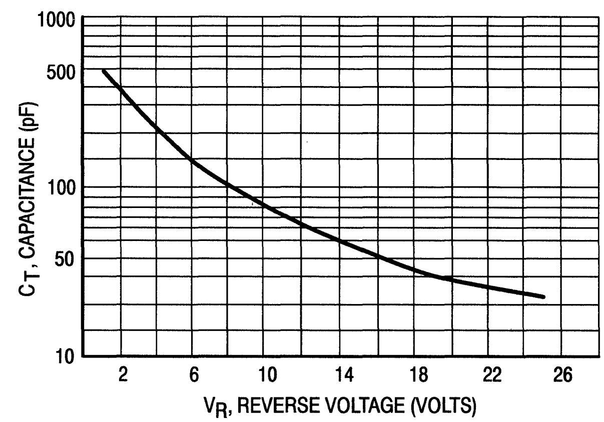


Figure 10. Capacitance versus Reverse Voltage

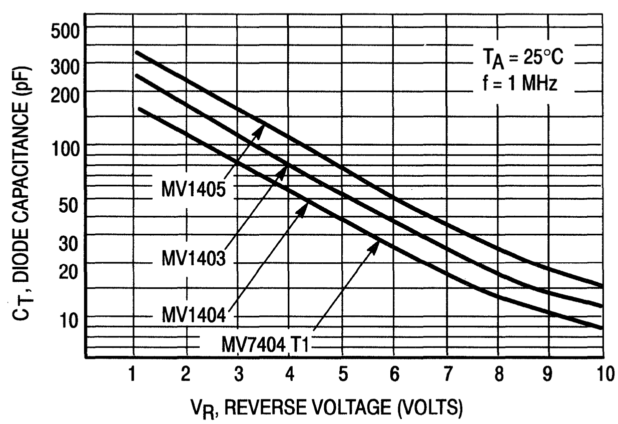


Figure 11. Diode Capacitance versus Reverse Voltage

Table 47. Hyper-Abrupt Tuning Diodes for Telecommunications — Single

The following is a listing of hyper-abrupt tuning diodes intended for high frequency, FM radio, and TV tuner applications.

Device	C_T @ V_R (f = 1.0 MHz) pF Min	pF Max	Volts	Cap Ratio @ V_R Min	Max	Volts	Q 3.0 V Min	50 MHz Max	$V_{(BR)R}$ Volts	Device Marking	Case Style	CV Curve Fig
Case 182-02 — TO-226AC (TO-92)												
MV209	26	32	3.0	5.0	6.5	3/25	200	—	30	—	1	2
MV409	26	32	3.0	1.5	2.0	3/8	200	—	20	—	1	3
Case 318-07 — TO-236AB (SOT-23)												
MMBV105GLT1	1.8	2.8	25	4.0	6.0	3/25	200	—	30	M4E	8	1
MMBV109LT1	26	32	3.0	5.0	6.5	3/25	200	—	30	M4A	8	2
MMBV409LT1	26	32	3.0	1.5	2.0	3/8	200	—	20	X5	8	3
MMBV809LT1	4.5	6.1	2.0	1.8	2.6	2/8	300	—	20	5K	8	4
MMBV3102LT1	20	25	3.0	4.5	—	3/25	200	—	30	M4C	8	5

Devices listed in bold, italic are Motorola preferred devices.

Tuning and Switching Diodes: Tuning Diodes — Hyper-Abrupt Juntion (continued)

Table 48. Hyper-Abrupt Tuning Diodes for Communications — Dual

Device	C_T @ V_R (f = 1.0 MHz) pF Min	pF Max	Volts	Cap Ratio @ V_R Min	Max	Volts	Q 3.0 V Min	50 MHz Max	$V_{(BR)R}$ Volts	Device Marking	Case Style	CV Curve Fig
Case 318-07 — TO-236AB (SOT-23)												
MMBV609LT1	26	32	3.0	1.8	2.4	3/8	250	—	20	5L	9	6

Table 49. Hyper-Abrupt Tuning Diodes for Low Frequency Applications — Single

The following is a listing of AM, hyper-abrupt tuning diodes that have a large capacity range and are designed for low frequency circuit applications.

Device	C_T @ 1.0 MHz pF Min	pF Max	Volts	Cap Ratio @ V_R Min	Volts	$V_{(BR)R}$ Volts	Style	CV Curve Figure
Case 182-02 — TO-226AC (TO-92)								
MVAM108	440	560	1.0	15	1.0/8.0	12	1	7
MVAM109	400	520	1.0	12	1.0/9.0	15	1	8
MVAM115	440	560	1.0	15	1.0/15	18	1	9
MVAM125	440	560	1.0	15	1.0/25	28	1	10

Table 50. Hyper-Abrupt High Capacitance Voltage Variable Diode — Surface Mount

The following are high capacitance voltage variable diodes intended for low frequency applications and circuits requiring large tuning capacitance.

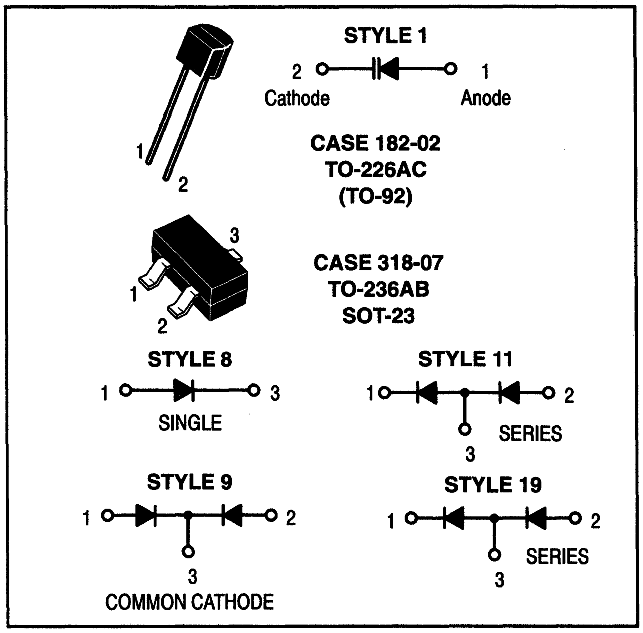
Device	$V_{(BR)R}$ Volts	I_R nA	C_T @ f = 1.0 MHz Min pF	Max pF	Cap Ratio Min	Q Min	Style	CV Curve Figure
Case 318E-04 — SOT-223 Pinout: 1-Anode, 2, 4-Cathode, 3-NC								
MV7005T1	15	100	400	520	12(26)	150(28)	2	8
MV7404T1	12	100	96	144	10(27)	200(29)	2	11

Table 51. Hyper-Abrupt High Capacitance Tuning Diodes — Axial Lead Glass Package

Device	C_T @ V_R pF Min	pF Max	Volts	Cap Ratio C2/C10 Min	Q 2.0 V, 1.0 MHz Min	$V_{(BR)R}$ Volts	Style	CV Curve Figure
Case 51-02 — DO-204AA (DO-7)								
MV1404	96	144	2.0	10	200	12	1	11
MV1403	140	210	2.0	10	200	12	1	11
MV1405	200	300	2.0	10	200	12	1	11

(26) V_R = 1.0 V/V_R = 9.0 V
(27) V_R = 2.0 V/V_R = 10 V
(28) V_R = 1.0 V, f = 1.0 MHz
(29) V_R = 2.0 V, f = 1.0 MHz

Devices listed in bold, italic are Motorola preferred devices.

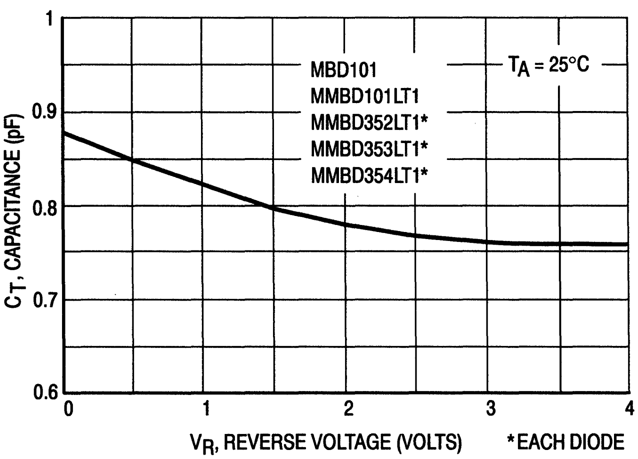


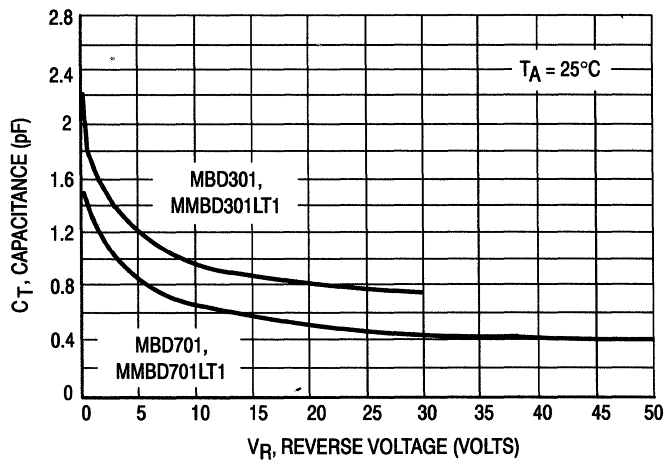
Hot-Carrier (Schottky) Diodes

Hot-Carrier diodes are ideal for VHF and UHF mixer and detector applications as well as many higher frequency applications. They provide stable electrical characteristics by eliminating the point-contact diode presently used in many applications.

Typical Characteristics

Capacitance versus Reverse Voltage





(See Table 12)

Table 52. Hot-Carrier (Schottky) Diodes

The following is a listing of hot carrier (Schottky) diodes that exhibit low forward voltage drop for improved circuit efficiency.

Device	$V_{(BR)R}$ Volts	C_T @ V_R pF Max	V_F @ 10 mA Volts Max	I_R @ V_R nA Max	Minority Lifetime pS (TYP)	Device Marking	Style
Case 182-02 — TO-226AC (TO-92)							
MBD701	70	1.0 @ 20 V	1.2	200 @ 35 V	15	—	1
MBD301	30	1.5 @ 15 V	0.6	200 @ 25 V	15	—	1
MBD101	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	—	—	1
Case 318-07 — TO-236AB (SOT-23)							
MMBD701LT1	70	1.0 @ 20 V	1.2	200 @ 35 V	15	5H	8
MMBD301LT1	30	1.5 @ 15 V	0.6	200 @ 25 V	15	4T	8
MMBD101LT1	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	—	4M	8
MMBD352LT1(23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	—	M5G	11
MMBD353LT1(23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	—	M4F	19
MMBD354LT1(23)	7.0	1.0 @ 0 V	0.6	250 @ 3.0 V	—	M6H	9

(23)Dual Diodes

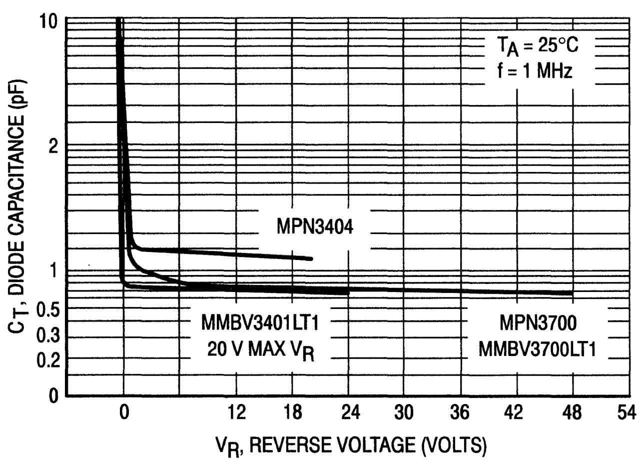
Devices listed in bold, italic are Motorola preferred devices.

Switching Diodes

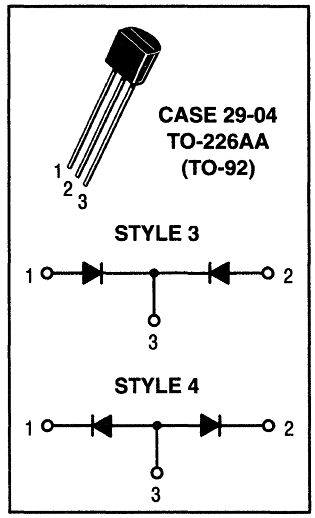
Small-signal switching diodes are intended for low current switching and steering applications. Hot-Carrier, PIN and general-purpose diodes allow a wide selection for specific application requirements.

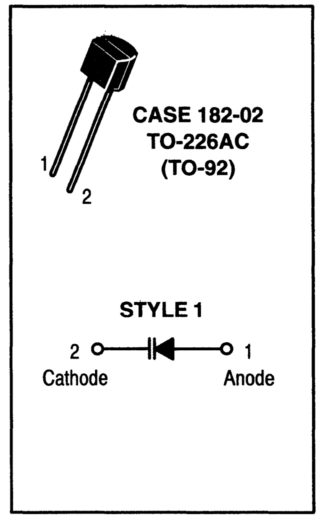
Typical Characteristics

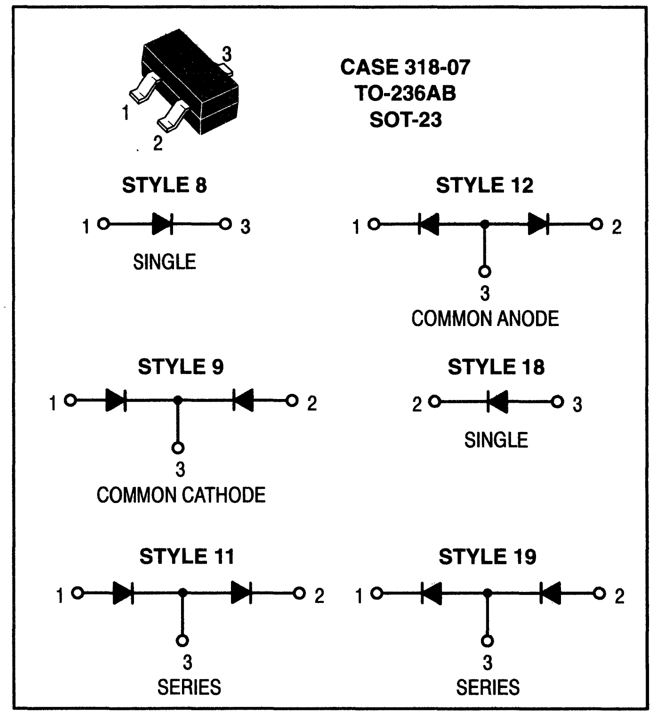
Capacitance versus Reverse Voltage

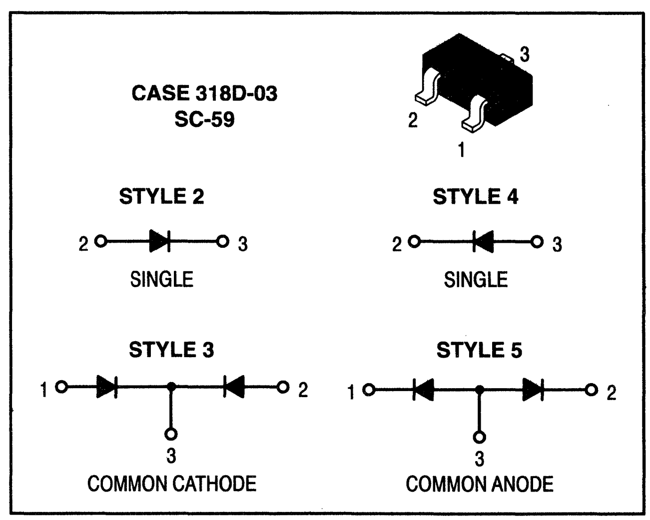


(See Table 13)









Tuning and Switching Diodes: Switching Diodes (continued)

Table 53. PIN Switching Diodes

The following PIN diodes are designed for VHF band switching and general-purpose low current switching applications.

Device	$V_{(BR)R}$ Volts Min	C_T @ V_R @ 1.0 MHz		I_R @ V_R nA Max	Series Resistance Ohm Max	Device Marking	Style
		pF Max	Volts				
Case 182-02 — TO-226AC (TO-92)							
MPN3700	200	1.0	20	0.1 @ 150	1.0 @ 10 mA	—	1
MPN3404	20	2.0	15	0.1 @ 25 V	0.85 @ 10 mA	—	1
Case 318-07 — TO-236AB (SOT-23)							
MMBV3700LT1	200	1.0	20	0.1 @ 150	1.0 @ 10 mA	4R	8
MMBV3401LT1	35	1.0	20	0.1 @ 25 V	0.7 @ 10 mA	4D	8

Table 54. General-Purpose Signal and Switching Diodes — Single

The following is a listing of small-signal switching diodes in surface mount packages. These diodes are intended for low current switching and signal steering applications.

Device	Marking	$V_{(BR)R}$		I_R		V_F			C_T (30)	t_{rr}	Pin Out
		Min Volts	@ I_{BR} (μA)	Max (μA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)	Max (pF)	Max (ns)	Case Style
Case 318-07 — TO-236AB (SOT-23)											
BAS21LT1	A82	250	100	0.1	200		1.0	100	5.0	50	8
MMBD914LT1	5D	100	100	5.0	75		1.0	10	4.0	4.0	8
BAS16LT1	A6	75	100	1.0	75		1.0	50	2.0	6.0	8
MMBD6050LT1	5A	70	100	0.1	50	0.85	1.1	100	2.5	4.0	8
BAL99LT1	JF	70	100	2.5	70		1.0	50	1.5	6.0	18

Device	Marking	$V_{(BR)R}$		I_R		V_F			C_J (30) Max (pF)	t_{rr} Max (ns)	Case Style
		Min Volts	@ I_{BR} (μA)	Max (μA)	@ V_R Volts	Min Volts	Max Volts	@ I_R (mA)			
Case 318D-03 — SC-59											
M1MA151AT1	MA	40	100	0.1	35	—	1.2	100	2.0	3.0	4
M1MA151KT1	MH	40	100	0.1	35	—	1.2	100	2.0	3.0	2

(30) V_R = 0 V, f = 1.0 MHz

Devices listed in bold, italic are Motorola preferred devices.

Tuning and Switching Diodes: Switching Diodes **(continued)**

Table 55. General-Purpose Signal and Switching Diodes — Dual

The following is a listing of small-signal switching diodes in surface mount packages. These diodes are intended for low current switching and signal steering applications.

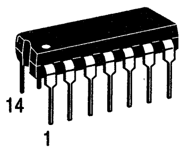
		$V_{(BR)R}$		I_R		V_F			C_T(30)	t_{rr}	Pin Out
Device	Marking	Min Volts	@ I_{BR} (µA)	Max (µA)	@ V_R Volts	Min Volts	Max Volts	@ I_F (mA)	Max (pF)	Max (ns)	Case Style
Case 318-07 — TO-236AB (SOT-23)											
MMBD7000LT1	M5C	100	100	0.3	50	0.75	1.1	100	1.5	4.0	11
MMBD2836LT1	A2	75	100	0.1	50		1.0	10	4.0	4.0	12
MMBD2838LT1	A6	75	100	0.1	50		1.0	10	4.0	4.0	9
BAV70LT1	A4	70	100	5.0	70		1.0	50	1.5	6.0	9
BAV99LT1	A7	70	100	2.5	70		1.0	50	1.5	4.0	11
BAW56LT1	A1	70	100	2.5	70		1.0	50	2.0	6.0	12
MMBD6100LT1	5BM	70	100	0.1	50	0.85	1.1	100	2.5	4.0	9
BAV74LT1	JA	50	5.0	0.1	50		1.0	100	2.0	4.0	9
MMBD2835LT1	A3	35	100	0.1	30		1.0	10	4.0	4.0	12
MMBD2837LT1	A5	35	100	0.1	30		1.0	10	4.0	4.0	9
Case 318D-03 — SC-59											
M1MA151WAT1	MN	40	100	0.1	35	—	1.2	100	15	10	5
M1MA151WKT1	MT	40	100	0.1	35	—	1.2	100	2.0	3.0	3

(30) V_R = 0 V, f = 1.0 MHz

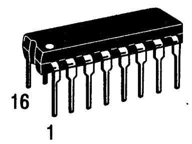
Devices listed in bold, italic are Motorola preferred devices.

Multiple Switching Diodes

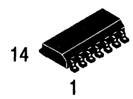
Multiple diode configurations utilize monolithic structures fabricated by the planar process. They are designed to satisfy fast switching requirements as in core driver and encoding/decoding applications where their monolithic configurations offer lower cost, higher reliability and space savings.



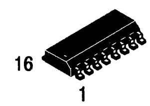
CASE 646-06
PIN DIP
PLASTIC



CASE 648-08
PIN DIP
PLASTIC

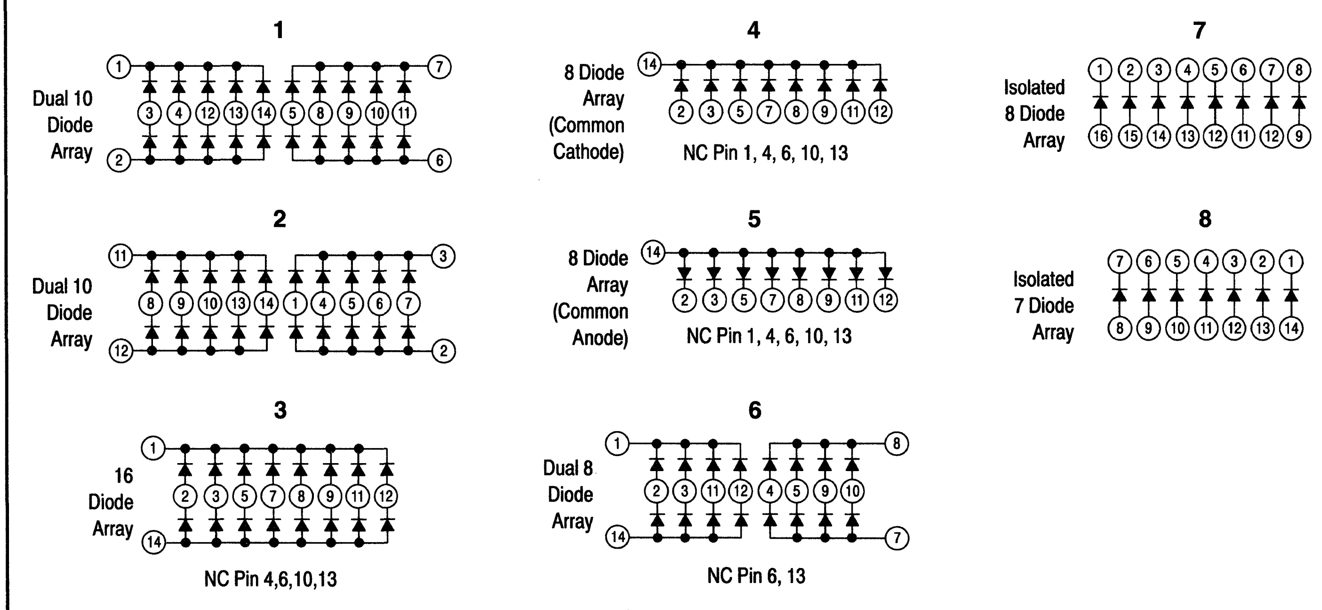


CASE 751A-03
SO-14
PLASTIC



CASE 751B-05
SO-16
PLASTIC

Diode Array Diagrams



Tuning and Switching Diodes: Multiple Switching Diodes **(continued)**

Table 56. Diode Arrays

Case 646-06 — TO-116

Device	Function	Pin Connections Diagram Number
MAD130P	Dual 10 Diode Array	1
MAD1103P	16 Diode Array	3
MAD1105P	8 Diode Common Cathode Array	4
MAD1107P	Dual 8 Diode Array	6
MAD1109P	7 Isolated Diode Array	8

Case 648-08

Device	Function	Pin Connections Diagram Number
MAD1108P	8 Isolated Diode Array	7

Case 751A-03 — SO-14

Device	Function	Pin Connections Diagram Number
MMAD130	Dual 10 Diode Array	2
MMAD1103	16 Diode Array	3
MMAD1105	8 Diode Common Cathode Array	4
MMAD1106	8 Diode Common Anode Array	5
MMAD1107	Dual 8 Diode Array	6
MMAD1109	7 Isolated Diode Array	8

Case 751B-05 — SO-16

Device	Function	Pin Connections Diagram Number
MMAD1108	8 Isolated Diode Array	7

Devices listed in bold, italic are Motorola preferred devices.

TVS/Zeners
Transient Voltage Suppressors
Zener Regulator and Reference Diodes

In Brief . . .

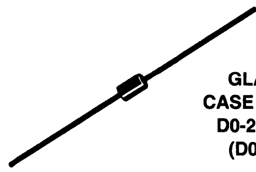
Motorola's standard TVS (Transient Voltage Suppressors) and Zener diodes comprise the largest inventoried line in the industry. Continuous development of improved manufacturing techniques have resulted in computerized diffusion and test, as well as critical process controls learned from surface-sensitive MOS fabrication. Resultant high yields lower factory costs. Check the following features for application to your specific requirements:

- *Wide selection of package materials and styles:*
  - *— Plastic (Surmetic) for low cost, mechanical ruggedness*
  - *— Glass for high reliability, low cost*
  - *— Surface Mount packages for state of the art designs*
- *Power Ratings from 0.25 to 5.0 Watts*
- *Breakdown voltages from 1.8 to 400 V in approximately 10% steps*
- *TVS from 24 W to 1500 W and from 6.2 to 250 Volts*
- *ESD protection devices*
- *Available tolerances from 10% (low cost) to as tight as 1% (critical applications) with off-the-shelf delivery*
- *Special selection of electrical characteristics available at low cost due to high-volume lines (check your Motorola sales representative for special quotations)*
- *UL Recognition on many TVS device types*
- *Tape and Reel options available on all axial leaded and surface mount types*

Zener Diodes

Voltage Regulator Diodes

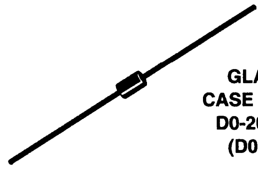
Table 1. Axial Leaded for Through-hole Designs – 500mW

Nominal Zener Breakdown Voltage	500 mW Cathode = Polarity Band	500 mW Low Level Cathode = Polarity Band	500 mW Cathode = Polarity Band					500 mW Low Level Cathode = Polarity Band	500 mW Cathode = Polarity Band	
(*Note 1)	(*Note 2)	(*Note 3)	(*Note 4)	(*Note 5)	(*Note 6)	(*Note 7)	(*Note 8)	(*Note 9)	(*Note 10)	(*Note 8)
Volts	 GLASS CASE 299-02 D0-204AH (D0-35)									
1.8		1N4678						MZ4614		
2.0		1N4679						MZ4615		
2.2		1N4680						MZ4616		
2.4	1N4370A	1N4681	***1N5221B***	1N5985B	BZX55C2V4	BZX79C2V4		MZ4617		
2.5			1N5222B							
2.7	1N4371A	1N4682	***1N5223B***	1N5986B	BZX55C2V7	BZX79C2V7	BZX83C2V7	MZ4618		ZPD2.7
2.8			1N5224B							
3.0	1N4372A	1N4683	1N5225B	1N5987B	BZX55C3V0	BZX79C3V0	BZX83C3V0	MZ4619		ZPD3.0
3.3	1N746A	1N4684	***1N5226B***	***1N5988B***	BZX55C3V3	BZX79C3V3	BZX83C3V3	MZ4620		ZPD3.3
3.6	1N747A	1N4685	1N5227B	1N5989B	BZX55C3V6	BZX79C3V6	BZX83C3V6	MZ4621		ZPD3.6
3.9	1N748A	1N4686	***1N5228B***	1N5990B	BZX55C3V9	BZX79C3V9	BZX83C3V9	MZ4622	MZ5520B	ZPD3.9
4.3	1N749A	1N4687	***1N5229B***	1N5991B	BZX55C4V3	BZX79C4V3	BZX83C4V3	MZ4623	MZ5521B	ZPD4.3
4.7	1N750A	1N4688	***1N5230B***	1N5992B	BZX55C4V7	BZX79C4V7	BZX83C4V7	MZ4624	MZ5522B	ZPD4.7
5.1	1N751A	***1N4689***	***1N5231B***	***1N5993B***	BZX55C5V1	BZX79C5V1	BZX83C5V1	MZ4625	MZ5523B	ZPD5.1
5.6	1N752A	1N4690	***1N5232B***	***1N5994B***	BZX55C5V6	BZX79C5V6	BZX83C5V6	MZ4626	MZ5524B	ZPD5.6
6.0			***1N5233B***							
6.2	1N753A	1N4691	***1N5234B***	1N5995B	BZX55C6V2	BZX79C6V2	BZX83C6V2	MZ4627	MZ5525B	ZPD6.2
6.8	1N754A 1N957B	1N4692	***1N5235B***	1N5996B	BZX55C6V8	BZX79C6V8	BZX83C6V8	MZ4099	MZ5526B	ZPD6.8
7.5	1N755A 1N958B	1N4693	***1N5236B***	1N5997B	BZX55C7V5	BZX79C7V5	BZX83C7V5	MZ4100	MZ5527B	ZPD7.5
8.2	1N756A 1N959B	1N4694	***1N5237B***	***1N5998B***	BZX55C8V2	BZX79C8V2	BZX83C8V2	MZ4101	MZ5528B	ZPD8.2
8.7		1N4695	1N5238B					MZ4102		
9.1	1N757A 1N960B	1N4696	***1N5239B***	1N5999B	BZX55C9V1	BZX79C9V1	BZX83C9V1	MZ4103	MZ5529B	ZPD9.1
10	1N758A 1N961B	1N4697	***1N5240B***	1N6000B	BZX55C10	BZX79C10	BZX83C10	MZ4104	MZ5530B	ZPD10
11	1N962B	1N4698	1N5241B	1N6001B	BZX55C11	BZX79C11	BZX83C11			ZPD11
12	1N759A 1N963B	1N4699	***1N5242B***	1N6002B	BZX55C12	BZX79C12	BZX83C12			ZPD12
13	1N964B	1N4700	***1N5243B***	1N6003B	BZX55C13	BZX79C13	BZX83C13			ZPD13
14		1N4701	***1N5244B***							
15	1N965B	1N4702	***1N5245B***	1N6004B	BZX55C15	BZX79C15	BZX83C15			ZPD15
16	1N966B	1N4703	***1N5246B***	1N6005B	BZX55C16	BZX79C16	BZX83C16			ZPD16
17		1N4704	1N5247B							
18	1N967B	1N4705	***1N5248B***	1N6006B	BZX55C18	BZX79C18	BZX83C18			ZPD18
19		1N4706	1N5249B							
20	1N968B	1N4707	***1N5250B***	***1N6007B***	BZX55C20	BZX79C20	BZX83C20			ZPD20

*See Notes — page 5.2-6

Devices listed in bold, italic are Motorola preferred devices.

Table 1. Axial Leaded for Through-hole Designs – 500mW (continued)

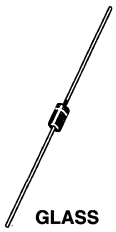
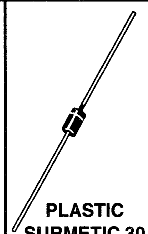
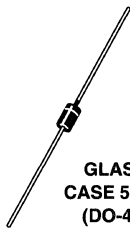
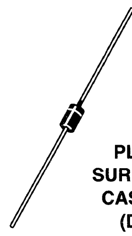
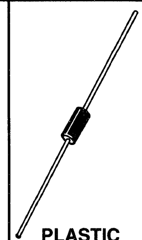
Nominal Zener Breakdown Voltage	500 mW Cathode = Polarity Band	500 mW Low Level Cathode = Polarity Band	500 mW Cathode = Polarity Band					500 mW Low Level Cathode = Polarity Band	500 mW Cathode = Polarity Band	
(*Note 1)	(*Note 2)	(*Note 3)	(*Note 4)	(*Note 5)	(*Note 6)	(*Note 7)	(*Note 8)	(*Note 9)	(*Note 10)	(*Note 8)
Volts	 GLASS CASE 299-02 D0-204AH (D0-35)									
22	1N969B	1N4708	1N5251B	1N6008B	BZX55C22	BZX79C22	BZX83C22			ZPD22
24	1N970B	1N4709	***1N5252B***	1N6009B	BZX55C24	BZX79C24	BZX83C24			ZPD24
25		1N4710	1N5253B							
27	1N971B	1N4711	***1N5254B***	1N6010B	BZX55C27	BZX79C27	BZX83C27			ZPD27
28		1N4712	1N5255B							
30	1N972B	1N4713	***1N5256B***	1N6011B	BZX55C30	BZX79C30	BZX83C30			ZPD30
33	1N973B	1N4714	***1N5257B***	1N6012B	BZX55C33	BZX79C33	BZX83C33			ZPD33
36	1N974B	1N4715	***1N5258B***	1N6013B	BZX55C36	BZX79C36				
39	1N975B	1N4716	1N5259B	1N6014B	BZX55C39	BZX79C39				
43	1N976B	1N4717	1N5260B	1N6015B	BZX55C43	BZX79C43				
47	1N977B		1N5261B	1N6016B	BZX55C47	BZX79C47				
51	1N978B		1N5262B	1N6017B	BZX55C51	BZX79C51				
56	1N979B		1N5263B	1N6018B	BZX55C56	BZX79C56				
60			1N5264B							
62	1N980B		1N5265B	1N6019B	BZX55C62	BZX79C62				
68	1N981B		1N5266B	1N6020B	BZX55C68	BZX79C68				
75	1N982B		1N5267B	1N6021B	BZX55C75	BZX79C75				
82	1N983B		1N5268B	1N6022B	BZX55C82	BZX79C82				
87			1N5269B							
91	1N984B		1N5270B	1N6023B	BZX55C91	BZX79C91				
100	1N985B		1N5271B	1N6024B		BZX79C100				
110	1N986B		1N5272B	1N6025B		BZX79C110				
120	1N987B		1N5273B			BZX79C120				
130	1N988B		1N5274B			BZX79C130				
140			1N5275B							
150	1N989B		1N5276B			BZX79C150				
160	1N990B		1N5277B			BZX79C160				
170			1N5278B							
180	1N991B		1N5279B			BZX79C180				
190			1N5280B							
200	1N992B		1N5281B			BZX79C200				
220										
240										
270										
300										
330										
360										
400										

*See Notes — page 5.2-6

Devices listed in bold, italic are Motorola preferred devices.

Voltage Regulator Diodes (continued)

Table 2. Axial Leaded for Through-hole Designs – 1, 1.3, 1.5, 3 and 5 Watt

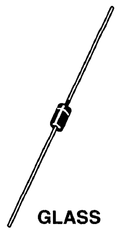
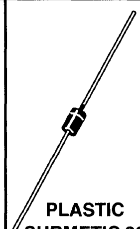
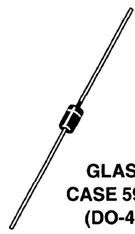
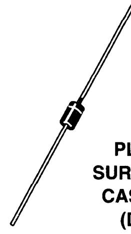
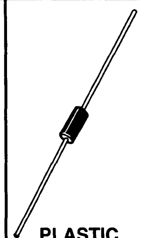
Nominal Zener Breakdown Voltage	1 Watt Cathode = Polarity Band		1.3 Watt Cathode = Polarity Band			1.5 Watt Cathode = Polarity Band	3 Watt Cathode = Polarity Band	5 Watt Cathode = Polarity Band
(*Note 1)	(*Note 11)	(*Note 12)	(*Note 13)	(*Note 14)	(*Note 15)	(*Note 16)	(*Note 17)	(*Note 18)
Volts	 GLASS CASE 59-03 (DO-41)	 PLASTIC SURMETIC 30 CASE 59-03 (DO-41)	 GLASS CASE 59-03 (DO-41)		 PLASTIC SURMETIC 30 CASE 59-03 (DO-41)			 PLASTIC SURMETIC 40 CASE 17-02
1.8								
2.0								
2.2								
2.4								
2.5								
2.7								
2.8								
3.0								
3.3	***1N4728A***	MZP4728A	BZX85C3V3			1N5913B		***1N5333B***
3.6	1N4729A	MZP4729A	BZX85C3V6			1N5914B		1N5334B
3.9	1N4730A	MZP4730A	BZX85C3V9	MZPY3.9	MZD3.9	1N5915B	3EZ3.9D5	1N5335B
4.3	***1N4731A***	MZP4731A	BZX85C4V3	MZPY4.3	MZD4.3	1N5916B	3EZ4.3D5	1N5336B
4.7	***1N4732A***	MZP4732A	BZX85C4V7	MZPY4.7	MZD4.7	1N5917B	3EZ4.7D5	1N5337B
5.1	***1N4733A***	***MZP4733A***	BZX85C5V1	MZPY5.1	MZD5.1	***1N5918B***	3EZ5.1D5	***1N5338B***
5.6	***1N4734A***	MZP4734A	BZX85C5V6	MZPY5.6	MZD5.6	1N5919B	3EZ5.6D5	***1N5339B***
6.0								1N5340B
6.2	***1N4735A***	***MZP4735A***	BZX85C6V2	MZPY6.2	MZD6.2	***1N5920B***	3EZ6.2D5	1N5341B
6.8	***1N4736A***	MZP4736A	BZX85C6V8	MZPY6.8	MZD6.8	1N5921B	3EZ6.8D5	***1N5342B***
7.5	1N4737A	MZP4737A	BZX85C7V5	MZPY7.5	MZD7.5	1N5922B	3EZ7.5D5	***1N5343B***
8.2	***1N4738A***	MZP4738A	BZX85C8V2	MZPY8.2	MZD8.2	1N5923B	3EZ8.2D5	***1N5344B***
8.7								1N5345B
9.1	***1N4739A***	MZP4739A	BZX85C9V1	MZPY9.1	MZD9.1	1N5924B	3EZ9.1D5	1N5346B
10	***1N4740A***	MZP4740A	BZX85C10	MZPY10	MZD10	1N5925B	3EZ10D5	***1N5347B***
11	***1N4741A***	MZP4741A	BZX85C11	MZPY11	MZD11	1N5926B	3EZ11D5	1N5348B
12	***1N4742A***	MZP4742A	BZX85C12	MZPY12	MZD12	1N5927B	3EZ12D5	***1N5349B***
13	***1N4743A***	MZP4743A	BZX85C13	MZPY13	MZD13	1N5928B	3EZ13D5	***1N5350B***
14							3EZ14D5	1N5351B
15	***1N4744A***	***MZP4744A***	BZX85C15	MZPY15	MZD15	***1N5929B***	3EZ15D5	***1N5352B***
16	***1N4745A***	***MZP4745A***	BZX85C16	MZPY16	MZD16	1N5930B	3EZ16D5	***1N5353B***
17							3EZ17D5	1N5354B
18	***1N4746A***	***MZP4746A***	BZX85C18	MZPY18	MZD18	1N5931B	3EZ18D5	***1N5355B***
19							3EZ19D5	1N5356B
20	***1N4747A***	MZP4747A	BZX85C20	MZPY20	MZD20	1N5932B	3EZ20D5	***1N5357B***
22	1N4748A	MZP4748A	BZX85C22	MZPY22	MZD22	1N5933B	3EZ22D5	1N5358B
24	***1N4749A***	***MZP4749A***	BZX85C24	MZPY24	MZD24	***1N5934B***	3EZ24D5	***1N5359B***
25								***1N5360B***
27	***1N4750A***	MZP4750A	BZX85C27	MZPY27	MZD27	1N5935B	3EZ27D5	***1N5361B***
28							3EZ28D5	1N5362B
30	***1N4751A***	***MZP4751A***	BZX85C30	MZPY30	MZD30	***1N5936B***	3EZ30D5	***1N5363B***

*See Notes — page 5.2-6

Devices listed in bold, italic are Motorola preferred devices.

Zener Diodes

Table 2. Axial Leaded for Through-hole Designs – 1, 1.3, 1.5, 3 and 5 Watt (continued)

Nominal Zener Breakdown Voltage	1 Watt Cathode = Polarity Band		1.3 Watt Cathode = Polarity Band			1.5 Watt Cathode = Polarity Band	3 Watt Cathode = Polarity Band	5 Watt Cathode = Polarity Band
(*Note 1)	(*Note 11)	(*Note 12)	(*Note 13)	(*Note 14)	(*Note 15)	(*Note 16)	(*Note 17)	(*Note 18)
Volts	 GLASS CASE 59-03 (DO-41)	 PLASTIC SURMETIC 30 CASE 59-03 (DO-41)	 GLASS CASE 59-03 (DO-41)		 PLASTIC SURMETIC 30 CASE 59-03 (DO-41)			 PLASTIC SURMETIC 40 CASE 17-02
33	1N4752A	MZP4752A	BZX85C33	MZPY33	MZD33	1N5937B	3EZ33D5	***1N5364B***
36	1N4753A	MZP4753A	BZX85C36	MZPY36	MZD36	1N5938B	3EZ36D5	***1N5365B***
39	1N4754A	MZP4754A	BZX85C39	MZPY39	MZD39	1N5939B	3EZ39D5	***1N5366B***
43	1N4755A	MZP4755A	BZX85C43	MZPY43	MZD43	1N5940B	3EZ43D5	1N5367B
47	1N4756A	MZP4756A	BZX85C47	MZPY47	MZD47	***1N5941B***	3EZ47D5	***1N5368B***
51	1N4757A	MZP4757A	BZX85C51	MZPY51	MZD51	1N5942B	3EZ51D5	1N5369B
56	1N4758A	MZP4758A	BZX85C56	MZPY56	MZD56	1N5943B	3EZ56D5	1N5370B
60								1N5371B
62	1N4759A	MZP4759A	BZX85C62	MZPY62	MZD62	1N5944B	3EZ62D5	***1N5372B***
68	1N4760A	MZP4760A	BZX85C68	MZPY68	MZD68	1N5945B	3EZ68D5	1N5373B
75	1N4761A	MZP4761A	BZX85C75	MZPY75	MZD75	1N5946B	3EZ75D5	1N5374B
82	1N4762A	MZP4762A	BZX85C82	MZPY82	MZD82	1N5947B	3EZ82D5	1N5375B
87								1N5376B
91	1N4763A	MZP4763A	BZX85C91	MZPY91	MZD91	1N5948B	3EZ91D5	1N5377B
100	1N4764A	MZP4764A	BZX85C100	MZPY100	MZD100	1N5949B	3EZ100D5	1N5378B
110		1M110ZS5			MZD110	1N5950B	3EZ110D5	1N5379B
120		1M120ZS5			MZD120	1N5951B	3EZ120D5	1N5380B
130		1M130ZS5			MZD130	1N5952B	3EZ130D5	1N5381B
140							3EZ140D5	1N5382B
150		1M150ZS5			MZD150	1N5953B	3EZ150D5	***1N5383B***
160		1M160ZS5			MZD160	1N5954B	3EZ160D5	1N5384B
170							3EZ170D5	1N5385B
180		1M180ZS5			MZD180	1N5955B	3EZ180D5	1N5386B
190							3EZ190D5	1N5387B
200		1M200ZS5			MZD200	1N5956B	3EZ200D5	1N5388B
220							3EZ220D5	
240							3EZ240D5	
270							3EZ270D5	
300							3EZ300D5	
330							3EZ330D5	
360							3EZ360D5	
400							3EZ400D5	

*See Notes — page 5.2-6

Devices listed in bold, italic are Motorola preferred devices.

Notes — Axial Leaded Chart

1. Zener Voltage is the key parameter for each device type. It is specified at a particular test current applied at either thermal equilibrium (T.E.) or pulse test condition. The voltage tolerance for the device types listed is, in general, ±5%; however, for some series, the voltage tolerance varies from device type to device type over a range of ±(5 to 8.5)%. Consult the complete data sheet to determine the exact test conditions and minimum/maximum limits for the zener voltage. Consult Application Note AN924 regarding measurement of Zener Voltage (pulse versus thermal equilibrium).

   Power Ratings represent the capability of the case size listed as supplied by Motorola. These ratings may be higher than the JEDEC registration and/or the same device types supplied by other manufacturers.

V_Z Test Conditions And Tolerances

2. 1N4370A/1N746A Series
   I_{ZT} = 20 mA (T.E.).
   No suffix = ±10%.
   A suffix = ±5%.
   C suffix = ±2%.
   D suffix = ±1%.

   1N957B Series
   I_{ZT} @ approximately 125 mW point (T.E.).
   A suffix = ±10%.
   B suffix = ±5%.
   C suffix = ±2%.
   D suffix = ±1%.

3. 1N4678 Series I_{ZT} = 50 µA (T.E.).
   No suffix = ±5%.
   C suffix = ±2%.
   D suffix = ±1%.
   Also has delta V_Z parameter and limit.

4. 1N5221B-42B I_{ZT} = 20 mA (T.E.).
   1N5243B-81B I_{ZT} @ approximately 125 mW point (T.E.).
   A suffix = ±10%.
   B suffix = ±5%.
   C suffix = ±2%.
   D suffix = ±1%.

5. 1N5985B-6013B I_{ZT} = 5 mA (T.E.).
   1N6014B-23B I_{ZT} = 2 mA (T.E.).
   1N6024B-25B I_{ZT} = 1 mA (T.E.).
   A suffix = ±10%.
   B suffix = ±5%.
   C suffix = ±2%.
   D suffix = ±1%.

6. BZX55C2V4-C36 I_{ZT} = 5 mA (T.E.).
   BZX55C39-C82 I_{ZT} = 2.5 mA (T.E.).
   BZX55C91 I_{ZT} = 1 mA (T.E.).
   C indicates ±(5 to 8.5)% depending on type number.
   Replace C with B for ±2%.

7. BZX79C2V4-C24 I_{ZT} = 5 mA (pulse).
   BZX79C27-C91 I_{ZT} = 2 mA (pulse).
   BZX79C100-C200 I_{ZT} = 1 mA (pulse).
   C indicates ±(5 to 8.5)% depending on type number.
   Replace C with B for ±2%.
   Replace C with A for ±1%.

8. BZX83C2V7-C33 I_{ZT} = 5 mA (pulse).
   ZPD2.7-33 I_{ZT} = 5 mA (pulse).
   Tolerance is ±(5 to 8.5)% depending on type number.

9. MZ4614-27 I_{ZT} = 250 µA (T.E.).
   MZ4099-4104 I_{ZT} = 250 µA (T.E.).
   Tolerance is ±5%.

10. MZ5520B-21B I_{ZT} = 20 mA (T.E.).
    MZ5522B I_{ZT} = 10 mA (T.E.).
    MZ5523B I_{ZT} = 5 mA (T.E.).
    MZ5524B I_{ZT} = 3 mA (T.E.).
    MZ5525B-30B I_{ZT} = 1 mA (T.E.).
    Tolerance is ±5%.
    Also has delta V_Z parameter and limit.

11. 1N4728A-64A
    I_{ZT} @ approximately 250 mW point (T.E.).
    No suffix = ±10%.
    A suffix = ±5%.
    C suffix = ±2%.
    D suffix = ±1%.

12. MZP4728A-64A
    1M110ZS5-200ZS5
    I_{ZT} @ approximately 250 mW point (T.E.).
    MZP Series non suffix = ±10%.
    MZP Series A suffix = ±5%.
    1M Series 10 suffix = ±10%.
    1M Series 5 suffix = ±5%.

13. BZX85C3V3-C100
    I_{ZT} varies from 185 mW to 300 mW point depending on type number (pulse).
    C indicates ±(5 to 8.5)% depending on type number.
    Replace C with B for ±2%.

14. MZPY3.9-8.2 I_{ZT} = 100 mA (pulse).
    MZPY9.1-15 I_{ZT} = 50 mA (pulse).
    MZPY16-33 I_{ZT} = 25 mA (pulse).
    MZPY36-82 I_{ZT} = 10 mA (pulse).
    MZPY91-100 I_{ZT} = 5 mA (pulse).
    No suffix tolerance is approximately ±(5 to 8.5)% depending on type number.
    C suffix = ±2%.
    D suffix = ±1%.

15. MZD3.9-8.2 I_{ZT} = 100 mA (pulse).
    MZD9.1-15 I_{ZT} = 50 mA (pulse).
    MZD16-33 I_{ZT} = 25 mA (pulse).
    MZD36-82 I_{ZT} = 10 mA (pulse).
    MZD91-200 I_{ZT} = 5 mA (pulse).
    Tolerance is ±(5 to 8.5)% depending on type number.

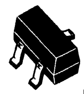
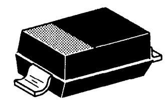
16. 1N5913B-56B
    I_{ZT} @ approximately 375 mW point (T.E.).
    A suffix = ±10%.
    B suffix = ±5%.

17. 3EZ3.9D5-400D5
    I_{ZT} @ approximately 750 mW point (pulse).
    Suffix 10= ±10%.
    Suffix 5 = ±5%.

18. 1N5333B-88B
    I_{ZT} varies from 0.9 to 1.5 W point depending on type number (pulse)
    A suffix = ±10%.
    B suffix = ±5%.
    Also has delta V_Z parameter and limit.

Zener Diodes

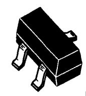
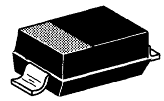
Table 3. Surface Mount Packages

Nominal Zener Breakdown Voltage	225 mW Surface Mount SOT-23		500 mW Surface Mount SOD-123	500 mW Low Level Surface Mount SOD-123	500 mW Surface Mount SOD-123	1.5 Watt Surface Mount SMB
(*Note 1)	(*Note 2)	(*Note 3)	(*Note 4)	(*Note 5)	(*Note 6)	(*Note 7)
Volts	 PLASTIC CASE 318-07 TO-236AB			 PLASTIC CASE 425-04, STYLE 1 CATHODE = NOTCH		 PLASTIC CASE 403A-03 CATHODE = NOTCH
1.8				MMSZ4678T1		
2.0				MMSZ4679T1		
2.2				MMSZ4680T1		
2.4	BZX84C2V4L	MMBZ5221BL	MMSZ2V4T1	MMSZ4681T1	MMSZ5221BT1	
2.5		MMBZ5222BL			MMSZ5222BT1	
2.7	BZX84C2V7L	MMBZ5223BL	MMSZ2V7T1	MMSZ4682T1	MMSZ5223BT1	
2.8		MMBZ5224BL			MMSZ5224BT1	
3.0	BZX84C3V0L	MMBZ5225BL	MMSZ3V0T1	MMSZ4683T1	MMSZ5225BT1	
3.3	BZX84C3V3L	***MMBZ5226BL***	MMSZ3V3T1	MMSZ4684T1	MMSZ5226BT1	1SMB5913BT3
3.6	BZX84C3V6L	MMBZ5227BL	MMSZ3V6T1	MMSZ4685T1	MMSZ5227BT1	1SMB5914BT3
3.9	BZX84C3V9L	MMBZ5228BL	MMSZ3V9T1	MMSZ4686T1	MMSZ5228BT1	1SMB5915BT3
4.3	BZX84C4V3L	***MMBZ5229BL***	MMSZ4V3T1	MMSZ4687T1	MMSZ5229BT1	1SMB5916BT3
4.7	***BZX84C4V7L***	***MMBZ5230BL***	MMSZ4V7T1	MMSZ4688T1	MMSZ5230BT1	1SMB5917BT3
5.1	***BZX84C5V1L***	***MMBZ5231BL***	MMSZ5V1T1	MMSZ4689T1	***MMSZ5231BT1***	***1SMB5918BT3***
5.6	***BZX84C5V6L***	***MMBZ5232BL***	MMSZ5V6T1	MMSZ4690T1	MMSZ5232BT1	1SMB5919BT3
6.0		MMBZ5233BL			***MMSZ5233BT1***	
6.2	***BZX84C6V2L***	***MMBZ5234BL***	MMSZ6V2T1	MMSZ4691T1	MMSZ5234BT1	***1SMB5920BT3***
6.8	***BZX84C6V8L***	***MMBZ5235BL***	MMSZ6V8T1	MMSZ4692T1	MMSZ5235BT1	1SMB5921BT3
7.5	BZX84C7V5L	***MMBZ5236BL***	MMSZ7V5T1	MMSZ4693T1	MMSZ5236BT1	1SMB5922BT3
8.2	***BZX84C8V2L***	***MMBZ5237BL***	MMSZ8V2T1	MMSZ4694T1	MMSZ5237BT1	1SMB5923BT3
8.7		MMBZ5238BL		MMSZ4695T1	MMSZ5238BT1	
9.1	***BZX84C9V1L***	***MMBZ5239BL***	MMSZ9V1T1	MMSZ4696T1	MMSZ5239BT1	1SMB5924BT3
10	***BZX84C10L***	***MMBZ5240BL***	MMSZ10T1	MMSZ4697T1	MMSZ5240BT1	***1SMB5925BT3***
11	BZX84C11L	MMBZ5241BL	MMSZ11T1	MMSZ4698T1	MMSZ5241BT1	1SMB5926BT3
12	***BZX84C12L***	***MMBZ5242BL***	MMSZ12T1	MMSZ4699T1	MMSZ5242BT1	***1SMB5927BT3***
13	BZX84C13L	MMBZ5243BL	MMSZ13T1	MMSZ4700T1	MMSZ5243BT1	1SMB5928BT3
14		MMBZ5244BL		MMSZ4701T1	***MMSZ5244BT1***	
15	***BZX84C15L***	***MMBZ5245BL***	MMSZ15T1	MMSZ4702T1	MMSZ5245BT1	***1SMB5929BT3***
16	BZX84C16L	MMBZ5246BL	MMSZ16T1	MMSZ4703T1	MMSZ5246BT1	1SMB5930BT3
17		MMBZ5247BL		MMSZ4704T1	MMSZ5247BT1	
18	BZX84C18L	MMBZ5248BL	MMSZ18T1	MMSZ4705T1	MMSZ5248BT1	***1SMB5931BT3***
19		MMBZ5249BL		MMSZ4706T1	MMSZ5249BT1	
20	BZX84C20L	MMBZ5250BL	MMSZ20T1	MMSZ4707T1	MMSZ5250BT1	1SMB5932BT3
22	BZX84C22L	MMBZ5251BL	MMSZ22T1	MMSZ4708T1	MMSZ5251BT1	1SMB5933BT3
24	BZX84C24L	MMBZ5252BL	MMSZ24T1	MMSZ4709T1	***MMSZ5252BT1***	***1SMB5934BT3***
25		MMBZ5253BL		MMSZ4710T1	MMSZ5253BT1	
27	BZX84C27L	***MMBZ5254BL***	MMSZ27T1	MMSZ4711T1	MMSZ5254BT1	1SMB5935BT3
28		***MMBZ5255BL***		MMSZ4712T1	MMSZ5255BT1	
30	***BZX84C30L***	MMBZ5256BL	MMSZ30T1	MMSZ4713T1	MMSZ5256BT1	***1SMB5936BT3***
33	BZX84C33L	MMBZ5257BL	MMSZ33T1	MMSZ4714T1	MMSZ5257BT1	1SMB5937BT3
36	BZX84C36L	MMBZ5258BL	MMSZ36T1	MMSZ4715T1	MMSZ5258BT1	1SMB5938BT3
39	BZX84C39L	MMBZ5259BL	MMSZ39T1	MMSZ4716T1	MMSZ5259BT1	1SMB5939BT3
43	BZX84C43L	MMBZ5260BL	MMSZ43T1	MMSZ4717T1	MMSZ5260BT1	1SMB5940BT3

*See Notes on page 5.2-8

Devices listed in bold, italic are Motorola preferred devices.

Table 3. Surface Mount Packages (continued)

Nominal Zener Breakdown Voltage	225 mW Surface Mount SOT-23		500 mW Surface Mount SOD-123	500 mW Low Level Surface Mount SOD-123	500 mW Surface Mount SOD-123	1.5 Watt Surface Mount SMB
(*Note 1)	(*Note 2)	(*Note 3)	(*Note 4)	(*Note 5)	(*Note 6)	(*Note 7)
Volts	Anode  Cathode, No Connection PLASTIC CASE 318-07 TO-236AB		 PLASTIC CASE 425-04, STYLE 1 CATHODE = NOTCH			 PLASTIC CASE 403A-03 CATHODE = NOTCH
47	BZX84C47L	MMBZ5261BL	MMSZ47T1		MMSZ5261BT1	1SMB5941BT3
51	BZX84C51L	MMBZ5262BL	MMSZC51T1		MMSZ5262BT1	1SMB5942BT3
56	BZX84C56L	MMBZ5263BL	MMSZC56T1		MMSZ5263BT1	1SMB5943BT3
60		MMBZ5264BL			MMSZ5264BT1	
62	BZX84C62L	MMBZ5265BL	MMSZC62T1		MMSZ5265BT1	1SMB5944BT3
68	BZX84C68L	MMBZ5266BL	MMSZC68T1		MMSZ5266BT1	1SMB5945BT3
75	BZX84C75L	MMBZ5267BL	MMSZC75T1		MMSZ5267BT1	1SMB5946BT3
82		MMBZ5268BL			MMSZ5268BT1	1SMB5947BT3
87		MMBZ5269BL			MMSZ5269BT1	
91		MMBZ5270BL			MMSZ5270BT1	1SMB5948BT3
100					MMSZ5271BT1	1SMB5949BT3
110						1SMB5950BT3
120						1SMB5951BT3
130						1SMB5952BT3
150						1SMB5953BT3
160						1SMB5954BT3
170						
180						1SMB5955BT3
200						1SMB5956BT3

*See Notes on page 5.2-8

Notes — Surface Mount Chart

1. Zener Voltage is the key parameter for each device type. It is specified at a particular test current applied at either thermal equilibrium (T.E.) or pulse test condition. The voltage tolerance for the device types listed is, in general ±5%; however, for some series, the voltage tolerance varies from device type to device type over a range of ±(5 to 8.5)%. Consult the complete data sheet to determine the exact test conditions and minimum/maximum limits for the zener voltage.

   Power Ratings represent the capability of the case size listed as supplied by Motorola. These ratings may be higher than the same device types supplied by other manufacturers.

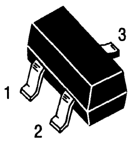
V_Z Test Conditions And Tolerances

2. BZX84C2V4L-C24L I_{ZT} = 5 mA (pulse).
   BZX84C27L-C75L I_{ZT} = 2 mA (pulse).
   Tolerance is ±(5 to 8.5)% depending on type number. Each device type also has other V_Z min/max limits at two other I_{ZT} pulse current values.
3. MMBZ5221BL-42BL I_{ZT} = 20 mA (pulse).
   MMBZ5243BL-70BL I_{ZT} @ approximately 125 mW point (pulse).
   BL suffix = ±5%.
4. MMSZ2V4T1-24T1 I_{ZT} = 5 mA (pulse).
   MMSZ27T1-C75T1 I_{ZT} = 2 mA (pulse).
   Tolerance is ±(5 to 8.5)% depending on type number. Each device type also has other V_Z min/max limits at two other I_{ZT} pulse current values.
5. MMSZ4678T1 Series I_{ZT} = 50 µA (T.E.).
   No suffix = ±5%.
6. MMSZ5221B-42BT1 I_{ZT} = 20 mA (T.E.).
   MMSZ5243B-70BT1 I_{ZT} @ approximately 125 mW point (T.E.).
   A suffix = ±10%.
   B suffix = ±5%.
7. 1SMB5913BT3 Series
   I_{ZT} @ approximately 375 mW point (T.E.).
   BT3 suffix = ±5%.
   T3 suffix designates tape and reel of 2500 units.

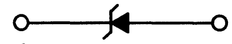
Devices listed in bold, italic are Motorola preferred devices.

Table 4. 225 mW Rating on FR-5 Board – Case 318-07 – SOT-23

ELECTRICAL CHARACTERISTICS (Pinout: 1-Anode, 2-NC, 3-Cathode) (V_F = 0.9 V Max @ I_F = 10 mA for all types)



CASE 318-07, STYLE 8
SOT-23 (TO-236AB)
PLASTIC



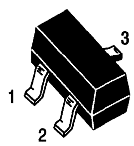
Type Number	Marking	Zener Voltage V_{Z1} (Volts) @ I_{ZT1} = 5 mA (20)			Max Zener Impedance Z_{ZT1} (Ohms) @ I_{ZT1} = 5 mA	Max Reverse Leakage Current		Zener Voltage V_{Z2} (Volts) @ I_{ZT2} = 1 mA (20)		Max Zener Impedance Z_{ZT2} (Ohms) @ I_{ZT12} = 1 mA	Zener Voltage V_{Z3} (Volts) @ I_{ZT3} = 20 mA (20)		Max Zener Impedance Z_{ZT3} (Ohms) @ I_{ZT3} = 20 mA	d_{VZ}/dt (mV/k) @ I_{ZT1} = 5 mA		C_{pF} Max @ V_R = 0 f = 1 MHz
		Nom	Min	Max		I_R mA	@ V_R Volts	Min	Max		Min	Max		Min	Max	
BZX84C2V4L	Z11	2.4	2.2	2.6	100	50	1	1.7	2.1	600	2.6	3.2	50	–3.5	0	450
BZX84C2V7L	Z12	2.7	2.5	2.9	100	20	1	1.9	2.4	600	3	3.6	50	–3.5	0	450
BZX84C3V0L	Z13	3	2.8	3.2	95	10	1	2.1	2.7	600	3.3	3.9	50	–3.5	0	450
BZX84C3V3L	Z14	3.3	3.1	3.5	95	5	1	2.3	2.9	600	3.6	4.2	40	–3.5	0	450
BZX84C3V6L	Z15	3.6	3.4	3.8	90	5	1	2.7	3.3	600	3.9	4.5	40	–3.5	0	450
BZX84C3V9L	Z16	3.9	3.7	4.1	90	3	1	2.9	3.5	600	4.1	4.7	30	–3.5	–2.5	450
BZX84C4V3L	W9	4.3	4	4.6	90	3	1	3.3	4	600	4.4	5.1	30	–3.5	0	450
BZX84C4V7L	Z1	4.7	4.4	5	80	3	2	3.7	4.7	500	4.5	5.4	15	–3.5	0.2	260
BZX84C5V1L	Z2	5.1	4.8	5.4	60	2	2	4.2	5.3	480	5	5.9	15	–2.7	1.2	225
BZX84C5V6L	Z3	5.6	5.2	6	40	1	2	4.8	6	400	5.2	6.3	10	–2.0	2.5	200
BZX84C6V2L	Z4	6.2	5.8	6.6	10	3	4	5.6	6.6	150	5.8	6.8	6	0.4	3.7	185
BZX84C6V8L	Z5	6.8	6.4	7.2	15	2	4	6.3	7.2	80	6.4	7.4	6	1.2	4.5	155
BZX84C7V5L	Z6	7.5	7	7.9	15	1	5	6.9	7.9	80	7	8	6	2.5	5.3	140
BZX84C8V2L	Z7	8.2	7.7	8.7	15	0.7	5	7.6	8.7	80	7.7	8.8	6	3.2	6.2	135
BZX84C9V1L	Z8	9.1	8.5	9.6	15	0.5	6	8.4	9.6	100	8.5	9.7	8	3.8	7.0	130
BZX84C10L	Z9	10	9.4	10.6	20	0.2	7	9.3	10.6	150	9.4	10.7	10	4.5	8.0	130
BZX84C11L	Y1	11	10.4	11.6	20	0.1	8	10.2	11.6	150	10.4	11.8	10	5.4	9.0	130
BZX84C12L	Y2	12	11.4	12.7	25	0.1	8	11.2	12.7	150	11.4	12.9	10	6.0	10.0	130
BZX84C13L	Y3	13	12.4	14.1	30	0.1	8	12.3	14	170	12.5	14.2	15	7.0	11.0	120
BZX84C15L	Y4	15	13.8	15.6	30	0.05	10.5	13.7	15.5	200	13.9	15.7	20	9.2	13.0	110
BZX84C16L	Y5	16	15.3	17.1	40	0.05	11.2	15.2	17	200	15.4	17.2	20	10.4	14.0	105
BZX84C18L	Y6	18	16.8	19.1	45	0.05	12.6	16.7	19	225	16.9	19.2	20	12.4	16.0	100
BZX84C20L	Y7	20	18.8	21.2	55	0.05	14	18.7	21.1	225	18.9	21.4	20	14.4	18.0	85
BZX84C22L	Y8	22	20.8	23.3	55	0.05	15.4	20.7	23.2	250	20.9	23.4	25	16.4	20.0	85
BZX84C24L	Y9	24	22.8	25.6	70	0.05	16.8	22.7	25.5	250	22.9	25.7	25	18.4	22.0	80

Type Number	Marking	V_{Z1} Below @ I_{ZT1} = 2 mA			Z_{ZT1} Below @ I_{ZT1} = 2 mA	I_R @ V_R mA Volts		V_{Z2} Below @ I_{ZT2} = 0.1 mA		Z_{ZT2} Below @ I_{ZT4} = 0.5 mA (23)	V_{Z3} Below @ I_{ZT3} = 10 mA		Z_{ZT3} Below @ I_{ZT3} = 10 mA	d_{VZ}/dt (mV/k) Below @ I_{ZT1} = 2 mA		C_{pF} Max @ V_R = 0 f = 1 MHz
BZX84C27L	Y10	27	25.1	28.9	80	0.05	18.9	25	28.9	300	25.2	29.3	45	21.4	25.3	70
BZX84C30L	Y11	30	28	32	80	0.05	21	27.8	32	300	28.1	32.4	50	24.4	29.4	70
BZX84C33L	Y12	33	31	35	80	0.05	23.1	30.8	35	325	31.1	35.4	55	27.4	33.4	70
BZX84C36L	Y13	36	34	38	90	0.05	25.2	33.8	38	350	34.1	38.4	60	30.4	37.4	70
BZX84C39L	Y14	39	37	41	130	0.05	27.3	36.7	41	350	37.1	41.5	70	33.4	41.2	45
BZX84C43L	Y15	43	40	46	150	0.05	30.1	39.7	46	375	40.1	46.5	80	37.6	46.6	40
BZX84C47L	Y16	47	44	50	170	0.05	32.9	43.7	50	375	44.1	50.5	90	42.0	51.8	40
BZX84C51L	Y17	51	48	54	180	0.05	35.7	47.6	54	400	48.1	54.6	100	46.6	57.2	40
BZX84C56L	Y18	56	52	60	200	0.05	39.2	51.5	60	425	52.1	60.8	110	52.2	63.8	40
BZX84C62L	Y19	62	58	66	215	0.05	43.4	57.4	66	450	58.2	67	120	58.8	71.6	35
BZX84C68L	Y20	68	64	72	240	0.05	47.6	63.4	72	475	64.2	73.2	130	65.6	79.8	35
BZX84C75L	Y21	75	70	79	255	0.05	52.5	69.4	79	500	70.3	80.2	140	73.4	88.6	35

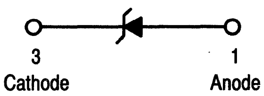
(20) V_Z is measured with a pulse test current (I_{ZT}) applied at an ambient temperature of 25°C.
(23) The zener impedance, Z_{ZT2}, for the 27 through 75 volt types is tested at 0.5 mA rather than the test current of 0.1 mA used for V_{Z2}.

Devices listed in bold, italic are Motorola preferred devices.

Table 5. 225 mW Rating on FR-5 Board – Case 318-07 – SOT-23
ELECTRICAL CHARACTERISTICS (Pinout: 1-Anode, 2-NC, 3-Cathode) (V_F = 0.9 V Max @ I_F = 10 mA for all types.)



CASE 318-07, STYLE 8
SOT-23 (TO-236AB)
PLASTIC

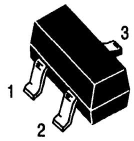


Device	Marking	Test Current I_{ZT} mA	Zener Voltage V_Z (±5%) Nominal(20)	Z_{ZK} I_Z = 0.25 mA Ω Max	Z_{ZT} $I_Z = I_{ZT}$ @ 10% Mode Ω Max	Max I_R μA	@ V_R V
MMBZ5221BL	18A	20	2.4	1200	30	100	1
MMBZ5222BL	18B	20	2.5	1250	30	100	1
MMBZ5223BL	18C	20	2.7	1300	30	75	1
MMBZ5224BL	18D	20	2.8	1400	30	75	1
MMBZ5225BL	18E	20	3	1600	29	50	1
MMBZ5226BL	8A	20	3.3	1600	28	25	1
MMBZ5227BL	8B	20	3.6	1700	24	15	1
MMBZ5228BL	8C	20	3.9	1900	23	10	1
MMBZ5229BL	8D	20	4.3	2000	22	5	1
MMBZ5230BL	8E	20	4.7	1900	19	5	2
MMBZ5231BL	8F	20	5.1	1600	17	5	2
MMBZ5232BL	8G	20	5.6	1600	11	5	3
MMBZ5233BL	8H	20	6	1600	7	5	3.5
MMBZ5234BL	8J	20	6.2	1000	7	5	4
MMBZ5235BL	8K	20	6.8	750	5	3	5
MMBZ5236BL	8L	20	7.5	500	6	3	6
MMBZ5237BL	8M	20	8.2	500	8	3	6.5
MMBZ5238BL	8N	20	8.7	600	8	3	6.5
MMBZ5239BL	8P	20	9.1	600	10	3	7
MMBZ5240BL	8Q	20	10	600	17	3	8
MMBZ5241BL	8R	20	11	600	22	2	8.4
MMBZ5242BL	8S	20	12	600	30	1	9.1
MMBZ5243BL	8T	9.5	13	600	13	0.5	9.9
MMBZ5244BL	8U	9	14	600	15	0.1	10
MMBZ5245BL	8V	8.5	15	600	16	0.1	11
MMBZ5246BL	8W	7.8	16	600	17	0.1	12
MMBZ5247BL	8X	7.4	17	600	19	0.1	13
MMBZ5248BL	8Y	7	18	600	21	0.1	14
MMBZ5249BL	8Z	6.6	19	600	23	0.1	14
MMBZ5250BL	81A	6.2	20	600	25	0.1	15
MMBZ5251BL	81B	5.6	22	600	29	0.1	17
MMBZ5252BL	81C	5.2	24	600	33	0.1	18
MMBZ5253BL	81D	5	25	600	35	0.1	19
MMBZ5254BL	81E	4.6	27	600	41	0.1	21
MMBZ5255BL	81F	4.5	28	600	44	0.1	21
MMBZ5256BL	81G	4.2	30	600	49	0.1	23
MMBZ5257BL	81H	3.8	33	700	58	0.1	25
MMBZ5258BL	81J	3.4	36	700	70	0.1	27
MMBZ5259BL	81K	3.2	39	800	80	0.1	30
MMBZ5260BL	81L	3	43	900	93	0.1	33

(20)V_Z is measured at pulse test current (I_{ZT}) at an ambient temperature of 25°C.

Devices listed in bold, italic are Motorola preferred devices.

Table 5. 225 mW Rating on FR-5 Board – Case 318-07 – SOT-23 (continued)
ELECTRICAL CHARACTERISTICS (Pinout: 1-Anode, 2-NC, 3-Cathode) (V_F = 0.9 V Max @ I_F = 10 mA for all types.)



CASE 318-07, STYLE 8
SOT-23 (TO-236AB)
PLASTIC

3
Cathode

1
Anode

Device	Marking	Test Current I_{ZT} mA	Zener Voltage V_Z (±5%) Nominal(20)	Z_{ZK} I_Z = 0.25 mA Ω Max	Z_{ZT} $I_Z = I_{ZT}$ @ 10% Mode Ω Max	Max I_R µA @	V_R V
MMBZ5261BL	81M	2.7	47	1000	105	0.1	36
MMBZ5262BL	81N	2.5	51	1100	125	0.1	39
MMBZ5263BL	81P	2.2	56	1300	150	0.1	43
MMBZ5264BL	81Q	2.1	60	1400	170	0.1	46
MMBZ5265BL	81R	2	62	1400	185	0.1	47
MMBZ5266BL	81S	1.8	68	1600	230	0.1	52
MMBZ5267BL	81T	1.7	75	1700	270	0.1	56
MMBZ5268BL	81U	1.5	82	2000	330	0.1	62
MMBZ5269BL	81V	1.4	87	2200	370	0.1	68
MMBZ5270BL	81W	1.4	91	2300	400	0.1	69

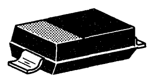
(20) V_Z is measured at pulse test current (I_{ZT}) at an ambient temperature of 25°C.

Devices listed in bold, italic are Motorola preferred devices.

Surface Mount Packages (continued)

Table 6. 500 mW Rating on FR-4 or FR-5 Board – Case 425-04 – SOD-123

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted(24), (V_F = 0.9 V Max. @ I_F = 10 mA for all types)



CASE 425-04 STYLE 1
PLASTIC
CATHODE = NOTCH

Type Number	Marking	Zener Voltage V_Z @ I_{ZT} Volts(24)(25) Nom	Min	Max	Test Voltage V_R Volts	Max Zener Impedance(21) Z_{ZT} @ $I_Z = I_{ZT}$ Ω	Z_{ZK} @ I_{ZK} = 0.25 mA Ω	Max Reverse Leakage Current I_R @ V_R µA	Test Voltage V_R Volts
MMSZ5221B	C1	2.4	2.28	2.52	20	30	1200	100	1
MMSZ5222B	C2	2.5	2.38	2.63	20	30	1250	100	1
MMSZ5223B	C3	2.7	2.57	2.84	20	30	1300	75	1
MMSZ5224B	C4	2.8	2.66	2.94	20	30	1400	75	1
MMSZ5225B	C5	3.0	2.85	3.15	20	30	1600	50	1
MMSZ5226B	D1	3.3	3.14	3.47	20	28	1600	25	1
MMSZ5227B	D2	3.6	3.42	3.78	20	24	1700	15	1
MMSZ5228B	D3	3.9	3.71	4.10	20	23	1900	10	1
MMSZ5229B	D4	4.3	4.09	4.52	20	22	2000	5	1
MMSZ5230B	D5	4.7	4.47	4.94	20	19	1900	5	2
MMSZ5231B	E1	5.1	4.85	5.36	20	17	1600	5	2
MMSZ5232B	E2	5.6	5.32	5.88	20	11	1600	5	3
MMSZ5233B	E3	6.0	5.70	6.30	20	7	1600	5	3.5
MMSZ5234B	E4	6.2	5.89	6.51	20	7	1000	5	4
MMSZ5235B	E5	6.8	6.46	7.14	20	5	750	3	5
MMSZ5236B	F1	7.5	7.13	7.88	20	6	500	3	6
MMSZ5237B	F2	8.2	7.79	8.61	20	8	500	3	6.5
MMSZ5238B	F3	8.7	8.27	9.14	20	8	600	3	6.5
MMSZ5239B	F4	9.1	8.65	9.56	20	10	600	3	7
MMSZ5240B	F5	10	9.50	10.50	20	17	600	3	8
MMSZ5241B	H1	11	10.45	11.55	20	22	600	2	8.4
MMSZ5242B	H2	12	11.40	12.60	20	30	600	1	9.1
MMSZ5243B	H3	13	12.35	13.65	9.5	13	600	0.5	9.9
MMSZ5244B	H4	14	13.30	14.70	9.0	15	600	0.1	10
MMSZ5245B	H5	15	14.25	15.75	8.5	16	600	0.1	11
MMSZ5246B	J1	16	15.20	16.80	7.8	17	600	0.1	12
MMSZ5247B	J2	17	16.15	17.85	7.4	19	600	0.1	13
MMSZ5248B	J3	18	17.10	18.90	7.0	21	600	0.1	14
MMSZ5249B	J4	19	18.05	19.95	6.6	23	600	0.1	14
MMSZ5250B	J5	20	19.00	21.00	6.2	25	600	0.1	15
MMSZ5251B	K1	22	20.90	23.10	5.6	29	600	0.1	17
MMSZ5252B	K2	24	22.80	25.20	5.2	33	600	0.1	18
MMSZ5253B	K3	25	23.75	26.25	5.0	35	600	0.1	19
MMSZ5254B	K4	27	25.65	28.35	4.6	41	600	0.1	21
MMSZ5255B	K5	28	26.60	29.40	4.5	44	600	0.1	21

(21)Z_{ZT} and Z_{ZK} are measured by dividing the AC voltage drop across the device by the AC current applied. The specified limits are for $I_{Z(AC)} = 0.1\ I_{Z(DC)}$, with the AC frequency = 1 kHz.
(24)Nominal zener voltage is measured with the device junction in thermal equilibrium at T_L = 30°C ± 1°C.
(25)All part numbers shown indicate a V_Z tolerance of ±5%.

Devices listed in bold, italic are Motorola preferred devices.

Surface Mount Packages (continued)

Table 7. 500 mW Rating on FR-4 or FR-5 Board – Case 425-04 – SOD-123

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted[24], (V_F = 0.9 V Max. @ I_F = 10 mA for all types)

Type Number	Marking	Zener Voltage V_Z @ I_{ZT} Volts[24][25]			Test Voltage V_R Volts	Max Zener Impedance[21]		Max Reverse Leakage Current I_R @ V_R μA	Test Voltage V_R Volts
		Nom	Min	Max		Z_{ZT} @ $I_Z = I_{ZT}$ Ω	Z_{ZK} @ I_{ZK} = 0.25 mA Ω		
MMSZ5256B	M1	30	28.50	31.50	4.2	49	600	0.1	23
MMSZ5257B	M2	33	31.35	34.65	3.8	58	700	0.1	25
MMSZ5258B	M3	36	34.20	37.80	3.4	70	700	0.1	27
MMSZ5259B	M4	39	37.05	40.95	3.2	80	800	0.1	30
MMSZ5260B	M5	43	40.85	45.15	3.0	93	900	0.1	33
MMSZ5261B	N1	47	44.65	49.35	2.7	105	1000	0.1	36
MMSZ5262B	N2	51	48.45	53.55	2.5	125	1100	0.1	39
MMSZ5263B	N3	56	53.20	58.80	2.2	150	1300	0.1	43
MMSZ5264B	N4	60	57.00	63.00	2.1	170	1400	0.1	46
MMSZ5265B	N5	62	58.90	65.10	2.0	185	1400	0.1	47
MMSZ5266B	P1	68	64.60	71.40	1.8	230	1600	0.1	52
MMSZ5267B	P2	75	71.25	78.75	1.7	270	1700	0.1	56
MMSZ5268B	P3	82	77.90	86.10	1.5	330	2000	0.1	62
MMSZ5269B	P4	87	82.65	91.35	1.4	370	2200	0.1	68
MMSZ5270B	P5	91	86.45	95.55	1.4	400	2300	0.1	69

Table 8. 500 mW Rating on FR-4 or FR-5 Board – Case 425-04 – SOD-123

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted[24], (V_F = 0.9 V Max. @ I_F = 10 mA for all types)

Type Number	Marking	Zener Voltage V_Z @ I_{ZT} = 50 μA Volts[24][25]			Max Reverse Leakage Current I_R @ V_R μA	Test Voltage V_R Volts
		Nom	Min	Max		
MMSZ4678	CC	1.8	1.71	1.89	7.5	1
MMSZ4679	CD	2.0	1.90	2.10	5	1
MMSZ4680	CE	2.2	2.09	2.31	4	1
MMSZ4681	CF	2.4	2.28	2.52	2	1
MMSZ4682	CH	2.7	2.57	2.84	1	1
MMSZ4683	CJ	3.0	2.85	3.15	0.8	1
MMSZ4684	CK	3.3	3.14	3.47	7.5	1.5
MMSZ4685	CM	3.6	3.42	3.78	7.5	2
MMSZ4686	CN	3.9	3.71	4.10	5	2
MMSZ4687	CP	4.3	4.09	4.52	4	2
MMSZ4688	CT	4.7	4.47	4.94	10	3
MMSZ4689	CU	5.1	4.85	5.36	10	3
MMSZ4690	CV	5.6	5.32	5.88	10	4
MMSZ4691	CA	6.2	5.89	6.51	10	5
MMSZ4692	CX	6.8	6.46	7.14	10	5.1
MMSZ4693	CY	7.5	7.13	7.88	10	5.7
MMSZ4694	CZ	8.2	7.79	8.61	1	6.2

[21] Z_{ZT} and Z_{ZK} are measured by dividing the AC voltage drop across the device by the AC current applied. The specified limits are for $I_{Z(AC)} = 0.1\ I_{Z(DC)}$, with the AC frequency = 1 kHz.
[24] Nominal zener voltage is measured with the device junction in thermal equilibrium at T_L = 30°C ± 1°C.
[25] All part numbers shown indicate a V_Z tolerance of ±5%.

Devices listed in bold, italic are Motorola preferred devices.

Table 8. 500 mW Rating on FR-4 or FR-5 Board – Case 425-04 – SOD-123

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted[24]), (V_F = 0.9 V Max. @ I_F = 10 mA for all types)

Type Number	Marking	Zener Voltage V_Z @ I_{ZT} = 50 μA Volts[24][25]			Max Reverse Leakage Current	Test Voltage V_R
		Nom	Min	Max	I_R @ V_R μA	Volts
MMSZ4695	DC	8.7	8.27	9.14	1	6.6
MMSZ4696	DD	9.1	8.65	9.56	1	6.9
MMSZ4697	DE	10	9.50	10.50	1	7.6
MMSZ4698	DF	11	10.45	11.55	0.05	8.4
MMSZ4699	DH	12	11.40	12.60	0.05	9.1
MMSZ4700	DJ	13	12.35	13.65	0.05	9.8
MMSZ4701	DK	14	13.30	14.70	0.05	10.6
MMSZ4702	DM	15	14.25	15.75	0.05	11.4
MMSZ4703	DN	16	15.20	16.80	0.05	12.1
MMSZ4704	DP	17	16.15	17.85	0.05	12.9
MMSZ4705	DT	18	17.10	18.90	0.05	13.6
MMSZ4706	DU	19	18.05	19.95	0.05	14.4
MMSZ4707	DV	20	19.00	21.00	0.01	15.2
MMSZ4708	DA	22	20.90	23.10	0.01	16.7
MMSZ4709	DZ	24	22.80	25.20	0.01	18.2
MMSZ4710	DY	25	23.75	26.25	0.01	19.00
MMSZ4711	EA	27	25.65	28.35	0.01	20.4
MMSZ4712	EC	28	26.60	29.40	0.01	21.2
MMSZ4713	ED	30	28.50	31.50	0.01	22.8
MMSZ4714	EE	33	31.35	34.65	0.01	25.0
MMSZ4715	EF	36	34.20	37.80	0.01	27.3
MMSZ4716	EH	39	37.05	40.95	0.01	29.6
MMSZ4717	EJ	43	40.85	45.15	0.01	32.6

(21) Z_{ZT} and Z_{ZK} are measured by dividing the AC voltage drop across the device by the AC current applied. The specified limits are for $I_{Z(AC)}$ = 0.1 $I_{Z(DC)}$, with the AC frequency = 1 kHz.
(24) Nominal zener voltage is measured with the device junction in thermal equilibrium at T_L = 30°C ± 1°C.
(25) All part numbers shown indicate a V_Z tolerance of ±5%.

Devices listed in bold, italic are Motorola preferred devices.

Surface Mount Packages (continued)

Table 9. 500 mW Rating on FR-4 or FR-5 Board — Case 425-04 — SOD-123

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted(25), (V_F = 0.9 V Max. @ I_F = 10 mA for all types)

Type Number	Marking	Zener Voltage V_{Z1} (Volts) @ I_{ZT1} = 5 mA(25)(27)			Max Zener Impedance Z_{ZT1} @ I_{ZT1} = 5 mA(21) Ω	Max Reverse Leakage Current		Zener Voltage V_{Z2} (Volts) @ I_{ZT2} = 1 mA(27)		Max Zener Impedance Z_{ZT2} @ I_{ZT1} = 1 mA(21) Ω
		Nom	Min	Max		I_R µ	@ V_R AVolts	Min	Max	
MMSZ2V4	T1	2.4	2.28	2.52	100	50	1	1.7	2.1	600
MMSZ2V7	T2	2.7	2.57	2.84	100	20	1	1.9	2.4	600
MMSZ3V0	T3	3.0	2.85	3.15	95	10	1	2.1	2.7	600
MMSZ3V3	T4	3.3	3.14	3.47	95	5	1	2.3	2.9	600
MMSZ3V6	T5	3.6	3.42	3.78	90	5	1	2.7	3.3	600
MMSZ3V9	U1	3.9	3.71	4.10	90	3	1	2.9	3.5	600
MMSZ4V3	U2	4.3	4.09	4.52	90	3	1	3.3	4.0	600
MMSZ4V7	U3	4.7	4.47	4.94	80	3	2	3.7	4.7	500
MMSZ5V1	U4	5.1	4.85	5.36	60	2	2	4.2	5.3	480
MMSZ5V6	U5	5.6	5.32	5.88	40	1	2	4.8	6.0	400
MMSZ6V2	V1	6.2	5.89	6.51	10	3	4	5.6	6.6	150
MMSZ6V8	V2	6.8	6.46	7.14	15	2	4	6.3	7.2	80
MMSZ7V5	V3	7.5	7.13	7.88	15	1	5	6.9	7.9	80
MMSZ8V2	V4	8.2	7.79	8.61	15	0.7	5	7.6	8.7	80
MMSZ9V1	V5	9.1	8.65	9.56	15	0.5	6	8.4	9.6	100
MMSZ10	A1	10	9.50	10.50	20	0.2	7	9.3	10.6	150
MMSZ11	A2	11	10.45	11.55	20	0.1	8	10.2	11.6	150
MMSZ12	A3	12	11.40	12.60	25	0.1	8	11.2	12.7	150
MMSZ13	A4	13	12.35	13.65	30	0.1	8	12.3	14.0	170
MMSZ15	A5	15	14.25	15.75	30	0.05	10.5	13.7	15.5	200
MMSZ16	X1	16	15.20	16.80	40	0.05	11.2	15.2	17.0	200
MMSZ18	X2	18	17.10	18.90	45	0.05	12.6	16.7	19.0	225
MMSZ20	X3	20	19.00	21.00	55	0.05	14	18.7	21.1	225
MMSZ22	X4	22	20.80	23.10	55	0.05	15.4	20.7	23.2	250
MMSZ24	X5	24	22.80	25.20	70	0.05	16.8	22.7	25.5	250

(21)Z_{ZT} and Z_{ZK} are measured by dividing the AC voltage drop across the device by the AC current applied. The specified limits are for $I_{Z(AC)}$ = 0.1 $I_{Z(DC)}$, with the AC frequency = 1 kHz.
(24)Nominal zener voltage is measured with the device junction in thermal equilibrium at T_L = 30°C ± 1°C.
(25)All part numbers shown indicate a V_Z tolerance of ±5%.
(27)Zener voltage is measured with the zener current applied for PW = 1.0 ms.

Devices listed in bold, italic are Motorola preferred devices.

Surface Mount Packages (continued)

Table 10. 500 mW Rating on FR-4 or FR-5 Board — Case 425-04 — SOD-123

Type Number	Marking	Zener Voltage V_{Z1} (Volts) @ I_{ZT1} = 2 mA(25)(27)			Max Zener Impedance Z_{ZT1} @ I_{ZT1} = 2 mA(21) Ω	Max Reverse Leakage Current		Zener Voltage V_{Z2} (Volts) @ I_{ZT2} = 0.1 mA(27)		Max Zener Impedance Z_{ZT2} @ I_{ZT1} = 0.5 mA(21)(23) Ω
		Nom	Min	Max		I_R @ µA	V_R Volts	Min	Max	
MMSZ27	Y1	27	25.65	28.35	80	0.05	18.9	25	28.9	300
MMSZ30	Y2	30	28.50	31.50	80	0.05	21	27.8	32	300
MMSZ33	Y3	33	31.35	34.65	80	0.05	23.1	30.8	35	325
MMSZ36	Y4	36	34.20	37.80	90	0.05	25.2	33.8	38	350
MMSZ39	Y5	39	37.05	40.95	130	0.05	27.3	36.7	41	350
MMSZ43	Z1	43	40.85	45.15	150	0.05	30.1	39.7	46	375
MMSZ47	Z2	47	44.65	49.35	170	0.05	32.9	43.7	50	375
MMSZ51	Z3	51	48.45	53.55	180	0.05	35.7	47.6	54	400
MMSZ56	Z4	56	53.20	58.80	200	0.05	39.2	51.5	60	425
MMSZ62	Z5	62	58.90	65.10	215	0.05	43.4	57.4	66	450
MMSZ68	Z6	68	64.60	71.40	240	0.05	47.6	63.4	72	475
MMSZ75	Z7	75	71.25	78.75	255	0.05	52.5	69.4	79	500

(21)Z_{ZT} and Z_{ZK} are measured by dividing the AC voltage drop across the device by the AC current applied. The specified (limits are for $I_{Z(AC)} = 0.1\ I_{Z(DC)}$, with the AC frequency = 1 kHz

(23)The zener impedance, Z_{ZT2}, for the 27 through 75 volt types is tested at 0.5 mA rather than the test current of 0.1 mA used for V_{Z2}.

(25)All part numbers shown indicate a V_Z tolerance of ±5%

(27)Zener voltage is measured with the zener current applied for PW = 1.0 ms.

Devices listed in bold, italic are Motorola preferred devices.

Voltage Reference Diodes

Temperature Compensated Reference Devices

For applications where output voltage must remain within narrow limits during changes in input voltage, load resistance and temperature. Motorola guarantees all reference devices to fall within the specified maximum voltage variations, ΔV_Z, at the specifically indicated test temperatures and test current (JEDEC Standard #5). Temperature coefficient is also specified but should be considered as a reference only — not a maximum rating.

Devices in this table are hermetically sealed structures.

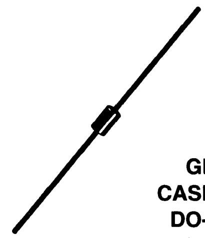


Table 11. Temperature Compensated Reference Devices

			AVERAGE TEMPERATURE COEFFICIENT OVER THE OPERATING RANGE									
			0.01 %/°C		0.005 %/°C		0.002 %/°C		0.001 %/°C		0.0005 %/°C	
V_Z Volts	Test Current mAdc	Test(2) Temp Points	Device Type	ΔV_Z Max Volts	Device Type	ΔV_Z Max Volts	Device Type	ΔV_Z Max Volts	Device Type	ΔV_Z Max Volts	Device Type	ΔV_Z Max Volts
6.2(1)	7.5	A	***1N821***	0.096	***1N823***	0.048	***1N825***	0.019	1N827	0.009	1N829	0.005
6.2(1)	7.5	A	1N821A	0.096	1N823A	0.048	1N825A	0.019	1N827A	0.009	1N829A	0.005

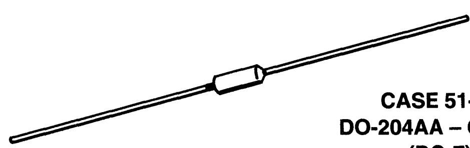
(1)Non-suffix — Z_{ZT} = 15 ohms, "A" Suffix — Z_{ZT} = 10 ohms
(2)Test Temperature Points °C: A = −55, 0, +25, +75, +100

Current Regulator Diodes

High impedance diodes whose "constant current source" characteristic complements the "constant voltage" of the zener line. Currents are available from 0.22 to 4.7 mA, with usable voltage range from a minimum limit of 1.0 to 2.5 V, up to a voltage compliance of 100 V, for the 1N5283 series.

Table 12. Current Regulator Diodes

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

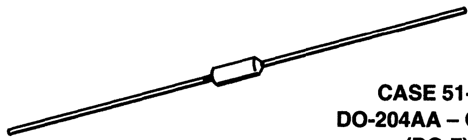


Type No.	Regulator Current I_P (mA) @ V_T = 25 V Nom	Min	Max	Minimum Dynamic Impedance @ V_T = 25 V Z_T (MΩ)	Minimum Knee Impedance @ V_K = 6.0 V Z_K (MΩ)	Maximum Limiting Voltage @ I_L = 0.8 I_P (min) V_L (Volts)
1N5283	0.22	0.198	0.242	25.0	2.75	1.00
1N5284	0.24	0.216	0.264	19.0	2.35	1.00
1N5285	0.27	0.243	0.297	14.0	1.95	1.00
1N5286	0.30	0.270	0.330	9.0	1.60	1.00
1N5287	0.33	0.297	0.363	6.6	1.35	1.00

Devices listed in bold, italic are Motorola preferred devices.

Table 12. Current Regulator Diodes

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)



CASE 51-02
DO-204AA – GLASS
(DO-7)

Type No.	Regulator Current I_P (mA) @ V_T = 25 V Nom	Min	Max	Minimum Dynamic Impedance @ V_T = 25 V Z_T (MΩ)	Minimum Knee Impedance @ V_K = 6.0 V Z_K (MΩ)	Maximum Limiting Voltage @ I_L = 0.8 I_P (min) V_L (Volts)
1N5288	0.39	0.351	0.429	4.10	1.00	1.05
1N5289	0.43	0.387	0.473	3.30	0.870	1.05
1N5290	0.47	0.423	0.517	2.70	0.750	1.05
1N5291	0.56	0.504	0.616	1.90	0.580	1.10
1N5292	0.62	0.558	0.682	1.55	0.470	1.13
1N5293	0.68	0.612	0.748	1.35	0.400	1.15
1N5294	0.75	0.675	0.825	1.15	0.335	1.20
1N5295	0.82	0.738	0.902	1.00	0.290	1.25
1N5296	0.91	0.819	1.001	0.880	0.240	1.29
1N5297	1.00	0.900	1.100	0.800	0.205	1.35
1N5298	1.10	0.990	1.210	0.700	0.180	1.40
1N5299	1.20	1.08	1.32	0.640	0.155	1.45
1N5300	1.30	1.17	1.43	0.580	0.135	1.50
1N5301	1.40	1.26	1.54	0.540	0.115	1.55
1N5302	1.50	1.35	1.65	0.510	0.105	1.60
1N5303	1.60	1.44	1.76	0.475	0.092	1.65
1N5304	1.80	1.62	1.98	0.420	0.074	1.75
1N5305	2.00	1.80	2.20	0.395	0.061	1.85
1N5306	2.20	1.98	2.42	0.370	0.052	1.95
1N5307	2.40	2.16	2.64	0.345	0.044	2.00
1N5308	2.70	2.43	2.97	0.320	0.035	2.15
1N5309	3.00	2.70	3.30	0.300	0.029	2.25
1N5310	3.30	2.97	3.63	0.280	0.024	2.35
1N5311	3.60	3.24	3.96	0.265	0.020	2.50
1N5312	3.90	3.51	4.29	0.255	0.017	2.60
1N5313	4.30	3.87	4.73	0.245	0.014	2.75
1N5314	4.70	4.23	5.17	0.235	0.012	2.90

Devices listed in bold, italic are Motorola preferred devices.

TVS (Transient Voltage Suppressors)

General-Purpose

Transient Voltage Suppressors are designed for applications requiring protection of voltage sensitive electronic devices in danger of destruction by high energy voltage transients. Many of the zener voltage regulator diodes listed in the previous charts are in fact used in circuits as transient voltage suppressors. The purpose of this section is to present the families of Motorola Zeners that are specified with the key transient voltage suppressor parameters and limits, e.g., maximum clamping voltage at maximum surge current rating and working peak reverse (stand-off) voltage.

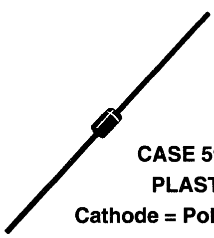
Selection sequence:

1. package type (axial or surface mount)
2. peak surge power expected for the application
3. working peak reverse stand-off voltage (or the breakdown voltage)
4. maximum reverse clamping voltage

Consult the factory for special electrical selections if there is no standard device type available to fit the application.

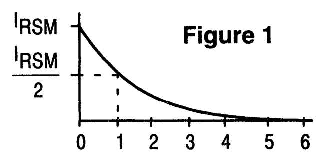
Axial Leaded for Through-hole Design

Table 13. Peak Power Dissipation(3) (*500 Watts* @ 1 ms Surge – Figure 1) Case 59-04 — Mini Mosorb
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 35 A Pulse (except bidirectional devices).



CASE 59-04 (Mini Mosorb™)
PLASTIC
Cathode = Polarity Band

Figure 1



Surge Current Characterisitcs

Working Peak Reverse Voltage V_{RWM} (Volts)	Device(4)	Breakdown Voltage V_{BR} (Volts) Min	Breakdown Voltage V_{BR} (Volts) Max	@ I_T Pulse (mA)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} Figure 1 (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
5	SA5.0	6.4	7.3	10	600	52	9.6
5	***SA5.0A***	6.4	7	10	600	54.3	9.2
6	SA6.0	6.67	8.15	10	600	43.9	11.4
6	***SA6.0A***	6.67	7.37	10	600	48.5	10.3
6.5	SA6.5	7.22	8.82	10	400	40.7	12.3
6.5	SA6.5A	7.22	7.98	10	400	44.7	11.2
7	SA7.0	7.78	9.51	10	150	37.8	13.3
7	SA7.0A	7.78	8.6	10	150	41.7	12
7.5	SA7.5	8.33	10.2	1	50	35	14.3
7.5	SA7.5A	8.33	9.21	1	50	38.8	12.9
8	SA8.0	8.89	10.9	1	25	33.3	15
8	SA8.0A	8.89	9.83	1	25	36.7	13.6
8.5	SA8.5	9.44	11.5	1	5	31.4	15.9
8.5	SA8.5A	9.44	10.4	1	5	34.7	14.4
9	SA9.0	10	12.2	1	1	29.5	16.9
9	SA9.0A	10	11.1	1	1	32.5	15.4

(3)Steady state power dissipation = 3 watt max rating
(4)For bidirectional types use C or CA suffix. ***SA6.5CA*** is a Motorola preferred device. Have cathode polarity band on each end. (Consult factory for availability).

Devices listed in bold, italic are Motorola preferred devices.

Table 13. Peak Power Dissipation[3] (*500 Watts* @ 1 ms Surge – Figure 1) Case 59-04 — Mini Mosorb (continued)
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 35 A Pulse (except bidirectional devices).

Working Peak Reverse Voltage V_{RWM} (Volts)	Device[4]	Breakdown Voltage V_{BR} (Volts) Min	Breakdown Voltage V_{BR} (Volts) Max	Breakdown Voltage @ I_T Pulse (mA)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} Figure 1 (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
10	SA10	11.1	13.6	1	1	26.6	18.8
10	SA10A	11.1	12.3	1	1	29.4	17
11	SA11	12.2	14.9	1	1	24.9	20.1
11	SA11A	12.2	13.5	1	1	27.4	18.2
12	SA12	13.3	16.3	1	1	22.7	22
12	***SA12A***	13.3	14.7	1	1	25.1	19.9
13	SA13	14.4	17.6	1	1	21	23.8
13	***SA13A***	14.4	15.9	1	1	23.2	21.5
14	SA14	15.6	19.1	1	1	19.4	25.8
14	SA14A	15.6	17.2	1	1	21.5	23.2
15	SA15	16.7	20.4	1	1	18.8	26.9
15	***SA15A***	16.7	18.5	1	1	20.6	24.4
16	SA16	17.8	21.8	1	1	17.6	28.8
16	SA16A	17.8	19.7	1	1	19.2	26
17	SA17	18.9	23.1	1	1	16.4	30.5
17	SA17A	18.9	20.9	1	1	18.1	27.6
18	SA18	20	24.4	1	1	15.5	32.2
18	SA18A	20	22.1	1	1	17.2	29.2
20	SA20	22.2	27.1	1	1	13.9	35.8
20	SA20A	22.2	24.5	1	1	15.4	32.4
22	SA22	24.4	29.8	1	1	12.7	39.4
22	SA22A	24.4	26.9	1	1	14.1	35.5
24	SA24	26.7	32.6	1	1	11.6	43
24	SA24A	26.7	29.5	1	1	12.8	38.9
26	SA26	28.9	35.3	1	1	10.7	46.6
26	SA26A	28.9	31.9	1	1	11.9	42.1
28	SA28	31.1	38	1	1	9.9	50
28	SA28A	31.1	34.4	1	1	11	45.4
30	SA30	33.3	40.7	1	1	9.3	53.5
30	SA30A	33.3	36.8	1	1	10.3	48.4
33	SA33	36.7	44.9	1	1	8.5	59
33	SA33A	36.7	40.6	1	1	9.4	53.3
36	SA36	40	48.9	1	1	7.8	64.3
36	SA36A	40	44.2	1	1	8.6	58.1
40	SA40	44.4	54.3	1	1	7	71.4
40	SA40A	44.4	49.1	1	1	7.8	64.5
43	SA43	47.8	58.4	1	1	6.5	76.7
43	SA43A	47.8	52.8	1	1	7.2	69.4
45	SA45	50	61.1	1	1	6.2	80.3
45	SA45A	50	55.3	1	1	6.9	72.7
48	SA48	53.3	65.1	1	1	5.8	85.5
48	SA48A	53.3	58.9	1	1	6.5	77.4
51	SA51	56.7	69.3	1	1	5.5	91.1
51	SA51A	56.7	62.7	1	1	6.1	82.4
54	SA54	60	73.3	1	1	5.2	96.3
54	SA54A	60	66.3	1	1	5.7	87.1

[3] Steady state power dissipation = 3 watt max rating
[4] For bidirectional types use C or CA suffix. ***SA12CA, SA13CA, SA15CA, SA18CA*** and ***SA24CA*** are Motorola preferred devices. Have cathode polarity band on each end. (Consult factory for availability).

Devices listed in bold, italic are Motorola preferred devices.

Table 13. Peak Power Dissipation(3) (*500 Watts* @ 1 ms Surge – Figure 1) Case 59-04 — Mini Mosorb (continued)
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 35 A Pulse (except bidirectional devices).

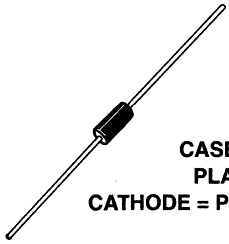
Working Peak Reverse Voltage V_{RWM} (Volts)	Device(4)	Breakdown Voltage V_{BR} (Volts) Min	Breakdown Voltage V_{BR} (Volts) Max	@ I_T Pulse (mA)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} Figure 1 (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
58	SA58	64.4	78.7	1	1	4.9	103
58	SA58A	64.4	71.2	1	1	5.3	93.6
60	SA60	66.7	81.5	1	1	4.7	107
60	SA60A	66.7	73.7	1	1	5.2	96.8
64	SA64	71.1	86.9	1	1	4.4	114
64	SA64A	71.1	78.6	1	1	4.9	103
70	SA70	77.8	95.1	1	1	4	125
70	SA70A	77.8	86	1	1	4.4	113
75	SA75	83.3	102	1	1	3.7	134
75	SA75A	83.3	92.1	1	1	4.1	121
78	SA78	86.7	106	1	1	3.6	139
78	SA78A	86.7	95.8	1	1	4	126
85	SA85	94.4	115	1	1	3.3	151
85	SA85A	94.4	104	1	1	3.6	137
90	SA90	100	122	1	1	3.1	160
90	SA90A	100	111	1	1	3.4	146
100	SA100	111	136	1	1	2.8	179
100	SA100A	111	123	1	1	3.1	162
110	SA110	122	149	1	1	2.6	196
110	SA110A	122	135	1	1	2.8	177
120	SA120	133	163	1	1	2.3	214
120	SA120A	133	147	1	1	2.5	193
130	SA130	144	176	1	1	2.2	231
130	SA130A	144	159	1	1	2.4	209
150	SA150	167	204	1	1	1.9	268
150	SA150A	167	185	1	1	2.1	243
160	SA160	178	218	1	1	1.7	287
160	SA160A	178	197	1	1	1.9	259
170	SA170	189	231	1	1	1.6	304
170	SA170A	189	209	1	1	1.8	275

(3)Steady state power dissipation = 3 watt max rating
(4)For bidirectional types use C or CA suffix. Have cathode polarity band on each end. (Consult factory for availability).

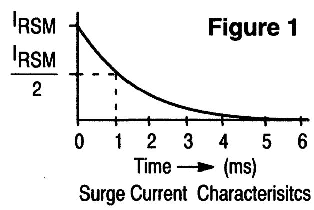
Devices listed in bold, italic are Motorola preferred devices.

TVS: Axial Leaded for Through-hole Design (continued)

Table 14. Peak Power Dissipation(5) (*600 Watts* @ 1 ms Surge – Figure 1) Case 17-02 — Surmetic 40
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A Pulse (except bidirectional devices).



CASE 17-02
PLASTIC
CATHODE = POLARITY BAND



Breakdown Voltage(6) VBR (Volts) Nom	@ IT Pulse (mA)	Device(4, 7)	Working Peak Reverse Voltage VRWM (Volts)	Maximum Reverse Leakage @ VRWM IR (µA)	Maximum Reverse Surge Current IRSM Figure 1 (Amps)	Maximum Reverse Voltage @ IRSM (Clamping Voltage) VRSM (Volts)
6.8	10	P6KE6.8	5.5	1000	56	10.8
6.8	10	***P6KE6.8A***	5.8	1000	57	10.5
7.5	10	P6KE7.5	6.05	500	51	11.7
7.5	10	P6KE7.5A	6.4	500	53	11.3
8.2	10	P6KE8.2	6.63	200	48	12.5
8.2	10	P6KE8.2A	7.02	200	50	12.1
9.1	1	P6KE9.1	7.37	50	44	13.8
9.1	1	P6KE9.1A	7.78	50	45	13.4
10	1	P6KE10	8.1	10	40	15
10	1	P6KE10A	8.55	10	41	14.5
11	1	P6KE11	8.92	5	37	16.2
11	1	P6KE11A	9.4	5	38	15.6
12	1	P6KE12	9.72	5	35	17.3
12	1	P6KE12A	10.2	5	36	16.7
13	1	P6KE13	10.5	5	32	19
13	1	***P6KE13A***	11.1	5	33	18.2
15	1	P6KE15	12.1	5	27	22
15	1	***P6KE15A***	12.8	5	28	21.2
16	1	P6KE16	12.9	5	26	23.5
16	1	P6KE16A	13.6	5	27	22.5
18	1	P6KE18	14.5	5	23	26.5
18	1	P6KE18A	15.3	5	24	25.2
20	1	P6KE20	16.2	5	21	29.1
20	1	P6KE20A	17.1	5	22	27.7
22	1	P6KE22	17.8	5	19	31.9
22	1	P6KE22A	18.8	5	20	30.6
24	1	P6KE24	19.4	5	17	34.7
24	1	P6KE24A	20.5	5	18	33.2

(4)For bidirectional types use C or CA suffix. ***P6KE7.5CA, P6KE20CA*** and ***P6KE22CA*** are Motorola preferred devices. Have cathode polarity band on each end. (Consult factory for availability).
(5)Steady state power dissipation = 5 watt max rating.
(6)Breakdown voltage tolerance is ±10% for no suffix and ±5% for A suffix.
(7)UL recognition for classification of protectors (QVGV2) under the UL standard for safety 497B for entire series including C & CA suffixes.

Devices listed in bold, italic are Motorola preferred devices.

Table 14. Peak Power Dissipation(5) (*600 Watts* @ 1 ms Surge – Figure 1) Case 17-02 — Surmetic 40 (continued)
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A Pulse (except bidirectional devices).

Breakdown Voltage(6) V_{BR} (Volts) Nom	@ I_T Pulse (mA)	Device(4, 7)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} Figure 1 (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
27	1	P6KE27	21.8	5	15	39.1
27	1	***P6KE27A***	23.1	5	16	37.5
30	1	P6KE30	24.3	5	14	43.5
30	1	P6KE30A	25.6	5	14.4	41.4
33	1	P6KE33	26.8	5	12.6	47.7
33	1	***P6KE33A***	28.2	5	13.2	45.7
36	1	P6KE36	29.1	5	11.6	52
36	1	***P6KE36A***	30.8	5	12	49.9
39	1	P6KE39	31.6	5	10.6	56.4
39	1	P6KE39A	33.3	5	11.2	53.9
43	1	P6KE43	34.8	5	9.6	61.9
43	1	P6KE43A	36.8	5	10.1	59.3
47	1	P6KE47	38.1	5	8.9	67.8
47	1	P6KE47A	40.2	5	9.3	64.8
51	1	P6KE51	41.3	5	8.2	73.5
51	1	P6KE51A	43.6	5	8.6	70.1
56	1	P6KE56	45.4	5	7.4	80.5
56	1	P6KE56A	47.8	5	7.8	77
62	1	P6KE62	50.2	5	6.8	89
62	1	***P6KE62A***	53	5	7.1	85
68	1	P6KE68	55.1	5	6.1	98
68	1	P6KE68A	58.1	5	6.5	92
75	1	P6KE75	60.7	5	5.5	108
75	1	P6KE75A	64.1	5	5.8	103
82	1	P6KE82	66.4	5	5.1	118
82	1	P6KE82A	70.1	5	5.3	113
91	1	P6KE91	73.7	5	4.5	131
91	1	P6KE91A	77.8	5	4.8	125
100	1	P6KE100	81	5	4.2	144
100	1	P6KE100A	85.5	5	4.4	137
110	1	P6KE110	89.2	5	3.8	158
110	1	P6KE110A	94	5	4	152
120	1	P6KE120	97.2	5	3.5	173
120	1	P6KE120A	102	5	3.6	165
130	1	P6KE130	105	5	3.2	187
130	1	P6KE130A	111	5	3.3	179
150	1	P6KE150	121	5	2.8	215
150	1	P6KE150A	128	5	2.9	207
160	1	P6KE160	130	5	2.6	230
160	1	P6KE160A	136	5	2.7	219

(4)For bidirectional types use C or CA suffix. ***P6KE27CA*** and ***P6KE30CA*** are Motorola preferred devices. Have cathode polarity band on each end. (Consult factory for availability).
(5)Steady state power dissipation = 5 watt max rating.
(6)Breakdown voltage tolerance is ±10% for no suffix and ±5% for A suffix.
(7)UL recognition for classification of protectors (QVGV2) under the UL standard for safety 497B for entire series including C & CA suffixes.

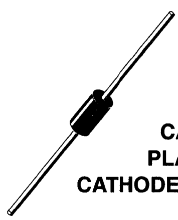
Devices listed in bold, italic are Motorola preferred devices.

Table 14. Peak Power Dissipation(5) (*600 Watts* @ 1 ms Surge – Figure 1) Case 17-02 — Surmetic 40 (continued)
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A Pulse (except bidirectional devices).

Breakdown Voltage(6) V_{BR} (Volts) Nom	@ I_T Pulse (mA)	Device(4, 7)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current I_{RSM} Figure 1 (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
170	1	P6KE170	138	5	2.5	244
170	1	P6KE170A	145	5	2.6	234
180	1	P6KE180	146	5	2.3	258
180	1	P6KE180A	154	5	2.4	246
200	1	P6KE200	162	5	2.1	287
200	1	P6KE200A	171	5	2.2	274

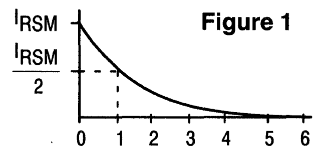
(4)For bidirectional types use C or CA suffix. Have cathode polarity band on each end. (Consult factory for availability).
(5)Steady state power dissipation = 5 watt max rating.
(6)Breakdown voltage tolerance is ±10% for no suffix and ±5% for A suffix.
(7)UL recognition for classification of protectors (QVGV2) under the UL standard for safety 497B for entire series including C & CA suffixes.

Table 15. Peak Power Dissipation(5) (*1500 WATTS* @ 1 ms Surge – Figure 1) Case 41A-02 — Mosorb
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse (C suffix denotes standard back to back bidirectional versions. Test both polarities)



CASE 41A-02
PLASTIC TVS-A
CATHODE = POLARITY BAND

Figure 1



Surge Current Characterisitcs

Maximum Reverse Stand-Off Voltage V_{RWM} Volts	JEDEC(8) Device	Device(8)	Breakdown Voltage V_{BR} Volts Min	Breakdown Voltage @I_T Pulse (mA)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Clamping Voltage(9) Peak Pulse Current @ I_{pp1} = 1 A Figure 1 V_{C1} (Volts max)	Clamping Voltage(9) Peak Pulse Current @ I_{pp2} = 10 A Figure 1 V_{C1} (Volts max)
5	***1N5908***		6	1	300	120	8.5	7.6 @ 30 A	8 @ 60 A
5	***1N6373***	ICTE-5/MPTE-5	6	1	300	160	9.4	7.1	7.5
8	1N6374	ICTE-8/MPTE-8	9.4	1	25	100	15	11.3	11.5
8	***1N6382***	ICTE-8C/MPTE-8C	9.4	1	25	100	15	11.4	11.6
10	1N6375	ICTE-10/MPTE-10	11.7	1	2	90	16.7	13.7	14.1
10	1N6383	ICTE-10C/MPTE-10C	11.7	1	2	90	16.7	14.1	14.5
12	***1N6376***	ICTE-12/MPTE-12	14.1	1	2	70	21.2	16.1	16.5
12	1N6384	ICTE-12C/MPTE-12C	14.1	1	2	70	21.2	16.7	17.1
15	1N6377	ICTE-15/MPTE-15	17.6	1	2	60	25	20.1	20.6
15	***1N6385***	ICTE-15C/MPTE-15C	17.6	1	2	60	25	20.8	21.4
18	1N6378	ICTE-18/MPTE-18	21.2	1	2	50	30	24.2	25.2
18	1N6386	ICTE-18C/MPTE-18C	21.2	1	2	50	30	24.8	25.5

(4)For bidirectional types use C or CA suffix. Have cathode polarity band on each end. (Consult factory for availability).
(5)Steady state power dissipation = 5 watts max rating.
(6)Breakdown voltage tolerance is ±10% for no suffix and ± 5% for A suffix.
(7)UL recognition for classification of protectors (QVGV2) under the UL standard for safety 497B for entire series including C & CA suffixes.
(8)1N6382 thru 1N6389 and C suffix ICTE/MPTE device types are bidirectional. Have cathode polarity band on each end.
All other device types are unidirectional only (Consult factory for availability).
(9)Clamping voltage peak pulse currents for 1N5908 are 30 Amps and 60 Amps.

Devices listed in bold, italic are Motorola preferred devices.

Table 15. Peak Power Dissipation(5) (*1500 WATTS* @ 1 ms Surge – Figure 1) Case 41A-02 — Mosorb (continued)

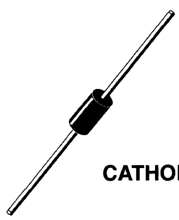
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse
(C suffix denotes standard back to back bidirectional versions. Test both polarities)

Maximum Reverse Stand-Off Voltage V_{RWM} Volts	JEDEC(8) Device	Device(8)	Breakdown Voltage: V_{BR} Volts Min	Breakdown Voltage: @ I_T Pulse (mA)	Maximum Reverse Leakage @ V_{RWM} I_R (µA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Clamping Voltage(9): Peak Pulse Current @ I_{pp1} = 1 A Figure 1 V_{C1} (Volts max)	Clamping Voltage(9): Peak Pulse Current @ I_{pp2} = 10 A Figure 1 V_{C1} (Volts max)
22	1N6379	ICTE-22/MPTE-22	25.9	1	2	40	37.5	29.8	32
22	1N6387	ICTE-22C/MPTE-22C	25.9	1	2	40	37.5	30.8	32
36	1N6380	ICTE-36/MPTE-36	42.4	1	2	23	65.2	50.6	54.3
36	1N6388	ICTE-36C/MPTE-36C	42.4	1	2	23	65.2	50.6	54.3
45	1N6381	ICTE-45/MPTE-45	52.9	1	2	19	78.9	63.3	70
45	1N6389	ICTE-45C/MPTE-45C	52.9	1	2	19	78.9	63.3	70

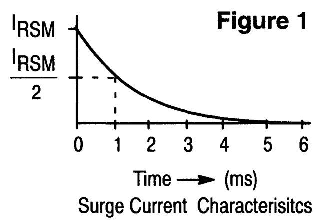
(4)For bidirectional types use C or CA suffix. Have cathode polarity band on each end. (Consult factory for availability).
(5)Steady state power dissipation = 5 watts max rating.
(6)Breakdown voltage tolerance is ±10% for no suffix and ± 5% for A suffix.
(7)UL recognition for classification of protectors (QVGV2) under the UL standard for safety 497B for entire series including C & CA suffixes.
(8)1N6382 thru 1N6389 and C suffix ICTE/MPTE device types are bidirectional. Have cathode polarity band on each end.
All other device types are unidirectional only (Consult factory for availability).
(9)Clamping voltage peak pulse currents for 1N5908 are 30 Amps and 60 Amps.

Table 16. Peak Power Dissipation(5) (1500 Watts @ 1 ms Surge – Figure 1) Case 41A-02 — Mosorb

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse



CASE 17-02
PLASTIC
CATHODE = POLARIRTY BAND



Breakdown Voltage(6): V_{BR} (Volts) Nom	Breakdown Voltage(6): @ I_T Pulse (mA)	JEDEC Device	Device(10,11)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (µA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
6.8	10	1N6267	1.5KE6.8	5.5	1000	139	10.8
6.8	10	***1N6267A***	1.5KE6.8A	5.8	1000	143	10.5
7.5	10	1N6268	1.5KE7.5	6.05	500	128	11.7
7.5	10	1N6268A	1.5KE7.5A	6.4	500	132	11.3
8.2	10	1N6269	1.5KE8.2	6.63	200	120	12.5
8.2	10	1N6269A	1.5KE8.2A	7.02	200	124	12.1
9.1	1	1N6270	1.5KE9.1	7.37	50	109	13.8
9.1	1	1N6270A	1.5KE9.1A	7.78	50	112	13.4

Devices listed in bold, italic are Motorola preferred devices.

Table 16. Peak Power Dissipation(5) (1500 Watts @ 1 ms Surge – Figure 1) Case 41A-02 — Mosorb (continued)
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse

Breakdown Voltage(6)							
V_{BR} (Volts) Nom	@ I_T Pulse (mA)	JEDEC Device	Device(10,11)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
10	1	1N6271	1.5KE10	8.1	10	100	15
10	1	1N6271A	1.5KE10A	8.55	10	103	14.5
11	1	1N6272	1.5KE11	8.92	5	93	16.2
11	1	1N6272A	1.5KE11A	9.4	5	96	15.6
12	1	1N6273	1.5KE12	9.72	5	87	17.3
12	1	1N6273A	1.5KE12A	10.2	5	90	16.7
13	1	1N6274	1.5KE13	10.5	5	79	19
13	1	1N6274A	1.5KE13A	11.1	5	82	18.2
15	1	1N6275	1.5KE15	12.1	5	68	22
15	1	1N6275A	1.5KE15A	12.8	5	71	21.2
16	1	1N6276	1.5KE16	12.9	5	64	23.5
16	1	1N6276A	1.5KE16A	13.6	5	67	22.5
18	1	1N6277	1.5KE18	14.5	5	56.5	26.5
18	1	1N6277A	1.5KE18A	15.3	5	59.5	25.2
20	1	1N6278	1.5KE20	16.2	5	51.5	29.1
20	1	1N6278A	1.5KE20A	17.1	5	54	27.7
22	1	1N6279	1.5KE22	17.8	5	47	31.9
22	1	1N6279A	1.5KE22A	18.8	5	49	30.6
24	1	1N6280	1.5KE24	19.4	5	43	34.7
24	1	***1N6280A***	1.5KE24A	20.5	5	45	33.2
27	1	1N6281	1.5KE27	21.8	5	38.5	39.1
27	1	1N6281A	1.5KE27A	23.1	5	40	37.5
30	1	1N6282	1.5KE30	24.3	5	34.5	43.5
30	1	***1N6282A***	1.5KE30A	25.6	5	36	41.4
33	1	1N6283	1.5KE33	26.8	5	31.5	47.7
33	1	***1N6283A***	1.5KE33A	28.2	5	33	45.7
36	1	1N6284	1.5KE36	29.1	5	29	52
36	1	***1N6284A***	1.5KE36A	30.8	5	30	49.9
39	1	1N6285	1.5KE39	31.6	5	26.5	56.4
39	1	1N6285A	1.5KE39A	33.3	5	28	53.9
43	1	1N6286	1.5KE43	34.8	5	24	61.9
43	1	1N6286A	1.5KE43A	36.8	5	25.3	59.3
47	1	1N6287	1.5KE47	38.1	5	22.2	67.8
47	1	1N6287A	1.5KE47A	40.2	5	23.2	64.8
51	1	1N6288	1.5KE51	41.3	5	20.4	73.5
51	1	***1N6288A***	1.5KE51A	43.6	5	21.4	70.1
56	1	1N6289	1.5KE56	45.4	5	18.6	80.5
56	1	1N6289A	1.5KE56A	47.8	5	19.5	77
62	1	1N6290	1.5KE62	50.2	5	16.9	89
62	1	***1N6290A***	1.5KE62A	53	5	17.7	85

(5)Steady state power dissipation = 5 watts max rating.
(6)Breakdown voltage tolerance is ±10% for no suffix and ±5% for A suffix.
(10)For bidirectional types use C or CA suffix. ***1.5KE36CA*** is a Motorola preferred device. Have cathode polarity band on each end. (Consult factory for availability). 1N6267-6303A series do not have C or CA option since C and CA are not included in EIA Registration.
(11)UL recognition for classification of protectors (QVGV2) under the UL standard for safety 497B for 1.5KE6.8,A,C,CA thru 1.5KE250,A,C,CA.

Devices listed in bold, italic are Motorola preferred devices.

Table 16. Peak Power Dissipation(5) (1500 Watts @ 1 ms Surge – Figure 1) Case 41A-02 — Mosorb (continued)
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse

Breakdown Voltage(6)							
V_{BR} (Volts) Nom	@ I_T Pulse (mA)	JEDEC Device	Device(10,11)	Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)
68	1	1N6291	1.5KE68	55.1	5	15.3	98
68	1	1N6291A	1.5KE68A	58.1	5	16.3	92
75	1	1N6292	1.5KE75	60.7	5	13.9	108
75	1	1N6292A	1.5KE75A	64.1	5	14.6	103
82	1	1N6293	1.5KE82	66.4	5	12.7	118
82	1	1N6293A	1.5KE82A	70.1	5	13.3	113
91	1	1N6294	1.5KE91	73.7	5	11.4	131
91	1	1N6294A	1.5KE91A	77.8	5	12	125
100	1	1N6295	1.5KE100	81	5	10.4	144
100	1	1N6295A	1.5KE100A	85.5	5	11	137
110	1	1N6296	1.5KE110	89.2	5	9.5	158
110	1	1N6296A	1.5KE110A	94	5	9.9	152
120	1	1N6297	1.5KE120	97.2	5	8.7	173
120	1	1N6297A	1.5KE120A	102	5	9.1	165
130	1	1N6298	1.5KE130	105	5	8	187
130	1	1N6298A	1.5KE130A	111	5	8.4	179
150	1	1N6299	1.5KE150	121	5	7	215
150	1	1N6299A	1.5KE150A	128	5	7.2	207
160	1	1N6300	1.5KE160	130	5	6.5	230
160	1	1N6300A	1.5KE160A	136	5	6.8	219
170	1	1N6301	1.5KE170	138	5	6.2	244
170	1	1N6301A	1.5KE170A	145	5	6.4	234
180	1	1N6302	1.5KE180	146	5	5.8	258
180	1	1N6302A	1.5KE180A	154	5	6.1	246
200	1	1N6303	1.5KE200	162	5	5.2	287
200	1	1N6303A	1.5KE200A	171	5	5.5	274
220	1		1.5KE220	175	5	4.3	344
220	1		1.5KE220A	185	5	4.6	328
250	1		1.5KE250	202	5	5	360
250	1		1.5KE250A	214	5	5	344

(5)Steady state power dissipation = 5 watts max rating.
(6)Breakdown voltage tolerance is ±10% for no suffix and ±5% for A suffix.
(10)For bidirectional types use C or CA suffix. Have cathode polarity band on each end. (Consult factory for availability). 1N6267-6303A series do not have C or CA option since C and CA are not included in EIA Registration.
(11)UL recognition for classification of protectors (QVGV2) under the UL standard for safety 497B for 1.5KE6.8,A,C,CA thru 1.5KE250,A,C,CA.

Devices listed in bold, italic are Motorola preferred devices.

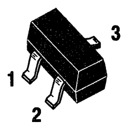
Surface Mount Packages

Table 17. Peak Power Dissipation (*40 Watts* @ 1 ms Surge – Figure 1) Case 318-07 — Common Cathode

MMBZ15VDLT1(12) — SOT-23 Dual Monolithic Common Cathode Bipolar Zener (for ESD protection)

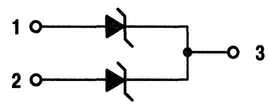
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

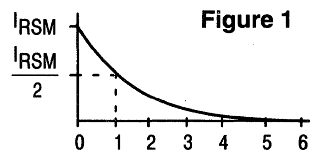
BIDIRECTIONAL (Circuit tied to pins 1 and 2)



CASE 318-07, STYLE 9
TO-236AB
LOW PROFILE SOT-23
PLASTIC

Pinout: TERMINAL 1 — ANODE
TERMINAL 2 — ANODE
TERMINAL 3 — COMMON CATHODE





Surge Current Characterisitcs

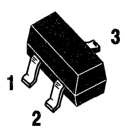
Breakdown Voltage V_{BR}(14) (Volts)				Working Peak Reverse Voltage V_{RWM} (Volts)	Maximum Reverse Leakage Current I_{RWM} I_R (nA)	Maximum Reverse Surge Current I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RMS} (Clamping Voltage) V_{RSM} (Volts)	Maximum Temperature Coefficient of V_{BR} (mV/°C)
Min	Nom	Max	@ I_T (mA)					
14.3	15	15.8	1.0	12.8	100	1.9	21.2	12

Table 18. Peak Power Dissipation (*24 Watts* @ 1 ms Surge – Figure 1) Case 318-07 — Common Anode

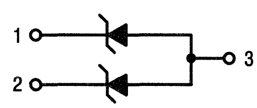
MMBZ5V6ALT1 — SOT-23 Dual Monolithic Common Anode Zener (for ESD Protection)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

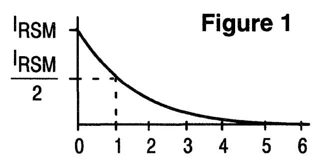
UNIDIRECTIONAL (Circuit tied to pins 1 and 3 or Pins 2 and 3) (V_F = 0.9 V Max @ I_F = 10 mA)



CASE 318-07, STYLE 12
T0-236AB
LOW PROFILE SOT-23
PLASTIC



PIN 1. CATHODE
2. CATHODE
3. COMMON ANODE



Surge Current Characterisitcs

V_{BR}(14) (V)			@ I_T (mA)	I_R (uA)	@ V_R (V)	Z_{ZT} @ I_{ZT} (Ω) (mA)	Z_{ZK} (Ω)	@ I_{ZK} (mA)	Max Reverse Surge Current I_{RSM}(4) (A)	Max Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (V)	Maximum Temperature Coefficient of V_{BR} (mV/°C)
Min	Nom	Max									
5.32	5.6	5.88	20	5.0	3.0	11	1600	0.25	3.0	8.0	1.26

(12)T1 suffix designates tape and reel of 3000 units.
(14)V_{BR} measured at pulse test current I_T at an ambient temperature of 25°C.
(21)Z_{ZT} and Z_{ZK} are measured by dividing the AC voltage drop across the device by the AC current supplied.
The specified limits are $I_{Z(AC)}$ = 0.1 $I_{Z(DC)}$, with AC frequency = 1 kHz.

Devices listed in bold, italic are Motorola preferred devices.

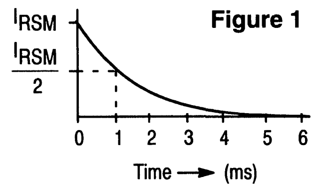
Surface Mount Packages (continued)

Table 19. Peak Power Dissipation (*600 Watts* @ 1 ms Surge – Figure 1) Case 403A-03

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

SMB
CASE 403A-03
PLASTIC
CATHODE = NOTCH

Figure 1



Surge Current Characterisitcs

Reverse Stand-Off V_R Volts(15)	Device(16)	Breakdown Voltage V_{BR} @ I_T Volts Min	Breakdown Voltage V_{BR} @ I_T Pulse mA	Maximum Clamping Voltage V_C @ I_{pp} Volts	Peak Pulse Current (See Figure 1) I_{pp} Amps	Maximum Reverse Leakage @ V_R I_R µA	Device Marking
5	1SMB5.0AT3	6.4	10	9.2	65.2	800	KE
6	1SMB6.0AT3	6.67	10	10.3	58.3	800	KG
6.5	1SMB6.5AT3	7.22	10	11.2	53.6	500	KK
7	1SMB7.0AT3	7.78	10	12	50	200	KM
7.5	1SMB7.5AT3	8.33	1	12.9	46.5	100	KP
8	1SMB8.0AT3	8.89	1	13.6	44.1	50	KR
8.5	1SMB8.5AT3	9.44	1	14.4	41.7	10	KT
9	1SMB9.0AT3	10	1	15.4	39	5	KV
10	1SMB10AT3	11.1	1	17	35.3	5	KX
11	1SMB11AT3	12.2	1	18.2	33	5	KZ
12	1SMB12AT3	13.3	1	19.9	30.2	5	LE
13	1SMB13AT3	14.4	1	21.5	27.9	5	LG
14	1SMB14AT3	15.6	1	23.2	25.8	5	LK
15	1SMB15AT3	16.7	1	24.4	24	5	LM
16	1SMB16AT3	17.8	1	26	23.1	5	LP
17	1SMB17AT3	18.9	1	27.6	21.7	5	LR
18	1SMB18AT3	20	1	29.2	20.5	5	LT
20	1SMB20AT3	22.2	1	32.4	18.5	5	LV
22	1SMB22AT3	24.4	1	35.5	16.9	5	LX
24	1SMB24AT3	26.7	1	38.9	15.4	5	LZ
26	1SMB26AT3	28.9	1	42.1	14.2	5	ME
28	1SMB28AT3	31.1	1	45.4	13.2	5	MG
30	1SMB30AT3	33.3	1	48.4	12.4	5	MK
33	1SMB33AT3	36.7	1	53.3	11.3	5	MM
36	1SMB36AT3	40	1	58.1	10.3	5	MP
40	1SMB40AT3	44.4	1	64.5	9.3	5	MR
43	1SMB43AT3	47.8	1	69.4	8.6	5	MT
45	1SMB45AT3	50	1	72.7	8.3	5	MV
48	1SMB48AT3	53.3	1	77.4	7.7	5	MX
51	1SMB51AT3	56.7	1	82.4	7.3	5	MZ
54	1SMB54AT3	60	1	87.1	6.9	5	NE
58	1SMB58AT3	64.4	1	93.6	6.4	5	NG
60	1SMB60AT3	66.7	1	96.8	6.2	5	NK
64	1SMB64AT3	71.1	1	103	5.8	5	NM
70	1SMB70AT3	77.8	1	113	5.3	5	NP

(15) A transient suppressor is normally selected according to the reverse "Stand Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.
(16) T3 suffix designates tape and reel of 2500 units.
(28) Bidirectional version available for 1SMB10AT3 thru 1SMB78AT3, electrical characteristics apply in both directions except for V_F. Use CAT3 suffix.

Devices listed in bold, italic are Motorola preferred devices.

Table 19. Peak Power Dissipation (*600 Watts* @ 1 ms Surge – Figure 1) Case 403A-03 (continued)

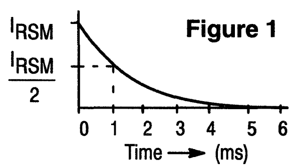
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Reverse Stand-Off V_R Volts(15)	Device(16)	Breakdown Voltage V_{BR} @ I_T Volts Min	Breakdown Voltage V_{BR} @ I_T Pulse mA	Maximum Clamping Voltage V_C @ I_{pp} Volts	Peak Pulse Current (See Figure 1) I_{pp} Amps	Maximum Reverse Leakage @ V_R I_R µA	Device Marking
75	1SMB75AT3	83.3	1	121	4.9	5	NR
78	1SMB78AT3	86.7	1	126	4.7	5	NT
85	1SMB85AT3	94.4	1	137	4.4	5	NV
90	1SMB90AT3	100	1	146	4.1	5	NX
100	1SMB100AT3	111	1	162	3.7	5	NZ
110	1SMB110AT3	122	1	177	3.4	5	PE
120	1SMB120AT3	133	1	193	3.1	5	PG
130	1SMB130AT3	144	1	209	2.9	5	PK
150	1SMB150AT3	167	1	243	2.5	5	PM
160	1SMB160AT3	178	1	259	2.3	5	PP
170	1SMB170AT3	189	1	275	2.2	5	PR

Table 20. Peak Power Dissipation (600 WATTS @ 1 ms Surge – Figure 1) Case 403A-03

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A Pulse

SMB
CASE 403A-03
PLASTIC
CATHODE = NOTCH



Surge Current Characterisitcs

Breakdown Voltage(17) V_{BR} @ I_T Pulse Volts Nom	(mA)	Device(16)	Working Peak Reverse Voltage V_{RWM} Volts	Maximum Reverse Leakage @ V_{RWM} I_R (µA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Device Marking
6.8	10	P6SMB6.8AT3	5.8	1000	57	10.5	6V8A
7.5	10	P6SMB7.5AT3	6.4	500	53	11.3	7V5A
8.2	10	P6SMB8.2AT3	7.02	200	50	12.1	8V2A
9.1	1	P6SMB9.1AT3	7.78	50	45	13.4	9V1A
10	1	P6SMB10AT3	8.55	10	41	14.5	10A
11	1	P6SMB11AT3	9.4	5	38	15.6	11A
12	1	P6SMB12AT3	10.2	5	36	16.7	12A
13	1	***P6SMB13AT3***	11.1	5	33	18.2	13A
15	1	***P6SMB15AT3***	12.8	5	28	21.2	15A
16	1	P6SMB16AT3	13.6	5	27	22.5	16A

(15) A transient suppressor is normally selected according to the reverse "Stand Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.
(16) T3 suffix designates tape and reel of 2500 units.
(17) Breakdown voltage tolerance is ±5% for A suffix.
(28) Bidirectional version available for 1SMB10AT3 thru 1SMB78AT3, electrical characteristics apply in both directions except for V_F. Use CAT3 suffix.
(29) Bidirectional version available for P6SMB11AT3 thru P6SMB91AT3. Electrical characteristics apply in both directional except for V_F. Use CAT3 suffix.

Devices listed in bold, italic are Motorola preferred devices.

Table 20. Peak Power Dissipation (600 WATTS @ 1 ms Surge – Figure 1) Case 403A-03 (continued)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 50 A Pulse

Breakdown Voltage(17) V_{BR} @ I_T Pulse Volts Nom	(mA)	Device(16)	Working Peak Reverse Voltage V_{RWM} Volts	Maximum Reverse Leakage @ V_{RWM} I_R (μA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Device Marking
18	1	P6SMB18AT3	15.3	5	24	25.2	18A
20	1	P6SMB20AT3	17.1	5	22	27.7	20A
22	1	P6SMB22AT3	18.8	5	20	30.6	22A
24	1	P6SMB24AT3	20.5	5	18	33.2	24A
27	1	***P6SMB27AT3***	23.1	5	16	37.5	27A
30	1	***P6SMB30AT3***	25.6	5	14.4	41.4	30A
33	1	***P6SMB33AT3***	28.2	5	13.2	45.7	33A
36	1	***P6SMB36AT3***	30.8	5	12	49.9	36A
39	1	P6SMB39AT3	33.3	5	11.2	53.9	39A
43	1	P6SMB43AT3	36.8	5	10.1	59.3	43A
47	1	P6SMB47AT3	40.2	5	9.3	64.8	47A
51	1	***P6SMB51AT3***	43.6	5	8.6	70.1	51A
56	1	P6SMB56AT3	47.8	5	7.8	77	56A
62	1	***P6SMB62AT3***	53	5	7.1	85	62A
68	1	P6SMB68AT3	58.1	5	6.5	92	68A
75	1	P6SMB75AT3	64.1	5	5.8	103	75A
82	1	P6SMB82AT3	70.1	5	5.3	113	82A
91	1	P6SMB91AT3	77.8	5	4.8	125	91A
100	1	P6SMB100AT3	85.5	5	4.4	137	100A
110	1	P6SMB110AT3	94	5	4	152	110A
120	1	P6SMB120AT3	102	5	3.6	165	120A
130	1	P6SMB130AT3	111	5	3.3	179	130A
150	1	P6SMB150AT3	128	5	2.9	207	150A
160	1	P6SMB160AT3	136	5	2.7	219	160A
170	1	P6SMB170AT3	145	5	2.6	234	170A
180	1	P6SMB180AT3	154	5	2.4	246	180A
200	1	P6SMB200AT3	171	5	2.2	274	200A

(16) T3 suffix designates tape and reel of 2500 units.
(17) Breakdown voltage tolerance is ±5% for A suffix.
(29) Bidirectional version available for P6SMB11AT3 thru P6SMB91AT3. Electrical characteristics apply in both directional except for V_F. Use CAT3 suffix.

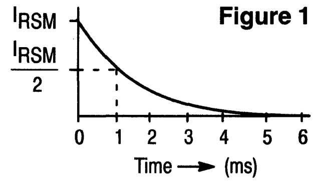
Devices listed in bold, italic are Motorola preferred devices.

Surface Mount Packages (continued)

Table 21. Peak Power Dissipation (1500 WATTS @ 1 ms Surge – Figure 1) Case 403-03
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

SMC
CASE 403-03
PLASTIC
CATHODE = NOTCH

Figure 1



Surge Current Characterisitcs

Reverse Stand-Off V_R Volts(15)	Device(16)	Breakdown Voltage V_{BR} @ I_T Volts Min	Breakdown Voltage V_{BR} @ I_T Pulse mA	Maximum Clamping Voltage V_C @ I_{pp} Volts	Peak Pulse Current (See Figure 1) I_{pp} Amps	Maximum Reverse Leakage @ V_R I_R µA	Device Marking
5	1SMC5.0AT3	6.4	10	9.2	163	1000	GDE
6	1SMC6.0AT3	6.67	10	10.3	145.6	1000	GDG
6.5	1SMC6.5AT3	7.22	10	11.2	133.9	500	GDK
7	1SMC7.0AT3	7.78	10	12	125	200	GDM
7.5	1SMC7.5AT3	8.33	1	12.9	116.3	100	GDP
8	1SMC8.0AT3	8.89	1	13.6	110.3	50	GDR
8.5	1SMC8.5AT3	9.44	1	14.4	104.2	20	GDT
9	1SMC9.0AT3	10	1	15.4	97.4	10	GDV
10	1SMC10AT3	11.1	1	17	88.2	5	GDX
11	1SMC11AT3	12.2	1	18.2	82.4	5	GDZ
12	1SMC12AT3	13.3	1	19.9	75.3	5	GEE
13	1SMC13AT3	14.4	1	21.5	69.7	5	GEG
14	1SMC14AT3	15.6	1	23.2	64.7	5	GEK
15	1SMC15AT3	16.7	1	24.4	61.5	5	GEM
16	1SMC16AT3	17.8	1	26	57.7	5	GEP
17	1SMC17AT3	18.9	1	27.6	53.3	5	GER
18	1SMC18AT3	20	1	29.2	51.4	5	GET
20	1SMC20AT3	22.2	1	32.4	46.3	5	GEV
22	1SMC22AT3	24.4	1	35.5	42.2	5	GEX
24	1SMC24AT3	26.7	1	38.9	38.6	5	GEZ
26	1SMC26AT3	28.9	1	42.1	35.6	5	GFE
28	1SMC28AT3	31.1	1	45.4	33	5	GFG
30	1SMC30AT3	33.3	1	48.4	31	5	GFK
33	1SMC33AT3	36.7	1	53.3	28.1	5	GFM
36	1SMC36AT3	40	1	58.1	25.8	5	GFP
40	1SMC40AT3	44.4	1	64.5	23.2	5	GFR
43	1SMC43AT3	47.8	1	69.4	21.6	5	GFT
45	1SMC45AT3	50	1	72.7	20.6	5	GFV
48	1SMC48AT3	53.3	1	77.4	19.4	5	GFX
51	1SMC51AT3	56.7	1	82.4	18.2	5	GFZ

(15)A transient suppressor is normally selected according to the reverse "Stand Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.
(16)T3 suffix designates tape and reel of 2500 units.
(17)Breakdown voltage tolerance is ±5% for A suffix.

Devices listed in bold, italic are Motorola preferred devices.

Table 21. Peak Power Dissipation (1500 WATTS @ 1 ms Surge – Figure 1) Case 403-03 (continued)
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

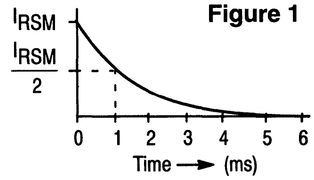
Reverse Stand-Off V_R Volts(15)	Device(16)	Breakdown Voltage V_{BR} @ I_T Volts Min	Breakdown Voltage V_{BR} @ I_T Pulse mA	Maximum Clamping Voltage V_C @ I_{pp} Volts	Peak Pulse Current (See Figure 1) I_{pp} Amps	Maximum Reverse Leakage @ V_R I_R µA	Device Marking
54	1SMC54AT3	60	1	87.1	17.2	5	GGE
58	1SMC58AT3	64.4	1	93.6	16	5	GGG
60	1SMC60AT3	66.7	1	96.8	15.5	5	GGK
64	1SMC64AT3	71.1	1	103	14.6	5	GGM
70	1SMC70AT3	77.8	1	113	13.3	5	GGP
75	1SMC75AT3	83.3	1	121	12.4	5	GGR
78	1SMC78AT3	86.7	1	126	11.4	5	GGT

(15)A transient suppressor is normally selected according to the reverse "Stand Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.
(16)T3 suffix designates tape and reel of 2500 units.
(17)Breakdown voltage tolerance is ±5% for A suffix.

Table 22. Peak Power Dissipation (1500 WATTS @ 1 ms Surge – Figure 1) Case 403-03
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse

SMC
CASE 403-03
PLASTIC
CATHODE = NOTCH

Figure 1



Surge Current Characterisitcs

Breakdown Voltage(17) V_{BR} @ I_T Pulse Volts Nom	(mA)	Device(16)	Working Peak Reverse Voltage V_{RWM} Volts	Maximum Reverse Leakage @ V_{RWM} I_R (µA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Device Marking
6.8	10	1.5SMC6.8AT3	5.8	1000	143	10.5	6V8A
7.5	10	1.5SMC7.5AT3	6.4	500	132	11.3	7V5A
8.2	10	1.5SMC8.2AT3	7.02	200	124	12.1	8V2A
9.1	1	1.5SMC9.1AT3	7.78	50	112	13.4	9V1A
10	1	1.5SMC10AT3	8.55	10	103	14.5	10A
11	1	1.5SMC11AT3	9.4	5	96	15.6	11A
12	1	1.5SMC12AT3	10.2	5	90	16.7	12A
13	1	1.5SMC13AT3	11.1	5	82	18.2	13A
15	1	1.5SMC15AT3	12.8	5	71	21.2	15A
16	1	1.5SMC16AT3	13.6	5	67	22.5	16A
18	1	1.5SMC18AT3	15.3	5	59.5	25.2	18A
20	1	1.5SMC20AT3	17.1	5	54	27.7	20A
22	1	1.5SMC22AT3	18.8	5	49	30.6	22A
24	1	1.5SMC24AT3	20.5	5	45	33.2	24A
27	1	1.5SMC27AT3	23.1	5	40	37.5	27A
30	1	1.5SMC30AT3	25.6	5	36	41.4	30A
33	1	1.5SMC33AT3	28.2	5	33	45.7	33A
36	1	***1.5SMC36AT3***	30.8	5	30	49.9	36A

(16)T3 suffix designates tape and reel of 2500 units.
(17)Breakdown voltage tolerance is ±5% for A suffix.

Devices listed in bold, italic are Motorola preferred devices.

Table 22. Peak Power Dissipation (1500 WATTS @ 1 ms Surge – Figure 1) Case 403-03 (continued)
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted) V_F = 3.5 V Max, I_F = 100 A Pulse

Breakdown Voltage(17) V_{BR} @ I_T Pulse Volts							
Nom	(mA)	Device(16)	Working Peak Reverse Voltage V_{RWM} Volts	Maximum Reverse Leakage @ V_{RWM} I_R (µA)	Maximum Reverse Surge Current Figure 1 I_{RSM} (Amps)	Maximum Reverse Voltage @ I_{RSM} (Clamping Voltage) V_{RSM} (Volts)	Device Marking
39	1	1.5SMC39AT3	33.3	5	28	53.9	39A
43	1	1.5SMC43AT3	36.8	5	25.3	59.3	43A
47	1	1.5SMC47AT3	40.2	5	23.2	64.8	47A
51	1	1.5SMC51AT3	43.6	5	21.4	70.1	51A
56	1	***1.5SMC56AT3***	47.8	5	19.5	77	56A
62	1	***1.5SMC62AT3***	53	5	17.7	85	62A
68	1	1.5SMC68AT3	58.1	5	16.3	92	68A
75	1	1.5SMC75AT3	64.1	5	14.6	103	75A
82	1	1.5SMC82AT3	70.1	5	13.3	113	82A
91	1	1.5SMC91AT3	77.8	5	12	125	91A

(16)T3 suffix designates tape and reel of 2500 units.
(17)Breakdown voltage tolerance is ±5% for A suffix.

Automotive Transient Suppressors

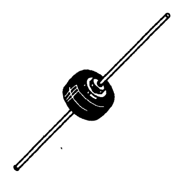
Automotive transient suppressors are designed for protection against over-voltage conditions in the auto electrical system including the "LOAD DUMP" phenomenon that occurs when the battery open circuits while the car is running.

Table 23. Automotive Transient Suppressor

	CASE 194-04 ***MR2535L(19)***
V_{RRM} (Volts)	20
I_O (Amp)	35
$V_{(BR)}$ (Volts)	24–32
I_{RSM}(18) (Amp)	110
T_C @ Rated I_O (°C)	150
T (°C)	175

(18)Time constant = 10 ms, duty cycle ≤ 1%, T_C = 25°C.
(19) MR2535L is considered part of the rectifier product portfolio.

CASE 194-04



Cathode Symbol on Package

Devices listed in bold, italic are Motorola preferred devices.

Power Transistor Products

In Brief . . .

Motorola's power transistor products include not only the wide range of specifications associated with bipolar and field-effect (TMOS®) transistors, the two primary discrete transistor categories, but enhance these capabilities with the emerging field of SMARTDISCRETES™ products that offer the advantages of a power MOS device with on-chip protective circuitry. The Motorola power products line offers the following choices and options:

Discrete Power Transistors

- *Bipolar and TMOS*
- *Metal and Plastic Packaging*
- *Unpackaged "Chips" for Hybrid Assemblies*
- *Virtually Unlimited Choice of Specifications*

SMARTDISCRETES Products

- *Automotive, Industrial, and other general purpose applications*

TMOS
Power MOSFETs

TMOS Power MOSFETs Numbering System

Wherever possible, Motorola has tried to use the following numbering systems for TMOS power MOSFET products.

MTP10N10M

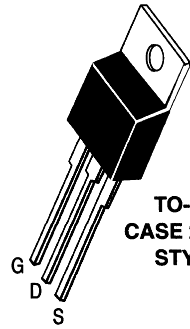
- **MOTOROLA** — M
- **TMOS** — T
  (T FOR TMOS
  G FOR IGBT
  L FOR SMARTDISCRETES
  P FOR MULTIPLE CHIP PRODUCTS)
- **PACKAGE TYPE** — P
  P FOR PLASTIC TO-220
  M FOR METAL TO-204 (TO-3)
  D FOR DPAK
  A FOR TO-220 ISOLATED
  W FOR TO-247
  B FOR D^{2}PAK
  Y FOR TO-3PBL
- **CURRENT** — 10
- **CHANNEL POLARITY, N OR P** — N
- **VOLTAGE RATING DIVIDED BY 10** — 10
- **OPTIONAL SUFFIX:** — M
  M FOR SENSEFET
  L FOR LOGIC LEVEL
  E FOR ENERGY RATED
  (-)1 FOR INSERTION DPAK*
  T4 FOR TAPE & REEL DPAK/D^{2}PAK
  HD FOR HIGH CELL DENSITY

* Add "1" to device titles ending with a letter.
Add "-1" to device titles ending with a numeral.

TMOS Power MOSFETs

Selection by Package

Plastic Packages TO-220AB



TO-220A
CASE 221A-06
STYLE 5

Table 1. TO-220AB P-Channel

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
500	6	1	***MTP2P50***	2	75
450	6	1	MTP2P45	2	
250	3	2.5	***MTP5P25***	5	
200	1	3	***MTP6P20E***	6	
	0.7	4	***MTP8P20***	8	
100	0.4	4	MTP8P10	8	60
	0.3	6	***MTP12P10***	12	88
60	0.6	3.5	MTP7P06	7	75
	0.3	6	***MTP2955E***	12	
	0.3	6	***MTP12P06***	12	
	0.12	11.5	***MTP23P06***	23	125

Table 2. TO-220AB N-Channel

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
1000	10	0.5	MTP1N100E	1	75
	4.0	1.5	***MTP3N100E***	3	
800	3	2	***MTP4N80E***	4	
600	3.8	1	***MTP2N60E***	2	50
	2.2	1.5	***MTP3N60E***	3	75

(1)T_C = 25°C

Devices listed in bold, italic are Motorola preferred devices.

Table 2. TO-220AB N-Channel (continued)

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
600	1.2	3	***MTP6N60E***	6	125
500	8	0.5	MTP1N50	1	75
	3	1.5	IRF820	2.5	40
	3	1.5	***MTP3N50E***	3	50
	1.5	1.5	IRF830	4.5	75
		2	***MTP4N50E***	4	
	0.85	4	IRF840	8	125
	0.8	4	***MTP8N50E***	8	
400	1.8	1.5	IRF720	3	40
	1.8	2	***MTP4N40E***	4	50
	1	3	IRF730	4.5	75
	1	2.5	***MTP5N40E***	5	
	0.55	5	IRF740	10	125
	0.55	5	***MTP10N40E***	10	
250	0.45	5	MTP10N25	10	100
200	1.8	1	MTP2N20	2	50
	1.5	1.3	IRF610	2.5	20
	1	1.3	MTP5N20	5	75
	0.8	1.3	IRF620	5	40
	0.7	3.5	MTP7N20	7	75
	0.4	4	MTP8N20	8	
	0.35	6	MTP12N20	12	100
	0.18	10	IRF640	18	125
	0.16	10	***MTP20N20E***	20	
150	0.3	5	MTP10N15	10	75
	0.25	7.5	MTP15N15	15	100
100	0.8	3	MTP6N10	6	50
	0.6	2	IRF510	4	20
	0.27	5	IRF520	8	40
	0.25	5	***MTP10N10E***	10	75
	0.16	7	IRF530	14	
	0.16	6	***MTP12N10E***	12	
	0.077	14	IRF540	28	125
	0.060	16.5	***MTP33N10E***	33	150
60	0.15	6	***MTP3055E***	12	40
	0.12	7.5	***MTP15N06E***	15	75
	0.014	27.5	***MTP54N06HD***	54	150

(1) $T_C = 25°C$

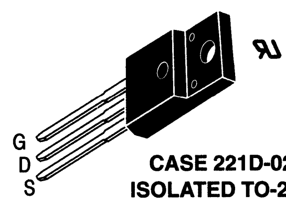
Devices listed in bold, italic are Motorola preferred devices.

Table 2. TO-220AB N-Channel (continued)

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
60	0.085	10	MTP20N06	20	75
	0.04	18	***MTP36N06E***	36	
	0.028	25	IRFZ44	50	150
	0.025	25	***MTP50N06E***	50	
50	0.12	6	BUZ71A	12	40
	0.12	6	***MTP12N05E***	12	
	0.1	6	BUZ71	12	
	0.1	7.5	***MTP15N05E***	15	
	0.1	7.5	IRFZ20	15	
	0.06	15	BUZ11A	25	75
	0.04	15	BUZ11	30	
	0.028	25	***MTP50N05E***	50	150
	0.0095	375	***MTP75N05HD***	75	150

Isolated TO-220

These devices eliminate the need for isolation hardware which in turn reduces assembly costs and improves reliability.



CASE 221D-02
ISOLATED TO-220
(MTA PREFIX)
STYLE 1

Table 3. Fully Isolated TO-220 N- and P-Channel

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
600	3.8	1	***MTA1N60E***	1	40
	2.2	1.5	***MTA2N60E***	2	
	1.2	3	***MTA4N60E***	4	50
500	1.5	2	***MTA4N50E***	4	40
	0.8	4	***MTA5N50E***	5	50

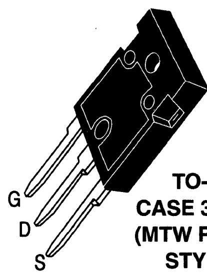
(1)T_C = 25°C
indicates UL Recognition — File #E69369

Devices listed in bold, italic are Motorola preferred devices.

Table 3. Fully Isolated TO-220 N- and P-Channel (continued)

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
400	1	2.5	***MTA4N40E***	4	40
	0.55	5	***MTA6N40E***	6	50
100	0.25	5	***MTA8N10E***	8	35
60	0.3	6	***MTA2955***(2)	8	40
	0.15	6	***MTA3055E***	9	30
	0.085	7.5	MTA15N06	15	50
	0.025	25	***MTA30N06E***	30	

Isolated Mounting Hole —Isolated TO-247



TO-247
CASE 340F-03
(MTW PREFIX)
STYLE 1

Table 4. Isolated TO-247 N-Channel

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
1000	2	3	***MTW6N100E***	6	180
	1.2	5	***MTW10N100E***(7)	10	250
800	3	2	***MTW4N80E***	4	150
	1.2	3.5	***MTW7N80E***	7	180
600	1.2	3	***MTW6N60E***	6	150
	0.5	4	***MTW8N60E***	8	180
500	0.8	4	***MTW8N50E***	8	150
	0.4	7	***MTW14N50E***	14	180
	0.27	10	***MTW20N50E***	20	250
400	0.55	5	***MTW10N40E***	10	150
	0.3	8	***MTW16N40E***	16	180
	0.2	12	***MTW24N40E***	24	250
250	0.28	7.5	***MTW15N25E***	15	150
	0.14	11.5	***MTW23N25E***	23	180
	0.1	16	***MTW32N25E***	32	250

(1)$T_C = 25°C$
(2)Indicates P-Channel
(7)To be introduced

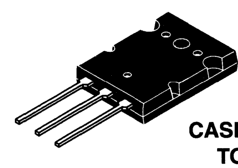
Devices listed in bold, italic are Motorola preferred devices.

Table 4. Isolated TO-247 N-Channel (continued)

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
200	0.16	11	***MTW20N20E***	22	150
	0.085	16	***MTW32N20E***	32	180
150	0.095	13	***MTW26N15E***	26	150
	0.065	17.5	***MTW35N15E***	35	180
100	0.06	18	***MTW33N10E***	36	150
	0.04	22.5	***MTW45N10E***	45	180
50	0.014	27	***MTW54N05E***	54	210

New Product New Product New Product New Product

Large Plastic Package — TO-3PBL



CASE 340G-01
TO-3PBL
STYLE 1

Table 5. TO-3PBL

This package extends the range of plastic packages to allow increased "power processing."

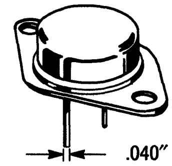
V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
1000	1.2	5	***MTY10N100E***(7)	10	250

(1)T_C = 25°C
(7)To be introduced

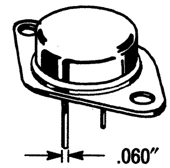
Devices listed in bold, italic are Motorola preferred devices.

TMOS®

Metal Packages — TO-220AA/EE



TO-204AA
CASE 1-07
STYLE 3



TO-204AE
CASE 197A-03
STYLE 3

Table 6. TO-220AA/AE P-Channel

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
100	0.3	6	MTM12P10	12	75
	0.15	10	MTM20P10	20	125

Table 7. TO-220AA/AE N-Channel

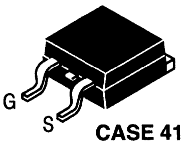
V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
500	0.4	3.5	IRF450	13	150
	0.4	7	***MTM14N50E***	14	
400	0.3	7.5	***MTM15N40E***	15	250
200	0.4	5	IRF230	9	75
	0.4	4	MTM8N20	8	75
	0.18	10	IRF240	18	125
	0.16	7.5	MTM15N20	15	150
	0.085	16	IRF250	30	
	0.08	20	MTM40N20	40	250(6)
100	0.16	8	IRF130	14	75
	0.16	6	MTM12N10E	12	
	0.085	15	IRF140	27	100
	0.075	12.5	***MTM25N10E***	25	150
	0.055	20	IRF150	40	
	0.04	27.5	MTM55N10	55	250(6)
60	0.028	30	MTM60N06	60	250(6)
50	0.028	25	MTM50N05E	50	125

(1)$T_C = 25°C$
(6)Indicates .060″ pin diameter

Devices listed in bold, italic are Motorola preferred devices.

TMOS

Surface Mount Packages



CASE 418B-02(5)
STYLE 2

New Product New Product New Product New Product

TMOS D^2PAK

Table 8. TMOS D^2PAK

These devices enable a total system solution for power surface mount applications. They are available in tape and reel and low profile insertion mount.

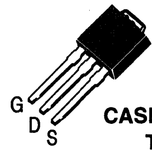
V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
1000	10	0.5	***MTB1N100E***	1	2.5(3)
	4.0	1.5	***MTB3N100E***	3	
800	3.0	2	***MTB4N80E***	4	
600	1.2	3	***MTB6N60E***	6	
500	0.8	4	***MTB8N50E***	8	
400	0.55	5	***MTB10N40E***	10	
200	0.16	10	***MTB20N20E***	20	
100	0.060	16.5	***MTB33N10E***	33	
60	0.12	11.5	***MTB23P06E***	23	
	0.12	7.5	***MTB15N06E***	15	
	0.05	15	***MTB30N06EL***	30	
	0.04	18	***MTB36N06E***	36	
	0.028	25	***MTB50N06EL***	50	
	0.025	25	***MTB50N06E***	50	
	0.014	27.5	***MTB54N06HD***	54	
50	0.095	37.5	***MTB75N05HD***	75	

(1)T_C = 25°C
(3)Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum pad size recommended.
(5)Available in tape and reel — add T4 suffix to part number.

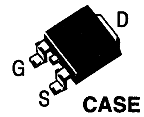
Devices listed in bold, italic are Motorola preferred devices.

Surface Mount Packages (continued)

TMOS DPAK



CASE 369-07(4)
TO-251
STYLE 2



CASE 369A-13(5)
TO-252
STYLE 2

Table 9. Case 369A-10 Surface Mount / Case 369-05 Insertion Mountable

These devices offer compatibility with automatic pick and place equipment for high density circuit board applications. They are available in tape and reel and insertion mount.

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
500	6	0.5	MTD1N50	1	1.75(3)
	4	1	MTD2N50E	2	
450	8	0.5	MTD1N45	1	
400	5	0.5	MTD1N40	1	
250	1.4	1.5	MTD3N25E	3	
200	1.5	1	MTD2N20	2	
	0.7	2	MTD4N20E	4	
150	0.3	3	MTD6N15	6	
100	0.5	2.5	MTD5N10	5	
	0.25	4.5	***MTD9N10E***	9	
	0.25	3	MTD6N10E	6	
60	0.6	2	***MTD5P06E***(2)	5	
	0.4	2.5	MTD5N06	5	
	0.3	6	***MTD2955E***(2)	8	
	0.18	6	***MTD3055EL***	10	
	0.15	4	***MTD3055E***	8	
50	0.4	2.5	MTD5N05	5	
	0.1	5	***MTD10N05E***	10	
30	0.040	10	***MTD20N03HDL***(7_	20	

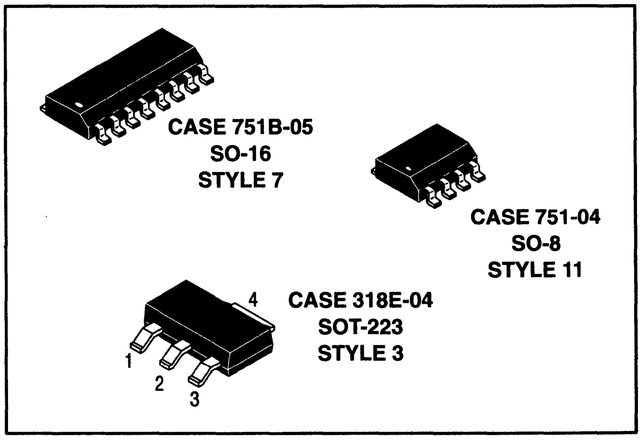
(1) $T_C = 25°C$
(2) Indicates P-Channel
(3) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum pad size recommended.
(4) Add "-1" Suffix to part number to order insertion mountable package.
(5) Available in tape and reel — add T4 suffix to part number.

Devices listed in bold, italic are Motorola preferred devices.

Surface Mount Packages (continued)

Medium Power TMOS FETs*

Multiple Chip TMOS Products in SOIC Surface Mount Packages

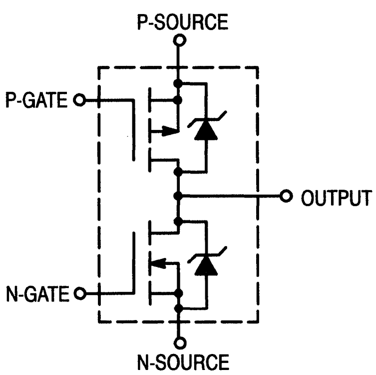


Multiple chip surface mount TMOS MOSFETs in SOIC packages simplify circuit design through component count and board space reduction. These devices are designed for use in bridge circuits in low voltage, motor control applications such as disk drives, tape drives, optical drives, printers and plotters and they can also be used for driving relays and solenoids. Both devices feature low $R_{DS(on)}$ and a specially designed leadframe for maximum power dissipation. These devices fit the standard SO-8 and SO-16 footprints.

Table 10. Multiple Chip Products in SOIC

V_{DSS} (Volts) Min	P-Channel $R_{DS(on)}$ Ohms	N-Channel $R_{DS(on)}$ Ohms	Part Number	I_D (cont) Amps	P_D[8] (Watts) Max	Description
50	0.3	0.3	***MMDF2C05E***	2.0	2.0[10]	Complementary Half-Bridge
20	—	0.1	***MMDF2N02E***	2.2	1.5[9]	Dual N-Channel

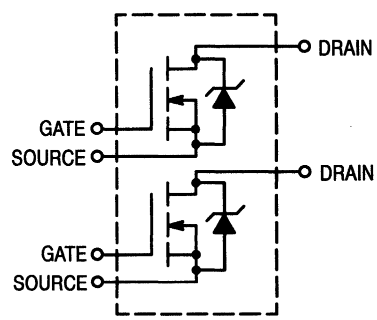
(8) T_A = 25°C
(9) Power rating with both die "on" when mounted on FR-4 glass epoxy printed circuit board with the recommended footprint
(10) P or N Channel device only



MMDF2C05E
Half-Bridge

Use MMDF2C05ER1 to order the 7 inch/500 unit reel.
Use MMDF2C05ER2 to order the 13 inch/2500 unit reel.

Tape Size = 16 mm



MMDF2N02E
Dual N-Channel

Use MMDF2N02ER1 to order the 7 inch/500 unit reel.
Use MMDF2N05ER2 to order the 13 inch/2500 unit reel.

Tape Size = 12 mm

*Medium Power TMOS FETs are manufactured and available from the Small Signal Products Group

Devices listed in bold, italic are Motorola preferred devices.

Surface Mount Packages: Medium Power TMOS FETs **(continued)**

Table 11. SOT-223 Medium Power TMOS FETs

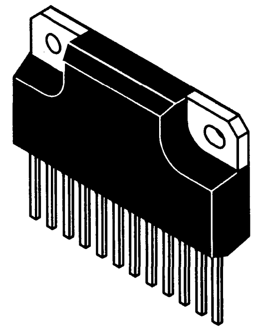
V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) @ Max	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max	Application
100	0.3	0.5	***MMFT1N10ET1***	1	0.8(11)	dc-dc Converters Power Supplies Motor Controls, Switching
60		0.6	***MMFT2955ET1***(2)	1.2		
	0.18	0.75	***MMFT3055ELT1***	1.5		
	0.15	0.85	***MMFT3055ET1***	1.7		
20	0.1	1	***MMFT2N02ELT1***	2		

(1) $T_C = 25°C$
(2) Indicates P-channel
(11) Device mounted on FR-4 glass epoxy printed circuit board using minimum recommended footprint as shown in Surface Mount Information Section.

Devices listed in bold, italic are Motorola preferred devices.

Multiple Chip Packages

The ICePAK leadframe is versatile and can be used to construct many different custom or semi-custom circuits — 2 pad (H-bridge), 3 pad (3-phase or tri-die), and 4 pad (quad die). Contact your local Motorola sales office for your copy of the ICePAK Selector Guide.



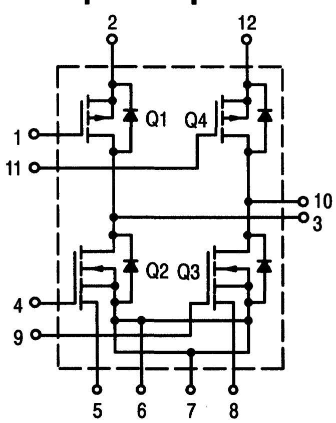
CASE 806-05

Table 12. IcePAK Insulated Products

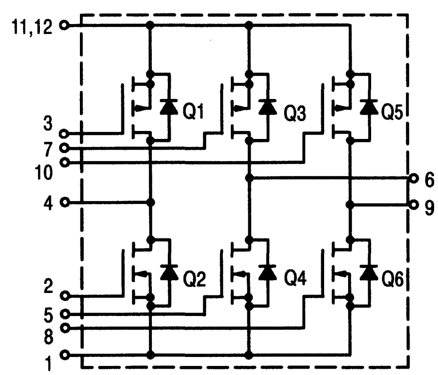
V_{DSS} (Volts) Min	P-Channel $R_{DS(on)}$ (Ohms) Max	N-Channel $R_{DS(on)}$ (Ohms) Max	Part Number	I_D (cont) Amps	P_D(1) (Watts) Max	Description
100	0.4	0.15	***MPM3002***	8	62.5	H-Bridge with Current Sensing
60	0.28		***MPM3003***	10		3-Phase Bridge with Complementary Outputs
			MPM3004			H-Bridge
	0.15	0.04	MPM3008	16		H-Bridge with Schottky Rectifiers
		0.15	MPM3010	12	50	H-Bridge with Current Sensing
	NA	0.04	MPM3013	25		Quad N-Channel Array
	NA	0.04	MPM3017	25	62.5	N-Channel H-Bridge
	0.15	0.15	MPM3021	10	35	3-Phase Bridge w/Complementary Outputs

(1)$T_C = 25°C$

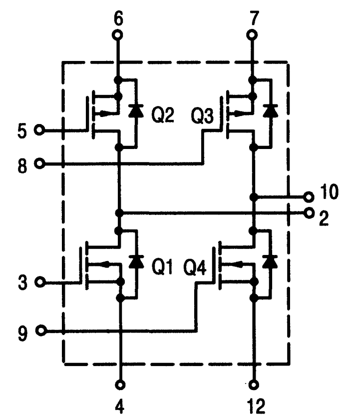
Multiple Chip Power Module Device Circuits



H-Bridge with Current Sensing MPM3002/MPM3010

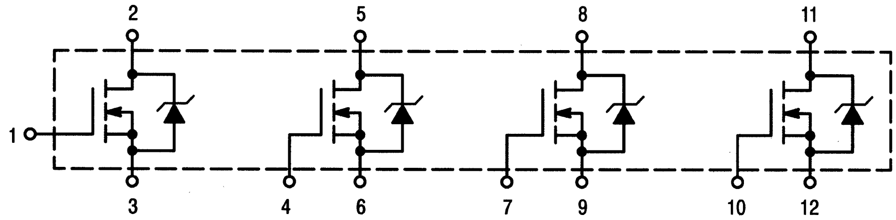


Three-Phase Bridge with Complementary Outputs MPM3003/MPM3021

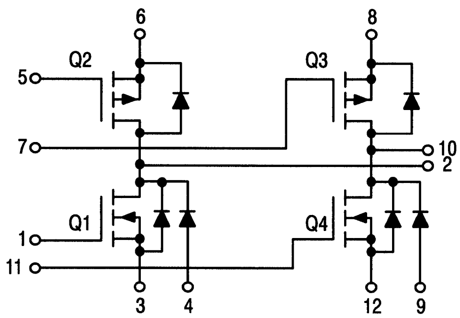


H-Bridge MPM3004

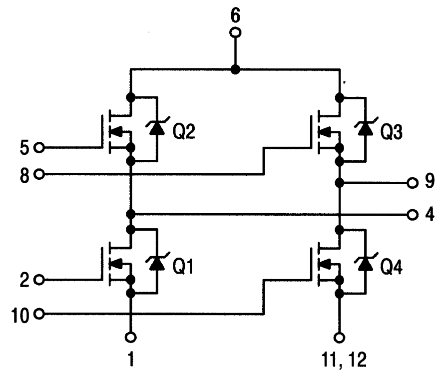
Devices listed in bold, italic are Motorola preferred devices.



Quad N-Channel Array
MPM3013



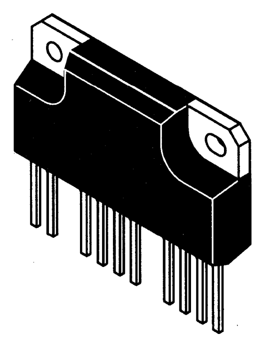
Complementary H-Bridge
with Schottky Clamps
MPM3008



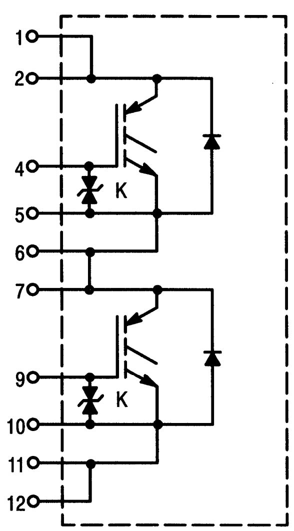
(PINS 3 AND 7 HAVE NO INTERNAL CONNECTION)

H-Bridge
N-Channel
MPM3017

The MPM6002 advanced high voltage Insulated Gate Bipolar Transistor (IGBT) Half-Bridge with Free Wheeling Diodes in the ICePAK package is designed for high voltage, high speed switching applications in bridge configurations such as servo drives, PWM motor controls and other application where a robust device with low on losses, fast switching times and ease of drive are important considerations.



CASE 806A-01



IGBT/Rectifier Half-Bridge
MPM6002

Table 13. ICePAK Insulated Products

V_{CEO} (Volts) Min	$V_{CE(on)}$ (Volts) Max	Device	I_D (cont) Amps	P_D(1) (Watts) Max	Description
600	3.5	MPM6002(7)	15	50	IGBT/Rectifier Half-Bridge

(1)T_C = 25°C
(7To be introduced

Devices listed in bold, italic are Motorola preferred devices.

Multiple Chip Packages (continued)

TO-240 Power MOSFET Modules

Motorola AIEG offers the N-Channel MOSFET modules in the TO-240 package. The modules are designed in common source or half-bridge circuit configurations for higher power switching applications such as power supplies, UPS systems and power inverters. The voltage ranges from 200 Volts to 500 Volts and the current ranges from 20 Amps to 45 Amps. The package provides 2500 Vac RMS electrical isolation to the heat sink and is UL recognized.

Additional application specific circuits will be considered where customer requirements and volume dictates.

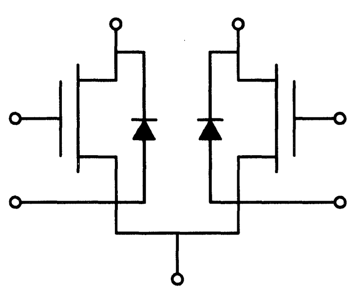
Table 14. TO-240 Power MOSFET Modules

Max V_{DSS} Volts	Max $R_{DS(on)}$ Ohms	Max $I_{D(cont)}$ Amps*	Device	Conditions		Circuit Configuration	Module Type
				I_D Amps	V_{GS} Volts		
500	0.14	20	MT40B3Y50	20	10	3Y	Dual
			MT40BY50			Y	
400	0.1	25	MT50B3Y40	25	10	3Y	Dual
			MT50BY40			Y	
200	0.026	45	MT90B3Y20	45	10	3Y	Dual
			MT90BY20			Y	

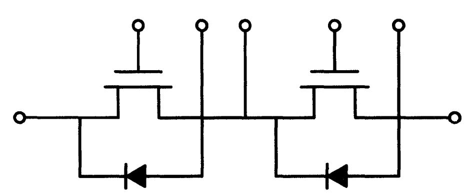
*Device current rating per leg.

N-Channel MOSFET Circuit Configurations

3Y: Common Source



Y: Half-Bridge

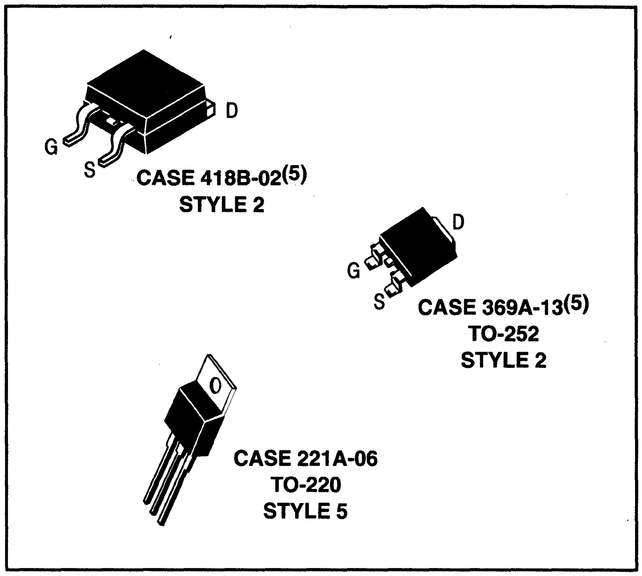


Additional information about the TO-240 MOSFET is available from the Motorola Automotive and Industrial Group
4000 Commercial Ave.
Northbrook, IL 60062.
Phone: (708) 480-8111

Devices listed in bold, italic are Motorola preferred devices.

HDTMOS Power MOSFETs

HDTMOS power MOSFETs offer vast improvement in system cost, efficiency and reliability. The HDTMOS high cell density TMOS power MOSFET series employs the same MOS process used to produce complex microcontrollers to achieve an ultra-low on-resistance. This reduction in on-resistance provides dramatically increased power-handling capability, allowing power systems to use fewer and smaller components. One of the first devices is a 7 mΩ surface mount D^2PAK rated at 50 volts with an incredible 9.5 mΩ maximum $R_{DS(on)}$. Other HDTMOS devices will include surface mount DPAK, a 3-volt logic level family, a P-Channel version, and ESD-Protected devices.



Types of Applications

- Servo/stepper motor controls
- Disk drives
- Printers, fax machines
- Radio-controlled hobby equipment
- Low Voltage DC-to-DC converters
- Portable PCs
- Power control switches
- ABS systems
- Solid state relays
- Reverse battery protection

Key Features

- Ultra-low $R_{DS(on)}$
- Soft, yet fast, internal diode
- High current capability in single device
- Low voltage-drop
- Low power dissipation

HDTMOS Benefits

- Improves efficiency
- Reduces size and part count of power systems
- Increases power density
- Increases frequency
- Reduces EMI and RFI
- Extends battery life

New Product New Product New Product New Product

Table 15. HDTMOS

V_{DSS}	$R_{DS(on)}$	@ I_D	Device	$I_{D(out)}$	P_D(1)	Package
60	0.014	27.5	***MTP54N06HD***	54	150	TO-220AB
	0.014	27.5	***MTB54N06HD***	54	2.5(3)	D^2PAK
50	0.0095	37.5	***MTB75N05HD***	75	2.5(3)	D^2PAK
	0.0095	37.5	***MTP75N05HD***	75	150	TO-220AB
30	0.085	8	***MTD16P03HDL***(7)	16	1.75(3)	TO-252
	0.040	10	***MTD20N03HDL***(7)	20	1.75(3)	TO-252

(1) T_C = 25°C
(3) Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum pad size recommended.
(5) Available in tape and reel — add T4 suffix to part number.
(7) To be introduced

Devices listed in bold, italic are Motorola preferred devices.

TMOS®

Logic Level Power MOSFETs

Logic level MOSFETs are fully enhanced with 5 volts applied to the gate.

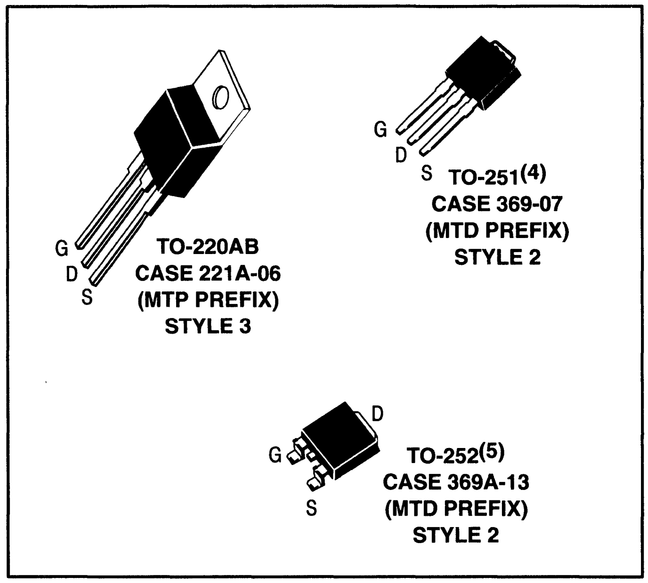


Table 16. N-Channel Logic Level Power MOSFETs (TO-220AB, TO-251 and TO-252)

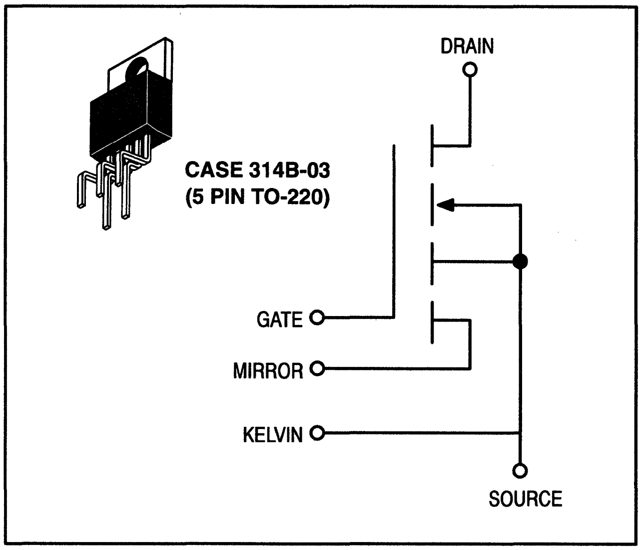
V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max	Package
80	0.3	2.5	***MTD5N08L***	5	1.75(3)	TO-252(4)
	0.135	7.5	***MTP15N08EL***(7)	15	75	TO-220AB
60	0.18	6	***MTD3055EL***	10	1.75(3)	TO-252(4)
	0.18	6	***MTP3055EL***	12	40	TO-220AB
	0.05	15	***MTP30N06EL***	30	75	TO-220AB
	0.028	25	***MTP50N06EL***	50	150	TO-220AB
50	0.1	7.5	***MTP15N05EL***	15	75	TO-220AB
30	0.085	8	***MTD16P03HDL***	16	1.75(3)	TO-252
	0.040	10	***MTD20N03HDL***	20	1.75(3)	TO-252

(1)T_C = 25°C
(3)Power rating when mounted on an FR-4 glass epoxy printed circuit board with the minimum pad size recommended.
(4)Add "-1" Suffix to part number to order insertion mountable package.
(5)Available in tape and reel — add T4 suffix to part number.
(7)To be introduced

Devices listed in bold, italic are Motorola preferred devices.

SENSEFETs Products

SENSEFET™ products are conventional power MOSFETs with an option provided to sense the drain current by measuring a small proportion of the total drain current. These devices are ideal for current mode switching regulators and motor controls.



CASE 314B-03
(5 PIN TO-220)

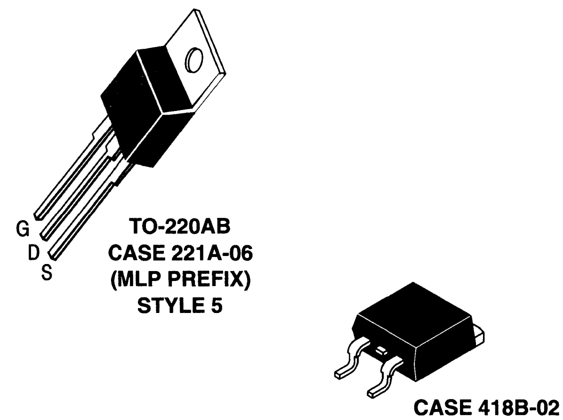
Table 17. Case 314B-03

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max @	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
60	0.04	20	MTP40N06M	40	125
80	0.065	15	MTP30N08M	30	
100	0.25	5	MTP10N10M	10	75

(1)$T_C = 25°C$

Devices listed in bold, italic are Motorola preferred devices.

SMARTDISCRETES Products



From a standard power MOSFET process, several active and passive elements can be obtained that provide on-chip protection to the basic power device. Such elements require only a small increase in silicon area and/or the addition of one masking layer to the process. The resulting device exhibits significant improvements in ruggedness and reliability and a system cost reduction. These SMARTDISCRETES functions can now provide an economical alternative to smart power ICs for power applications requiring low on-resistance, high voltage and high current.

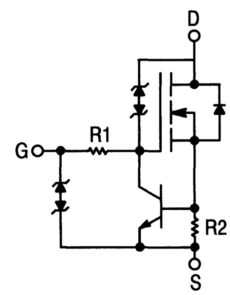
These devices make up a series of "smart" power devices that automatically clamp spikes in automotive ignition systems and guard against ESD. The devices feature a logic level IGBT (Insulated Gate Bipolar Transistor) with integral active collector clamp and ESD gate protection and are designed primarily as ignition coil drivers to withstand high current in a pulsed mode without latching.

Table 18. Ignition IGBTs

BV_{CES} (Volts) Clamped	$V_{CE(on)}$ @ 10 A	Device	P_D(1) (Watts) Max	Package
350 V	1.8	***MGP20N35CL*** ***MGB20N35CL***	150	TO-220 D^2PAK
400 V	1.8	***MGP20N40CL*** ***MGB20N40CL***	150	TO-220 D^2PAK

Table 19. Case 221A-06 — MLP1N06CL

The MLP1N06CL is a SMARTDISCRETES device that has integrated on-chip current limit capability, drain-to-source voltage clamping and gate voltage protection. The logic level processing allows operation of this device at half of the gate-to-source (5 volts) voltage of the conventional MOSFETs and can now be driven directly from CMOS or TTL logic drivers. This integration of technologies results in an intelligent, monolithic power circuit that offers a reduced parts count and improved reliability by replacing resistors, diodes, a bipolar transistor and a MOSFET with one device.



MLP1N06CL

V_{DSS} (Volts) Min	$R_{DS(on)}$ (Ohms) Max	I_D (Amps)	Device	I_D (cont) Amps	P_D(1) (Watts) Max
60 Clamped Voltage	0.75	1	***MLP1N06CL***	Current Limited	40

(1)T_C = 25°C

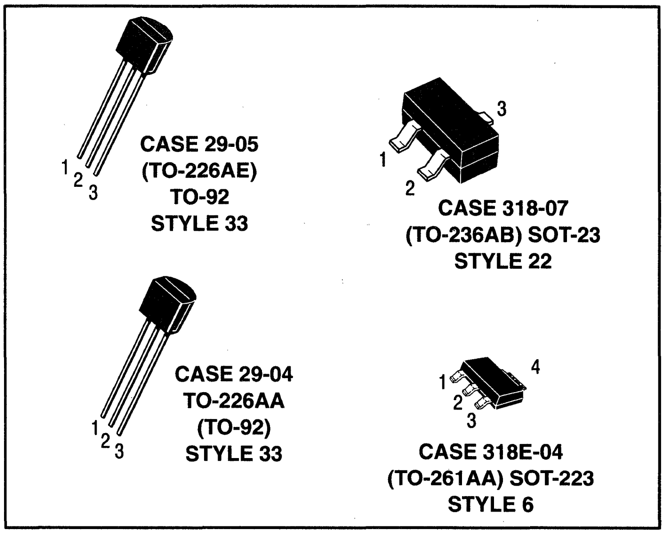
Devices listed in bold, italic are Motorola preferred devices.

TMOS®

MOSFET Turn-Off Devices

SMALLBLOCK™ Products*

This new series of MOSFET turn-off devices offers an economical way to reduce the turn-off time of power MOSFETs. Additionally, they clamp the MOSFET gate voltage to a safe level. The use of a MOSFET turn-off device lowers component count, reduces system cost and board space, and optimizes the switching performance of the MOSFET. Applications for these devices include PWM circuits in switchmode power supplies, DC-DC converters and motor controls for brush and brushless motors.



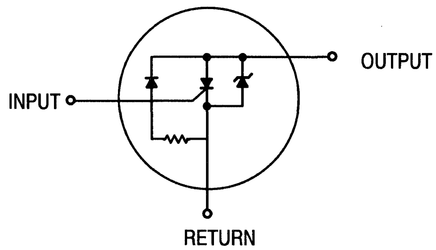


Table 20. MOSFET Turn-Off Devices

The following table is a listing of MOSFET turn-off devices used for reduced turn-off of power MOSFETs.

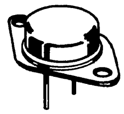
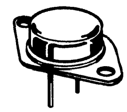
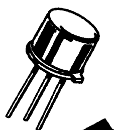
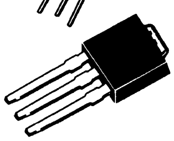
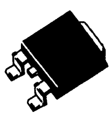
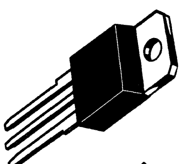
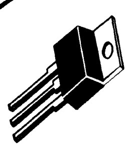
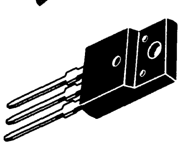
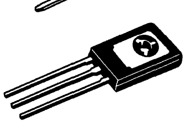
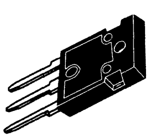
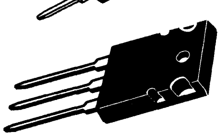
Device	Marking	V_{in} @ 2 mA Min	V_{in} @ 2 mA Max	V_{out} @ 2 mA Min	V_{out} @ 2 mA Max	t_{off} (1000 pF) Typ
Case 29-04 TO-226AA (TO-92) Pinout: 1-Return, 2-Input, 3-Output						
MDC1000A	MDC1000	9.5	12.5	9	12	15 ns
MDC1005A	MDC1005	5.5	6.8	5	6.3	22 ns
Case 318-07 TO-236AB (SOT-23) Pinout: 1-Return, 3-Output, 2-Input						
MDC1000BLT1	C10	9.5	12.5	9	12	15 ns
MDC1005BLT1	C05	5.5	6.8	5	6.3	22 ns
Case 318E-04 TO-261AA (SOT-223) Pinout: 1-Return, 2-Input, 3-Output, 4-Input						
MDC1000CT1	C1000	9.5	12.5	9	11.5	15 ns
Case 29-05 TO-226AE (TO-92) Pinout: 1-Return, 2-Input, 3-Output						
MDC1100A	MDC1100	9.5	12	9	11.5	15 ns
MDC1115A	MDC1115	15	17.5	14.5	17.5	20 ns
Case 318E-04 TO-261AA (SOT-223) Pinout: 1-Return, 2-Input, 3-Output, 4-Input						
MDC1100CT1	C1100	9.5	12	9	11.5	15 ns
MDC1115CT1	C1115	15	17.5	14.5	17.5	20 ns

*SMALLBLOCK MOSFET turn-off devices are manufactured and available from the Small Signal Products Group.

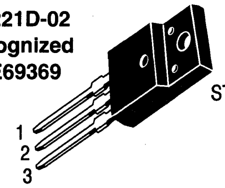
Devices listed in bold, italic are Motorola preferred devices.

Bipolar Power Transistors

Selection By Package

Package		I_C Range (Amps)	V_{CE} Range (Volts)	P_D (Watts)	Page #
	TO-204AA (TO-3) CASE 1-07	4-30	40-1500	90-250	5.3-32
	TO-204AE CASE 197A-03	50-80	60-1000	150-300	5.3-32
	TO-205AD (TO-39) CASE 79-04	0.5-5.0	40-400	5.0-10	5.3-38
	DPAK CASE 369-07	0.5-10	40-400	12.5-20	5.3-31
	DPAK CASE 369A-13	0.5-10	40-400	12.5-20	5.3-31
	TO-218 TYPE CASE 340D-01	5.0-25	60-1500	80-150	5.3-26
	TO-220AB CASE 221A-06	0.5-15	30-1800	30-125	5.3-23
	ISOLATED TO-220 TYPE CASE 221D-02	1-12	80-450	20-45	5.3-22
	TO-225AA (TO-126 TYPE) CASE 77-07	0.3-5.0	25-400	12.5-40	5.3-29
	CASE 340F-03 (TO-247 TYPE)	10-30	400-1500	125-180	5.3-28
	TO-3PBL CASE 340G-01	15-16	200-250	250	5.3-29

CASE 221D-02
UL Recognized
File #E69369



STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

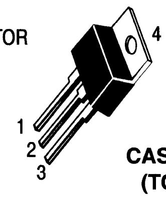
Table 1. Plastic (Isolated TO-220 Type)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	V_{CES} Volts Min	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
1	250		***MJF47***		30/150	0.3	2 typ	0.17 typ	0.3	10	28
2	400	700	***BUL44F***		14/34	0.2	2.75(3)	0.2(3)	1	13 typ	25
		1000	***MJF18002***		14/34	0.2	2.75(3)	0.175(3)	1	13 typ	25
3	100		***MJF31C***	***MJF32C***	10 min	1	0.6	0.3	1	3	28
5	100		***MJF122***(2)	***MJF127***(2)	2000 min	3	1.5 typ	1.5 typ	3	4(1)	28
	400	700	***BUL45F***		14/34	0.3	1.7(3)	0.15(3)	1	12 typ	35
	450	1000	***BUT11AF***		10 min	.005	4	0.8	2.5		40
		1000	***MJF16002***		5 min	5	3	0.3	3		40
		1000	***MJF18004***		14/34	0.3	1.7(3)	0.15(3)	1	13 typ	35
6	250	550	***MJF16204***		5 min	6	1.5(3)	0.15(3)	1	10	45
	400	700	***BUL146F***		14/34	0.5	2.5(3)	0.15(3)	3	14 typ	40
	450	1000	***MJF18006***		14/34	0.5	3.2(3)	0.15(3)	3	14 typ	40
8	80			***MJF6107***	30/90	2	0.5 typ	0.13 typ	2	4	35
	150		***MJF15030***	***MJF15031***	40 min	3	1 typ	0.15 typ	3	30	35
	400	700	***MJF13007***		5/30	5	3	0.7	5	4	40
			BUL147F		14/34	1	2.5(3)	0.18(3)	2	14 typ	45
	450	1000	***MJF18008***		16/34	1	2.75(3)	0.18(3)	2	13 typ	45
10	60		***MJF3055***	***MJF2955***	20/100	4	—	—	—	2	40
	80		***MJF44H11***	***MJF45H11***	40/100	4	0.5 typ	0.14 typ	5	40	35
	100		***MJF6388***(2)	***MJF6668***(2)	3k/20k	3	1.5 typ	1.5 typ		20(1)	40
12	400	700	***MJF13009***		6/30	8	3	0.7	8	8	40

(1)$|h_{FE}|$ @ 1 MHz
(2)Darlington
(3)Switching tests performed w/special application simulator circuit. See data sheet for details.

Devices listed in bold, italic are Motorola preferred devices.

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR



CASE 221A-06
(TO-220AB)

Table 2. Plastic TO-220

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min[8]	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
0.5	350	***MJE2360T***		15 min	0.1				10 typ	30
		MJE2361T		40 min	0.1				10 typ	30
1	80	TIP29B	TIP30B	15/75	1	0.6 typ	0.3 typ	1	3	30
	100	TIP29C	TIP30C	15/75	1	0.6 typ	0.3 typ	1	3	30
	250	***TIP47***		30/150	0.3	2 typ	0.18 typ	0.3	10	40
	300	***TIP48***	***MJE5730***	30/150	0.3	2 typ	0.18 typ	0.3	10	40
	350	***TIP49***	***MJE5731***	30/150	0.3	2 typ	0.18 typ	0.3	10	40
	400	***TIP50***	***MJE5731A***[7]	30/150	0.3	2 typ	0.18 typ	0.3	10	40
2	60	TIP110[2]	TIP115[2]	500 min	2	1.7 typ	1.3 typ	2	25[1]	50
	80	***TIP111***[2]	***TIP116***[2]	500 min	2	1.7 typ	1.3 typ	2	25[1]	50
	100	***TIP112***[2][6]	***TIP117***[2][6]	500 min	2	1.7 typ	1.3 typ	2	25[1]	50
	400/700	***BUL44***		14/36	0.4	2.75[3]	0.175[3]	1	13 typ	50
	450/1000	***BUX85***		30	0.1	3.5	1.4	1	4	50
	450/1000	***MJE18002***		14/34	0.2	3[3]	0.17[3]	1	12 typ	40
	900/1800	***MJE1320***		3 min	1	4 typ	0.8 typ	1		80
3	60	TIP31A	TIP32A	25 min	1	0.6 typ	0.3 typ	1	3	40
	80	***BD241B***	***BD242B***	25 min	1				3	40
		TIP31B	***TIP32B***	25 min	1	0.6 typ	0.3 typ	1	3	40
	100	***BD241C***	***BD242C***	25 min	1				3	40
		TIP31C[6]	***TIP32C***[6]	25 min	1	0.6 typ	0.3 typ	1	3	40
	150		***MJE9780***	50/200	0.5				5 typ	40

(1) $|h_{FE}|$ @ 1 MHz
(2) Darlington
(3) Switching tests performed w/special application simulator circuit. See data sheet for details.
(6) Available as preferred chip
(7) V_{CEO} = 375 V
(8) When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.

Devices listed in bold, italic are Motorola preferred devices.

Table 2. Plastic TO-220 (continued)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
4	40		***MJE1123***	45/100	4				5	75
	60	***MJE800T***(2)	***MJE700T***(2)	750 min	1.5				1(1)	40
	80	***D44C12***	***D45C12***	40/120	0.2			1	40 typ	30
	400/700	***MJE13005***		6/30	3	3	0.7	3	4	60
5	60	TIP120(2)	TIP125(2)	1k min	3	1.5 typ	1.5 typ	3	4(1)	65
	80	***TIP121***(2)	***TIP126***(2)	1k min	3	1.5 typ	1.5 typ	3	4(1)	65
	100	***TIP122***(2)(6)	***TIP127***(2)(6)	1k min	3	1.5 typ	1.5 typ	4	4(1)	75
	250	***2N6497***		10/75	2.5	1.8	0.8	2.5	5	80
	300	***2N6498***		10/75	2.5	1.8	0.8	2.5	5	80
	400/700	***BUL45***		14/34	0.3	1.7(3)	0.15(3)	1	12 typ	75
	450/1000	***MJE16002***		5 min	5	3	0.3	3		80
	450/850	***MJE16004***		7 min	5	2.7	0.35	3		80
	450/1000	***MJE18004***		14/34	0.3	1.7	0.15	1.0	13	75
	700/1500	***MJE8503A***		7.5	1	4	2	2.5	7 typ	80
6	60	TIP41A	TIP42A	15/75	3	0.4 typ	0.15 typ	3	3	65
	80	***TIP41B***	***TIP42B***	15/75	3	0.4 typ	0.15 typ	3	3	65
		BD243B	***BD244B***	15 min	3	0.4 typ	0.15 typ	3	3	65
	100	***BD243C***	***BD244C***	15 MIN	3	0.4 typ	0.15 typ	3	3	65
		TIP41C	***TIP42C***	15/75	3	0.4 typ	0.15 typ	3	3	65
	250/550	***MJE16204***		5 min	6	1.5(2)	0.15(2)	1	10	80
	400/700	***BUL146***		14/34	0.5	1.75(3)	0.15(3)	3	14 typ	100
	450/1000	***MJE18006***		14/34	0.5	3.2(3)	0.13(3)	3	14 typ	100
7	30	2N6288	2N6111	30/150	3	0.4 typ	0.15 typ	3	4	40
	50		2N6109	30/150	2.5	0.4 typ	0.15 typ	3	4	40
	70	***2N6292***	***2N6107***	30/150	2	0.4 typ	0.15 typ	3	4	40
	100	***BD801***	***BD802***	15 min	3				3	65
	150	***BU407,D***		30 min	1.5		0.75	5	10	60
	200	***BU406,D***		30 min	1.5		0.75	5	10	60
	450	***BU522B***(2)		250 min	2.5				7.5	75

(1)$|h_{FE}|$ @ 1 MHz
(2)Darlington
(3)Switching tests performed w/special application simulator circuit. See data sheet for details.
(6)Available as preferred chip
(7)V_{CEO} = 375 V
(8)When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.

Devices listed in bold, italic are Motorola preferred devices.

Table 2. Plastic TO-220 (continued)

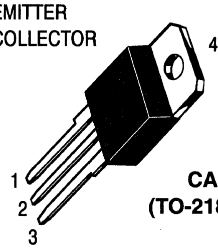
I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
8	60	2N6043(2)	2N6040(2)	1k/10k	4	1.5 typ	1.5 typ	3	4(1)	75
		TIP100(2)	TIP105(2)	1k/20k	3	1.5 typ	1.5 typ	3	4(1)	80
	80	***2N6044***(2)	***2N6041***(2)	1k/10k	4	1.5 typ	1.5 typ	3	4(1)	75
		BDX53B(2)	***BDX54B***(2)	750 min	3				4(1)	60
		TIP101(2)	***TIP106***(2)	1k/20k	3	1.5 typ	1.5 typ	3	4(1)	80
	100	***2N6045***(2)	***2N6042***(2)	1k/10k	3	1.5 typ	1.5 typ	3	4(1)	75
		BDX53C(2)	***BDX54C***(2)	750 min	3					
		TIP102(2)	***TIP107***(2)	1k/20k	3	1.5 typ	1.5 typ	3	4(1)	80
	120	***MJE15028***	***MJE15029***	20 min	4				30	50
	150	***MJE15030***(6)	***MJE15031***(6)	20 min	4				30	50
	200	***BU806***(2)		100 min	5	0.55 typ	0.2 typ	5		60
	300/600	MJE5740(2)		200 min	4	8 typ	2 typ	6	4	80
			MJE5850	15 min	2	2	0.5	4		80
	350	***MJE5741***(2)		200 min	4	8 typ	2 typ	6		80
			MJE5851	15 min	2	2	0.5	4		80
		MJE5742(2)		200 min	4	8 typ	2 typ	6		80
		MJE13007(6)		5/30	5	3	0.7	5		80
			MJE5852(6)	15 min	2	2	0.5	4		80
	400/650	***MJE16106***		6/22	8	2 typ	0.1 typ	5		100
	400/700	***BUL147***		14/34	1	2.5(3)	0.18(3)	2	14 typ	125
	450/1000	***MJE18008***		16/34	1	2.75(3)	0.18(3)	2	13 typ	125
10	20	***MJE5420Z***(2)(9)		6k min	6					100
			BD808	15 min	4				1.5	90
	60	***D44H8***	***D45H8***	40 min	4					50
		MJE3055T	***MJE2955T***	20/70	4					75
		2N6387(2)	***2N6667***(2)	1k/20k	5				20(1)	65
	80	***BDX33B***(2)	***BDX34B***(2)	750 min	3				3	70
		BD809	***BD810***	15 min	4				1.5	90
		D44E3(2)		1000 min	5	2 typ	0.5 typ	10		50
		2N6388(2)(6)	***2N6668***(2)(6)	1k/20k	5				20(1)	65
		D44H10	***D45H10***	20 min	4	0.5 typ	0.14 typ	5	50 typ	50
		D44H11(6)	***D45H11***(6)	40 min	4	0.5 typ	0.14 typ	5	50 typ	50

(1)$|h_{FE}|$ @ 1 MHz
(2)Darlington
(3)Switching tests performed w/special application simulator circuit. See data sheet for details.
(6)Available as preferred chip
(7)V_{CEO} = 375 V
(8)When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.
(9)Self protected Darlington

Devices listed in bold, italic are Motorola preferred devices.

Table 2. Plastic TO-220 (continued)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
10	100	***BDX33C***(2)	***BDX34C***(2)	750 min	3				3	70
12	400/700	***MJE13009***		6/30	8	3	0.7	8	4	100
15	60	***2N6487***	***2N6490***	20/150	5	0.6 typ	0.3 typ	5	5	75
	80	***2N6488***	***2N6491***	20/150	5	0.6 typ	0.3 typ	5	5	75
		D44VH10	***D45VH10***	20 min	4	0.5	0.09	8	50 typ	83
	100	***BDW42***(2)	***BDW47***(2)	1k min	5	1 typ	1.5 typ	5	4	85



CASE 340D-01
(TO-218 Type, SOT-93)

Table 3. Plastic TO-218 Type

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
5	450/850	***MJH16002***		5 min	5	3	0.3	3		100
	450/850	MJH16004		7 min	5	2.7	0.35	3		100
	500/1000	***MJH16002A***		5 min	5	3	0.3	3		100
8	450/850	***MJH16006***		5 min	8	2.5	0.25	5		125
		MJH16008		7 min	8	2.2	0.25	5		125
	500/1000	***MJH16006A***		5 min	8	2.5	0.25	5		125
	700/1500	BU508A		2.25 min	4.5	8 typ	0.5 typ	4.5	7	125
10	60	TIP140(2)	TIP145(2)	500 min	10	2.5 typ	2.5 typ	5	4(1)	125
	80	***TIP33B***	***TIP34B***	20/100	3				3	80
		TIP141(2)	***TIP146***(2)	500 min	10	2.5 typ	2.5 typ	5	4(1)	125
	100	***BDV65B***(2)	***BDV64B***(2)	1k min	5					125
		TIP33C	TIP34C	20/100	3				3	80
		TIP142(2)	TIP147(2)	500 min	10	2.5 typ	2.5 typ	5	4(1)	125
	400	***BU323AP***(2)		150/100	6	15	15	6		125
		MJH10012(2)		100/2k	6	15	15	6		118

(1)$|h_{FE}|$ @ 1 MHz
(2)Darlington
(8)When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.

Devices listed in bold, italic are Motorola preferred devices.

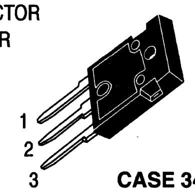
Table 3. Plastic TO-218 Type (continued)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min[8]	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
15	60	***TIP3055***	***TIP2955***	5 min	10				2.5	80
	150	***MJH11018***[2]	***MJH11017***[2]	400/15k	10				3	150
	200	***MJH11020***[2]	***MJH11019***[2]	400/15k	10				3	150
	250	***MJH11022***[2]	***MJH11021***[2]	400/15k	10				3	150
	400	***BUV48***		8 min	10	2	0.4	10		150
	450	***BUV48A***		8 min	8	2	0.4	10		150
	500	***BUT51P***[2]		40 min	5	1.1	0.16	10		125
16	140	***MJE4342***	***MJE4352***	15 min	8	1.2 typ	1.2 typ	8	1	125
	160	***MJE4343***	***MJE4353***	15 min	8	1.2 typ	1.2 typ	8	1	125
20	60	MJH6282[2]	MJH6285[2]	750/18k	10				4	125
	80	***MJH6283***[2]	***MJH6286***[2]	750/18k	10				4	125
	100	***MJH6284***[2]	***MJH6287***[2]	750/18k	10				4	125
25	80	TIP35A	TIP36A	15/75	15	0.6 typ	0.3 typ	10	3	125
		TIP35B	***TIP36B***	15/75	15	0.6 typ	0.3 typ	10	3	125
	100	***BD249C***	***BD250C***	10 min	15				3	125
		TIP35C	***TIP36C***	15/75	15	0.6 typ	0.3 typ	10	3	125

[2] Darlington
[8] When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.

Devices listed in bold, italic are Motorola preferred devices.

STYLE 2:
PIN 1. BASE
2. COLLECTOR
3. EMITTER



CASE 340F-03
(TO-247 Type)

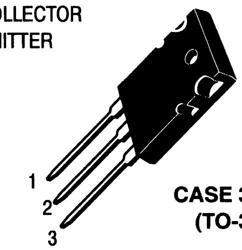
Table 4. Isolated Mounting Hole — Plastic TO-247 Type

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	V_{CES} Volts Min	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
10	650	1500	***MJW16212***		4/10	10	4(3)	0.5(3)	5.5		150
	800	1500	***MJW16018***		4 min	5	4.5 typ	0.2 typ	5	3 typ	150
12	500	1200	***MJW16206***		5/13	10	2.25	0.25	6.5	3 typ	150
15	400	650	***MJW6678***		8 min	15	2.5	0.5	15		125
	400	650	***MJW16110***		6/20	10	0.8 typ	0.1 typ	10		135
	450	850	***MJW16010***		5 min	15	1.2 typ	0.2 typ	10		150
		850	***MJW16012***		7 min	15	0.9 typ	0.15 typ	10		150
	500	1000	***MJW16010A***		5 min	15	3	0.4	10		150
		1000	***MJW16210***		5/13	15		0.24(10)	8.5(10)	2.5 typ	150
30	450	1000	***MJW18020***		8 min	20					180

(3) Switching tests performed w/special application simulator circuit. See data sheet for details.
(10) Tested in Applications simulator: see Data Sheet

Devices listed in bold, italic are Motorola preferred devices.

STYLE 2:
PIN 1. BASE
2. COLLECTOR
3. EMITTER



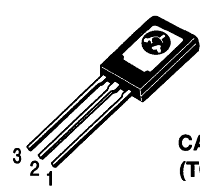
CASE 340G-01
(TO-3PBL)

Table 5. Large Plastic TO-3PBL

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	PNP	hFE Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
15	200	***MJL3281A***	***MJL1302A***	60/175	0.1				30 typ	200
16	250	***MJL21193***	***MJL21194***	25/75	8				4	200

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

STYLE 3:
PIN 1. BASE
2. COLLECTOR
3. EMITTER



CASE 77-07
(TO-225AA)

Table 6. Plastic TO-225 Type (Formerly TO-126 Type)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
0.3	350	***MJE3439***		40/160	0.02				15	15
0.5	150	***MJE341***		25/200	0.05				15	20.8
	200	***MJE344***		30/300	0.05				15	20.8
	250	2N5655		30/250	0.1	3.5 typ	0.24 typ	0.1	10	20
		BD157		30/240	0.05					20
	300	BD158		30/240	0.05					20
		MJE340(6)	***MJE350***(6)	30/240	0.05					20.8
		2N5656		30/250	0.1	3.5 typ	0.24 typ	0.1	10	20

(6)Available as preferred chip

Devices listed in bold, italic are Motorola preferred devices.

Table 6. Plastic TO-225 Type (Formerly TO-126 Type) (continued)

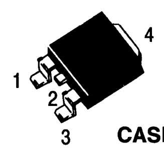
I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
0.5	350	***2N5657***		30/250	0.1	3.5 typ	0.24 typ	0.1	10	20
		BD159		30/240	0.05					20
1	40	***2N4921***	***2N4918***	20/100	0.5	0.6 typ	0.3 typ	0.5	3	30
	60	***2N4922***	***2N4919***	20/100	0.5	0.6 typ	0.3 typ	0.5	3	30
	80	***2N4923***	***2N4920***	20/100	0.5	0.6 typ	0.3 typ	0.5	3	30
1.5	45	BD165	BD166	15 min	0.5				6	20
		BD135	***BD136***	40/250	0.15					12.5
	60	BD137	BD138	40/250	0.15					12.5
	80	***BD169***		15 min	0.5				6	20
		BD139	***BD140***	40/250	0.15					12.5
			BD140.10	63/160	0.15					12.5
	300	***MJE13002***(11)		5/25	1	4	0.7	1	5	40
	400	***MJE13003***(6)(11)		5/25	1	4	0.7	1	5	40
2	80	***BD237***	***BD238***	25 min	1				3	25
	100	***MJE270***(2)(11)	***MJE271***(2)(11)	1.5k min	0.12				6	15
3	60	***MJE181***	***MJE171***	50/250	0.1	0.6 typ	0.12 typ	0.1	50	12.5
	80	***BD179***	***BD180***	40/250	0.15				3	30
		MJE182(6)	***MJE172***(6)	50/250	0.1	0.6 typ	0.12 typ	0.1	50	12.5
	200	***BUY49P***		30 min	0.5				25	20
4	40	***MJE521***	***MJE371***	40 min	1					40
	45	***BD437***	***BD438***	40 min	2				3	36
			BD776(2)	750 min	2				20	15
	60		BD440	25 min	2				3	36
		BD677(2)	***BD678***(2)	750 min	1.5					40
		BD677A(2)	***BD678A***(2)	750 min	2					40
		BD787	BD788	20 min	2				50	15
		BD777(2)	***BD778***(2)	750 min	2				20	15
		2N5191	***2N5194***	25/100	1.5	0.4 typ	0.4 typ	1.5	2	40
		MJE800(2)	***MJE700***(2)	750 min	1.5				1(1)	40
		2N6038(2)	***2N6035***(2)	750/18k	2	1.7 typ	1.2 typ	2	25	40
	80	***2N5192***	***2N5195***	25/100	1.5	0.4 typ	0.4 typ	1.5	2	40
		BD441	***BD442***	15 min	2				3	36
		BD679(2)	***BD680***(2)	750 min	1.5					40
		BD679A(2)	***BD680A***(2)	750 min	2					40
		BD789	***BD790***	10 min	2				40	15

(1)$|h_{FE}|$ @ 1 MHz
(2)Darlington
(6)Available as preferred chip
(11)Case 77, Style 3

Devices listed in bold, italic are Motorola preferred devices.

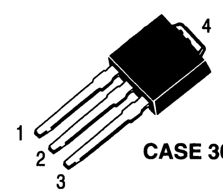
Table 6. Plastic TO-225 Type (Formerly TO-126 Type) (continued)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
4	80	***BD779***[2]	***BD780***[2]	750 min	2				20	15
		MJE240	***MJE250***	40/200	0.2	0.15 typ	0.07 typ	2	40	15
		MJE241	***MJE251***	40/120	0.2	0.15 typ	0.07 typ	2	40	15
		MJE802[2]	***MJE702***[2]	750 min	1.5				1[1]	40
		MJE803[2]	MJE703[2]	750 min	2				1[1]	40
		2N6039[2]	***2N6036***[2]	750/18k	2	1.7 typ	1.2 typ	2	25	40
	100	***BD681***[2]	***BD682***[2]	750 min	1.5					40
		BD791	***BD792***	10 min	2				40	15
		MJE243	***MJE253***	40/120	0.2	0.15 typ	0.07 typ	2	40	15
5	25	***MJE200***[6]	***MJE210***[6]	45/180	2	0.13 typ	0.035 typ	2	65	15



CASE 369A-13[13]

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR



CASE 369-07[12]

Table 7. DPAK – Surface Mount Power Packages

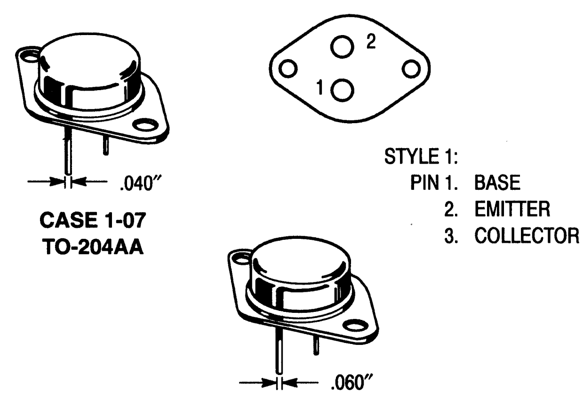
I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
0.5	300	***MJD340***	***MJD350***	30/240	0.05					15
1	250	***MJD47***		30/150	0.3	2	0.2	0.3	10	15
	350		***MJD5731***	30/175	0.3	1.5	0.2	0.3	10	15
	400	***MJD50***		30/150	0.3	2	0.2	0.3	10	15
1.5	400	***MJD13003***		5/25	1	4	0.7	1	4	15

[1]$|h_{FE}|$ @ 1 MHz
[2]Darlington
[6]Available as preferred chip
[12]Case 369-07 may be ordered by adding -1 suffix to part number.
[13]Case 369A-13 may be ordered as tape and reel by adding a "T4" suffix; 2500 units/reel.

Devices listed in bold, italic are Motorola preferred devices.

Table 7. DPAK – Surface Mount Power Packages (continued)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	Resistive Switching t_f µs Max	Resistive Switching @ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
2	100	***MJD112***(2)	***MJD117***(2)	1000 min	2	1.7	1.3	2	25(1)	20
3	40	***MJD31***	***MJD32***	10 min	1	0.6	0.3	1	3	15
	100	***MJD31C***	***MJD32C***	10 min	1	0.6	0.3	1	3	15
4	45	***MJD148***		30 min	4				3	20
	80	***MJD6039***(2)	***MJD6036***(2)	1k/12k	2	1.7	1.2	2	25	20
	100	***MJD243***	***MJD253***	40/180	0.2	0.16	0.04	1	40	12.5
5	25	***MJD200***	***MJD210***	45/180	2	0.15	0.04	2	65	12.5
6	100	***MJD41C***	***MJD42C***	15/75	3	0.4	0.15	3	3	20
8	80	***MJD44H11***	***MJD45H11***	40 min	4	0.5	0.14	5	50 typ	20
	100	***MJD122***(2)	***MJD127***(2)	1k/12k	4	1.5	2	4	4(1)	20
10	60	***MJD3055***	***MJD2955***	20/100	4	1.5	1.5	3	2	20
	80	***MJD44E3***(2)		1k min	5	2	0.5	10		20



CASE 197A-03 TO-204AE
(Used for high current types at end of table. See types w/footnote(16).)

Table 8. Metal TO-204 (Formerly TO-3), TO-204AE

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	Resistive Switching t_f µs Max	Resistive Switching @ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
4	200	MJ15018	MJ15019	30 min	1				20	150
	250	***MJ15020***	***MJ15021***	30 min	1				20	150
5	500/1000	***MJ16002A***		5 min	5	3	0.3	3		125
	700/1500	***BU208A***		2.5 min	4.5	8 typ	0.4 typ	4.5	4 typ	90

(1)$|h_{FE}|$ @ 1 MHz
(2)Darlington
(8)When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.
(12)Case 369-07 may be ordered by adding -1 suffix to part number.
(13)Case 369A-13 may be ordered as tape and reel by adding a "T4" suffix; 2500 units/reel.

Devices listed in bold, italic are Motorola preferred devices.

Table 8. Metal TO-204 (Formerly TO-3), TO-204AE (continued)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min[8]	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
6	100	***2N5758***		25/100	3	0.7 typ	0.5 typ	3	1	150
8	60	MJ1000[2]	MJ900[2]	1k min	3					90
		2N6055[2]	2N6053[2]	750/18k	4	1.5 typ	1.5 typ	4	4[1]	100
	80	***MJ1001***[2]	***MJ901***[2]	1k min	3					90
	80	***2N6056***[2]	***2N6054***[2]	750/18k	4	1.5 typ	1.5 typ	4	4[1]	100
	380	***MJ6308***		5/20	8	2.3[14]	0.12[14]	5		125
	400		***MJ6503***	15 min	2	2	0.5	4		125
	450/850	***MJ16006***		5 min	8	2.5	0.25	5		150
	450/1000	***MJ16008***		7 min	8	2.2	0.25	5		150
	500/1000	MJ16006A		5 min	8	3	0.4	5		150
10	60	2N3715	2N3791	30 min	3	0.3 typ	0.4 typ	5	4	150
		2N5877	2N5875	20/100	4	1	0.8	4	4	150
		MJ3000[2]	MJ2500[2]	1k min	5					150
	80	***2N3716***[6]	***2N3792***[6]	30 min	3	0.3 typ	0.4 typ	5	4	150
		2N5878	***2N5876***	20/100	4	1	0.8	4	4	150
		MJ3001[2]	***MJ2501***[2]	1k min	5					150
	140	***2N3442***		20/70	4					117
	250	***MJ15011***	***MJ15012***	20/100	2					200
	300	***MJ3041***[2]		250 min	2.5					175
	325	***MJ413***		20/80	0.5				2.5	125
		MJ423		30/90	1				2.5	125
	350	MJ13014		8/20	5	2	0.5	5		150
	400	***BU323A***[2]		150 min	6	7.5 typ	5.2 typ	6		175
		MJ10007[2]		30/300	5	1.5	0.5	5	10[1]	150
		MJ10012[2]		100/2k	6	15	15	6		175
		MJ13015		8/20	5	2	0.5	5		150
	600	***MJ10014***[2]		10/250	10	2.5	0.8	10		175
	800/1500	***MJ16018***		4 min	5	4.5 typ	0.2 typ	5		150
12	60	2N6057[2]	2N6050[2]	750/18k	6	1.6 typ	1.5 typ	6	4[1]	150
	80	2N6058[2]	2N6051[2]	750/18k	6	1.6 typ	1.5 typ	6	4[1]	150
	100	***2N6059***[2][6]	***2N6052***[2][6]	750/18k	6	1.6 typ	1.5 typ	6	4[1]	150

(1) $|h_{FE}|$ @ 1 MHz
(2) Darlington
(6) Available as preferred chip
(8) When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.
(14) Inductive switching

Devices listed in bold, italic are Motorola preferred devices.

Table 8. Metal TO-204 (Formerly TO-3), TO-204AE (continued)

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
15	60	***2N3055***(6)	***MJ2955***(6)	20/70	4	0.7 typ	0.3 typ	4	2.5	115
		2N3055A	***MJ2955A***	20/70	4				0.8	115
		2N6576(2)		2k/20k	4	2	7	10	10-200(1)	120
		2N5881	2N5879	20/100	6	1	0.8	6	4	160
	80	***2N5882***(6)	***2N5880***(6)	20/100	6	1	0.8	6	4	160
	90	***2N6577***(2)		2k/20k	4	2	7	10	10-200(1)	120
	120	***MJ15015***(6)	***MJ15016***	20/70	4	0.7 typ	0.3 typ	4	1	180
		2N6578(2)		2k/20k	4	2	7	10	10-200(1)	120
	140	***MJ15001***	***MJ15002***	25/150	4				2	200
	150	MJ11018(2)	MJ11017(2)	100 min	15				3(1)	175
	200	***BUX41***		8 min	8	1.5	0.4	8	8	120
		MJ11020(2)		100 min	15				3(1)	175
		MJ3281A	***MJ1302A***	60/175	0.1				30 typ	250
	250	***MJ11022***(2)(6)	***MJ11019***(2)(6)	100 min	15				3(1)	175
			MJ11021(2)	6/30	10	4	0.7	10	6 to 24	175
	350	***2N6251***		6/50	10	3.5	1	10	2.5	175
	400/850	***BUX48***		8 min	10	2	0.4	10		175
		2N6547		6/30	10	4	0.7	10	6 to 24	175
	400/650	***MJ16110***		6/20	15	0.8 typ	0.1 typ	10		175
	450/1000	***BUX48A***		8 min	8	2	0.4	10		175
	450/850	***MJ16010***		5 min	15	1.2 typ	0.2 typ	10		175
		MJ16012(6)		7 min	15	0.9 typ	0.15 typ	10		175
		2N6836		10/30	10	3	0.35	10	10	175
	500/1000	***MJ16010A***		5 min	15	3	0.4	10		175
16	120	2N5630	2N6030	20/80	8	1.2 typ	1.2 typ	8	1	200
	140	***2N3773***(6)	***2N6609***	15/60	8	1.1 typ	1.5 typ	8	4	150
		2N5631	***2N6031***(6)	15/60	8	1.2 typ	1.2 typ	8	1	200
	200	MJ15022	MJ15023	15/60	8				5	250

(1)$|h_{FE}|$ @ 1 MHz
(2)Darlington
(6)Available as preferred chip
(8)When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.

Devices listed in bold, italic are Motorola preferred devices.

Table 8. Metal TO-204 (Formerly TO-3), TO-204AE (continued)

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type NPN	PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	t_f µs Max	@ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
	250	***MJ15024***	***MJ15025***	15/60	8				5	250
		MJ21194	***MJ21193***	25/75	8				4	250
20	60	***2N3772***		15/60	10				2	150
		2N6282(2)	2N6285(2)	750/18k	10	2.5 typ	2.5 typ	10	4(1)	160
	75	2N5039		20/100	10	1.5	0.5	10	60	140
20	80	***2N5303***	***2N5745***	15/60	10	2	1	10	2	200
		2N6283(2)	***2N6286***(2)	750/18k	10	2.5 typ	2.5 typ	10	4(1)	160
	90	***2N5038***(6)		20/100	12	1.5	0.5	12	60	140
	100	***2N6284***(2)(6)	***2N6287***(2)(6)	750/18k	10	2.5 typ	2.5 typ	10	4(1)	160
	140	***MJ15003***(6)	***MJ15004***(6)	25/150	5				2	250
	200	***BUV11***		10 min	12	1.8	0.4	12	8	150
	350	***MJ10000***(2)		40/400	10	3	1.8	10	10(1)	175
		MJ10004(2)		40/400	10	1.5	0.5	10	10(1)	175
	400	***MJ10001***(2)		40/400	10	3	1.8	10	10(1)	175
		MJ10005(2)		40/400	10	1.5	0.5	10	10(1)	175
		MJ13333		10/60	5	4	0.7	10		175
	450	***MJ10008***(2)		30/300	10	2	0.6	10	8(1)	175
	450/850	***MJ16014***		5 min	20	2.7	0.35	20		250
		MJ16016		7 min	20	2.2	0.25	20		250
	500	***MJ10009***(2)		30/300	10	2	0.6	10	8(1)	175
		MJ13335		10/60	5	4	0.7	10		175
25	60	2N5885	2N5883	20/100	10	1	0.8	10	4	200
	80	***2N5886***(6)	***2N5884***(6)	20/100	10	1	0.8	10	4	200
			2N6436	30/120	10	1	0.25	10	40	200
	100	***2N6338***	***2N6437***	30/120	10	1	0.25	10	40	200
	120	***2N6339***(6)	***2N6438***(6)	30/120	10	1	0.25	10	40	200
	140	2N6340		30/120	10	1	0.25	10	40	200
	150	***2N6341***		30/120	10	1	0.25	10	40	200

(1)h_{FE} @ 1 MHz
(2)Darlington
(6)Available as preferred chip
(8)When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.

Devices listed in bold, italic are Motorola preferred devices.

Table 8. Metal TO-204 (Formerly TO-3), TO-204AE (continued)

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	Resistive Switching t_f µs Max	Resistive Switching @ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
30	40	***2N3771***		15/60	15				2	150
		2N5301	2N4398	15/60	15	2	1	10	2	200
	60	***2N5302***	***2N4399***	15/60	15	2	1	10	2	200
		MJ11012(2)	MJ11011(2)	1k min	20				4(1)	200
	90	***BUX39***		8 min	20	1	0.25	20	8	120
		MJ11014(2)	***MJ11013***(2)	1k min	20				4(1)	200
	100	***2N6328***		6/30	30				3	200
		MJ802	***MJ4502***	25/100	7.5				2	200
	120	***MJ11016***(2)(6)	***MJ11015***(2)(6)	1k min	20				4(1)	200
	325	BUV23		8 min	16	1.8	0.4	16	8	250
	400/1000	***BUS98***		8 min	20	2.3	0.4	20		250
		BUX98		8 min	20	3	0.8	20		250
	450/850	***MJ16020***(16)		5 min	30	1.8	0.2	20		250
		MJ16022(16)		7 min	30	1.5	0.15	20		250
	450/1000	***BUS98A***		8 min	16	2.3	0.4	16		250
		BUX98A		8 min	16	3	0.8	16		250
40	200	***BUV21***(16)		10 min	25	1.8	0.4	25	8	150
	250	***BUV22***(16)		10 min	20	1.1	0.35	20	8	250
	350	***MJ10022***(2)(16)		50/600	10	2.5	0.9	20		250
	400	***MJ10023***(2)(16)		50/600	10	2.5	0.9	20		250
50	60	***2N5685***(16)	***2N5683***(16)	15/60	25	0.5 typ	0.3 typ	25	2	300
		MJ11028(2)(16)	MJ11029(2)(16)	400 min	50					300
	80	***2N5686***(16)	***2N5684***(16)	15/60	25	0.5 typ	0.3 typ	25	2	300
	90	***MJ11030***(2)(16)	***MJ11031***(2)(16)	400 min	50					300
	100	***2N6274***(16)	***2N6378***(16)	30/120	20	0.8	0.25	20	30	250
	120	***2N6275***(16)	***2N6379***(16)	30/120	20	0.8	0.25	20	30	250
		MJ11032(2)(16)	***MJ11033***(2)(16)	400 min	50					300
	125	***BUV20***(16)		10 min	50	1.2	0.25	50	8	250
		BUV60(16)		10 min	80	1.1	0.25	80		250
	150	***2N6277***(16)		30/120	20	0.8	0.25	20	30	250
	400	***MJ10015***(2)(16)		10 min	40	2.5	1	20		250
	500	***BUT34***(2)(16)		15 min	32	3	1.5	32		250
		MJ10016(2)(16)		10 min	40	2.5	1	20		250

(1)$|h_{FE}|$ @ 1 MHz
(2)Darlington
(6)Available as preferred chip
(8)When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.
(16)Case 197A-03 (TO-204AE)

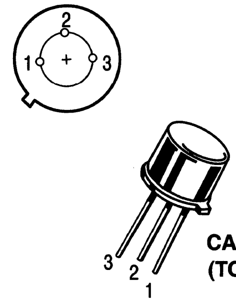
Devices listed in bold, italic are Motorola preferred devices.

Table 8. Metal TO-204 (Formerly TO-3), TO-204AE (continued)

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min(8)	Device Type		h_{FE} Min/Max	@ I_C Amp	Resistive Switching			f_T MHz Min	P_D (Case) Watts @ 25°C
		NPN	PNP			t_s µs Max	t_f µs Max	@ I_C Amp		
56	400	***BUT33***(2)(16)		20 min	36	3.3	1.6	36		250
60	60	MJ14000(16)	MJ14001(16)	15/100	50					300
	80	***MJ14002***(16)	***MJ14003***(16)	15/100	50					300
	200	***MJ10020***(2)(16)		75 min	15	3.5	0.5	30		250
	250	***MJ10021***(2)(16)		75 min	15	3.5	0.5	30		250
70	125	***BUS50***(16)		15 min	50	1.5	0.3	70		350
80	100	BUV18A(16)		10 min	80	1.1	0.25	80		250

(2)Darlington
(8)When two voltages are given, the format is $V_{CEO(sus)}/V_{CES}$.
(16)Case 197A-03 (TO-204AE)

Devices listed in bold, italic are Motorola preferred devices.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
(Pin 3 Connected To Case)

CASE 79-04
(TO-205AD)

Table 9. Metal TO-205 (Formerly TO-39)

I_CCont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	Resistive Switching t_s µs Max	Resistive Switching t_f µs Max	Resistive Switching @ I_C Amp	f_T MHz Min	P_D (Case) Watts @ 25°C
0.5	300		***MJ4646***	20 min	0.5	0.72*		0.05	40	5
	400		***MJ4647***	20 min	0.5	0.72*		0.05	30	5
3	40		***2N3719***	25/180	1	0.4*		1	60	6
			2N3867	40/200	1.5	0.4*		1.5	60	6
	60		***2N3720***	25/180	1	0.4*		1	60	6
			2N3868	30/150	1.5	0.4*		1.5	60	6
	80		***2N6303***	30/150	1.5	0.4*		1.5	60	6
5	80	***2N5336***	***2N6190***	30/120	2	2	0.2	2	30	6
		2N5337	***2N6191***	60/240	2	2	0.2	2	30	6
	100	***2N5338***		30/120	2	2	0.2	2	30	10
		2N5339	***2N6193***	60/240	2	2	0.2	2	30	6

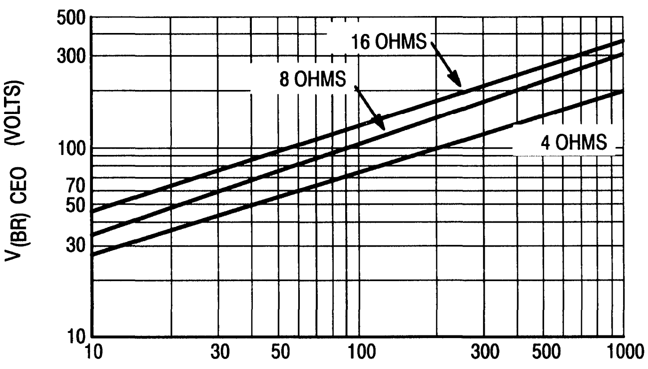
* t_{off}

Devices listed in bold, italic are Motorola preferred devices.

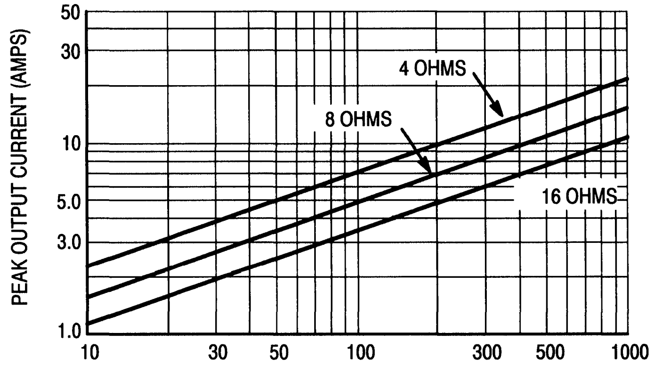
Audio

General Design Curves For Power Audio Output Stages

$V_{(BR)CEO}$ Required on Output and Driver Transistor
versus
Output Power for 4, 8 and 18 Ohm Load



Output Transistor Peak Collector Current
versus
Output Power for 4, 8 and 16 Ohm Loads



Another important parameter that must be considered before selecting the output transistors is the safe-operating area these devices must withstand. For a complete discussion on these see Application Notes AN484A and AN485.

Table 10. Recommended Power Transistors for Audio/Servo Loads

The Power Transistors shown are provided for reference only and show device capability. The final choice of the Power Transistors used is left to the circuit designer and depends upon the particular safe-operating area required and the mounting and heat sinking configuration used.

RMS Power Output	NPN	PNP	Case	P_D Watts @ 25°C	V_{CEO}	h_{FE} @ Min/Max	I_C Amps	f_T MHz Typ	ISB Volts/Amps
To 25W	MJE15030	MJE15031	TO-220	50	150	20 min	4	70	14/3.6
25 to 50W	2N3055A	MJ2955A	TO-204	120	120	20/70	4	3	60/2
	MJ15001	MJ15002	TO-204	200	140	25/150	4	3	40/5
50 to 100W	MJ15015	MJ15016	TO-204	180	120	20/70	4	3	60/3
	MJ15003	MJ15004	TO-204	250	140	25/150	5	3	100/1
	MJ15020	MJ15021	TO-204	150	250	30 min	1	20	50/3
Over 100W	MJ15024	MJ15025	TO-204	250	250	15/60	8	8	80/2.2
	MJ3281A	MJ1302A	TO-204	250	200	60/175	0.1	30	50/4
	MJL3281A	MJL1302A	340G-01	150	200	60/175	0.1	30	40/4
	MJ21193	MJ21194	TO-204	250	250	25/75	8	7	100/2
	MJL21193	MJL21194	340G-01	200	200	25/75	8	7	100/2

Devices listed in bold, italic are Motorola preferred devices.

CRT Deflection

A new family of SCANSWITCH™ bipolar power transistors, containing state-of-the-art application specific die, and a series of damper diodes have been designed for high and very high resolution horizontal deflection circuits. The horizontal output transistors minimize fall time, storage time and dynamic desaturation; turn-off energy is specified for optimum design considerations. The power rectifiers, designed for use as damper diodes in horizontal deflection circuits, are enhanced for turn-on overshoot voltage and forward recovery time. Overall circuit performance is optimized when these damper diodes are paired with their specific horizontal output transistors.

Dynamic Desaturation

A large amount of power dissipation in horizontal deflection output circuitry occurs during the transistor's turn-off. Most of this dissipation happens as the collector-emitter voltage rises during storage time. Since there is a tendency for the voltage waveform to be soft and rounded as opposed to abrupt and square. The parameter used to describe this behavior is dynamic desaturation and is shown in Figure A as the area below the dashed line. The SCANSWITCH series of transistors has been designed to minimize dynamic desaturation and simultaneously avoid collector current tailing.

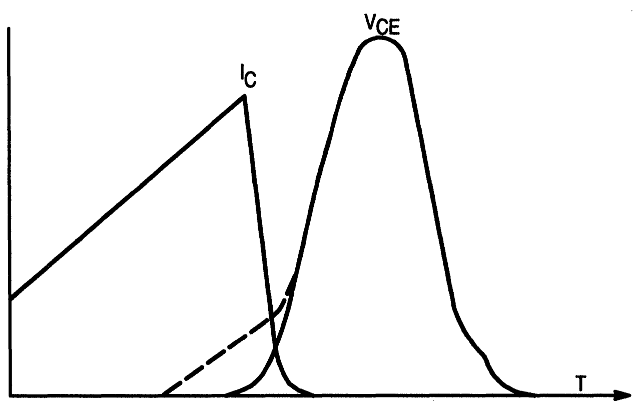


Figure A. Dynamic Desaturation

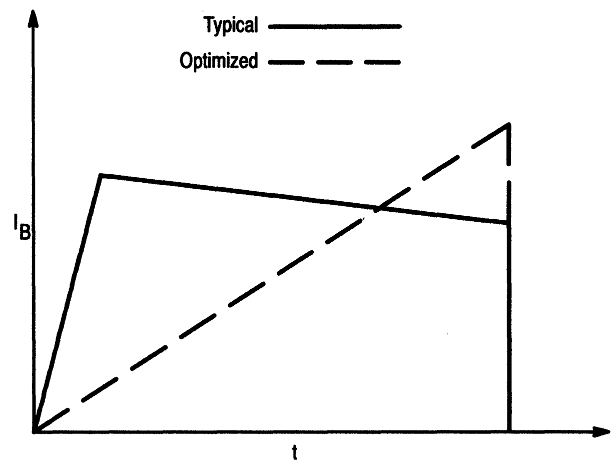


Figure B. Base Drive Comparison

Optimized Base Drive

The base drive can be optimized to take full advantage of the advanced device design of the SCANSWITCH series of transistors. The five conditions necessary for optimization are:

1) Provide adequate drive just prior to turn-off to minimize dynamic desaturation.
2) Avoid overdrive during any portion of the turn-on time to avoid collector current tailing.
3) Provide reverse base current that is independent of forward base current so full transistor performance can be realized.
4) Provide for a controlled rate of transition from forward to reverse drive to avoid tailing.
5) Avalanche the base-emitter junction during fall time.

Typical techniques for driving horizontal outputs use a base drive waveform which results in overdrive at turn-on and underdrive just prior to turn-off. An optimized base drive is one with the same forced gain throughout the turn-on period. A comparison of the two drives is shown in Figure B.

CRT Deflection (continued)

Table 11. Horizontal CRT Deflection Transistor Selector Guide

Monitor Description	Horizontal Scan Freq.	CRT Size	Pixel Size	Transistor	Diode
Monochrome					
Low Resolution to Mid Resolution	15-50 kHz	12-15 in.	>1024 x 768	MJE/MJF16204 MJE/MJF16205(15) MJ12004	MUR860E MUR880E
High Resolution	50-100 kHz	15-19 in.	>2000 x 1600	MJW16206 MJW16210 MJW16212	MR/MUR10120E MR/MUR10120E MR/MUR10150E
Ultra-High Resolution	>100 kHz	19-24 in.	>2000 x 2000	MJW16214(15) MJW16216(15) MJW16218(15)	MR/MUR10120E MR/MUR10120E MR/MUR10150E
Color					
Low Resolution	15-22 kHz	12-15 in.	>320 x 200	BU508A	MUR5150E
Mid Resolution	22-50 kHz	12-15 in.	>1024 x 768	BU508A	MUR5150E
High Resolution	50-90 kHz	17-27 in.	>1280 x 1024	MJW16206 MJW16210 MJW16212	MR/MUR10120E MR/MUR10120E MR/MUR10150E
Ultra-High Resolution	>90 kHz	17-27 in.	>1600 x 1280	MJW16210(17) MJW16218(15)	MUR8100E(17) MR/MUR10150E

(15)To be introduced
(17)Use two in parallel

Rectifiers

In Brief . . .

Continuing investment in research and development for discrete products has led to a rectifier manufacturing facility that matches the precision and versatility of the most advanced integrated circuits. As a result, Motorola's silicon rectifiers span all applications categories with quality levels capable of passing the most stringent environmental tests – including those for automotive under-hood applications.

Product Highlights:

- *Application specific rectifiers — MEGAHERTZ™ series rectifiers for high frequency switching power supplies and automotive transient suppressors.*
- *Schottky rectifiers for low voltage (15 to 200 volts), high current (to 600 amps) requirements in switching power supplies.*
- *Schottky rectifiers with low forward voltage drop (0.3 to 0.6 V).*
- *Fast and Ultrafast rectifiers with reverse recovery times as low as 25 ns to complement the Schottky devices for higher voltage requirements in high frequency applications.*
- *A full line of low-cost, general-purpose rectifiers with forward currents from 1 to 40 amps and breakdown voltages from 50 to 1000 volts.*
- *A wide variety of package options to match virtually any potential requirement.*

Page

Application Specific Rectifiers

The focus for Rectifier Products continues to be on Schottky and Ultrafast technologies, with process and packaging improvements to achieve greater efficiency in high frequency switching power supplies, and high current mainframe supplies. Our new product thrust is intended to be more "application specific" than in the past, while continuing to strive for broad market acceptance.

Table 1. MEGAHERTZ

MEGAHERTZ Series — This group of ultrafast rectifiers is designed to provide improved efficiency in very high frequency switching power supplies.

Device	I_O Amps	V_{RRM} (Volts)	Maximum		t_{rr} (Nanosecond)
			V_F @ Rated I_O and Temp. (Volts)	I_R @ Rated V_{RRM}/25°C (mAmps)	
MURH840CT	8	400	1.7	0.01	28
MURH860CT	8	600	2.0	0.01	28

Table 2. Automotive Transient Suppressors

Automotive transient suppressors are designed for protection against over-voltage conditions in the auto electrical system including the "LOAD DUMP" phenomenon that occurs when the battery open circuits while the car is running.

Device	I_O Amps	V_{RRM} (Volts)	$V_{(BR)}$ (Volts)	I_{RSM}(7) (Amps)	T (°C)
MR2535L	35	20	24–32	110	175

Table 3. Low V_F Schottky

State of the art geometry is used in low V_F Schottky devices for improved efficiency in low voltage, high frequency switching power supplies, free-wheeling diodes, and polarity protection diodes.

Device	I_O Amps	V_{RRM} (Volts)	V_F @ Rated I_O and Temperature Volts (Max)	I_R @ Rated V_{RRM} mAmps (Max)	Package
MBR60035CTL	600	35	0.5	10	POWERTAP
MBR20030CTL	200	30	0.39	5	POWERTAP
MBR6030L	60	30	0.38	50	DO-203AB
MBRB2535CTL	25	35	0.41	10	D^2PAK
MBR2535CTL	25	35	0.41	5	TO-220
MBRB2515L	25	15	0.42	15	D^2PAK
MBR2030CTL	20	30	0.40	5	TO-220
MBRD340L	3	40	0.39	0.2	DPAK
MBRD330L	3	30	0.39	0.2	DPAK
MBRS130LT3	1	30	0.395	1	SMB

(5)Schottky barrier device.
(7)Time constant = 10 ms, Duty Cycle ≤ 1%, T_C = 25°C.

Devices listed in bold, italic are Motorola preferred devices.

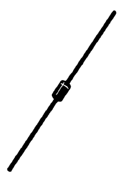
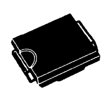
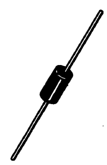
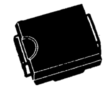
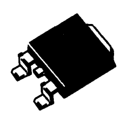
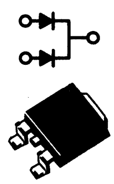
Schottky Rectifiers

SWITCHMODE™ Schottky power rectifiers with the high speed and low forward voltage drop characteristic of Schottky's metal/silicon junctions are produced with ruggedness and temperature performance comparable to silicon-junction rectifiers. Ideal for use in low-voltage, high-frequency power supplies, and as very fast clamping diodes, these devices feature switching times less than 10 ns, and are offered in current ranges from 1 to 600 amperes, and reverse voltages to 200 volts.

In some current ranges, devices are available with junction temperature specifications of 125°C, 150°C, 175°C. Devices with higher T_J ratings can have significantly lower leakage currents, but higher forward-voltage specifications. These parameter tradeoffs should be considered when selecting devices for applications that can be satisfied by more than one device type number.

All devices are connected cathode-to-case or cathode-to-heatsink, where applicable. Reverse polarity may be available on some devices upon special request. Contact your Motorola representative for more information.

Table 4. Schottky Rectifiers

	I_O, Average Rectified Forward Current (Amperes)[1]							
	1		3				5	6
	59-04 Plastic Cathode = Polarity Band	403A-03 SMB Cathode = Notch	267-03 Plastic Cathode = Polarity Band		403-03 SMC Cathode = Notch	369A-13 DPAK Style 3	60-01 Metal Style 1	369A-13 DPAK Style 3
V_{RRM} (Volts)								
20	***1N5817***	MBRS120T3	1N5820	MBR320	MBRS320T3	MBRD320	1N5823	MBRD620CT
25								
30	1N5818	***MBRS130LT3**** MBRS130T3	1N5821	MBR330	MBRS330T3	MBRD330	1N5824	MBRD630CT
35						***MBRD330L****		
40	***1N5819***	***MBRS140T3***	***1N5822***	***MBR340***	***MBRS340T3***	***MBRD340***	***1N5825***	***MBRD640CT***
45						***MBRD340L***		
50	MBR150			MBR350		MBRD350		MBRD650CT
60	MBR160			***MBR360***		***MBRD360***		***MBRD660CT***
70	MBR170			MBR370				
80	MBR180			MBR380				
90	MBR190			MBR390				
100	***MBR1100***	***MBRS1100T3***		***MBR3100***				
I_{FSM} (Amperes)	25	40	80	80	80	75	500	75
Max V_F @ $I_{FM} = I_O$	0.6[2] T_L = 25°C	0.6[2]/0.395* T_C = 25°C	0.525[2] T_L = 25°C	0.74[2] T_L = 25°C	0.525[2] T_L = 25°C	0.45/0.390* T_C = 125°C	0.38[2] T_C = 25°C	0.85 T_C = 125°C
T_J (Max) °C	125	125	125	150	125	150	125	150

(1) I_O is total device output current.
(2) Values are for 40 volt units, lower voltage parts exhibit lower V_F.

Devices listed in bold, italic are Motorola preferred devices.

Schottky Rectifiers (continued)

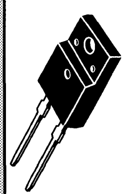
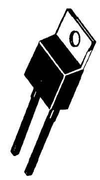
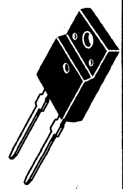
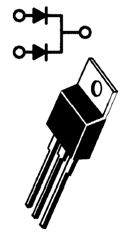
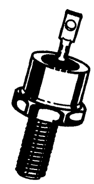
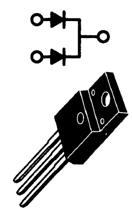
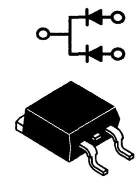
There are many other standard features in Motorola Schottky rectifiers that give added performance and reliability.

1. GUARDRINGS are included in all Schottky die for reverse voltage stress protection from high rates of dv/dt to virtually eliminate the need for snubber networks. The guardring also operates like a zener and avalanches when subjected to voltage transients.

2. MOLYBDENUM DISCS on both sides of the die minimize fatigue from power cycling in all metal products. The plastic TO-220 devices have a special solder formulation for the same purpose.

3. QUALITY CONTROL monitors all critical fabrication operations and performs selected stress tests to assure constant processes.

Table 4. Schottky Rectifiers (continued)

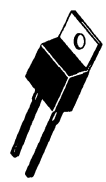
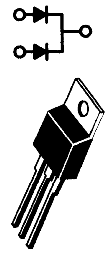
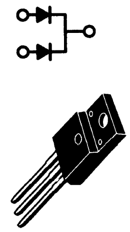
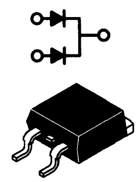
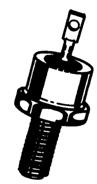
	I_O, Average Rectified Forward Current (Amperes)(1)							
	7.5		10		15			
V_{RRM} (Volts)	221E-01 Style 1 	221B-02 (TO-220AC) Style 1 		221E-01 Style 1 	221A-06 (TO-220AB) Style 6 	56-03 (DO-203AB) Style 2 	221D-02 Style 3 	418B-02 D2PAK Style 3 
15								
20						1N5826		
30						1N5827		
35		MBR735	MBR1035		MBR1535CT			
40						***1N5828***		
45	***MBRF745***	***MBR745***	***MBR1045***	***MBRF1045***	***MBR1545CT***		***MBRF1545CT***	***MBRB1545CT***
50								
60			***MBR1060***					
70			MBR1070					
80			MBR1080					
90			MBR1090					
100			***MBR10100***					
200								
I_{FSM} (Amperes)	150	150	150	150	150	500	150	150
Max V_F @ $I_{FM} = I_O$	0.57 T_C = 125°C	0.57 T_C = 125°C	0.57 T_C = 125°C	0.57 T_C = 125°C	0.72 T_C = 125°C	0.5 T_C = 125°C	0.57 T_C = 125°C	0.57 T_C = 125°C
T_J (Max) °C	150	150	150	150	150	150	150	150

(1)I_O is total device output current.
(2)Values are for 40 volt units, lower voltage parts exhibit lower V_F.

Devices listed in bold, italic are Motorola preferred devices.

Schottky Rectifiers (continued)

Table 4. Schottky Rectifiers (continued)

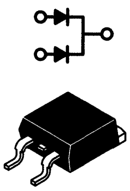
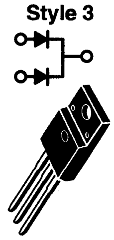
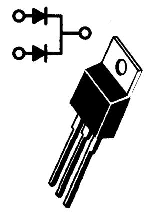
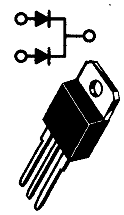
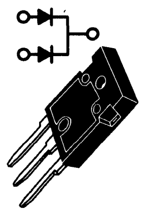
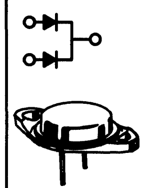
V_{RRM} (Volts)	I_O, Average Rectified Forward Current (Amperes)(1) 16	20			25	
	221B-02 (TO-220AC) Style 1 	221A-06 (TO-220AB) Style 6 	221D-02 Style 3 	418B-02 D^2PAK Style 3 	56-03 (DO-203AA) Style 2 	
15						
20					1N5829	
25		***MBR2030CTL***			1N5830	1N6095
30	MBR1635	MBR2035CT				
35					***1N5831***	***1N6096***
40	***MBR1645***	***MBR2045CT***				***SD41***
45			***MBRF2045CT***			
50		***MBR2060CT***				
60		MBR2070CT	***MBRF2060CT***	***MBRB2060CT***		
70		MBR2080CT				
80		MBR2090CT				
90		***MBR20100CT***				
100		***MBR20200CT***	***MBRF20100CT***			
200			***MBRF20200CT***	***MBRB20100CT***		
I_{FSM} (Amperes)	150	150	150	150	800	400
Max V_F @ $I_{FM} = I_O$	0.57 $T_C = 125°C$	0.72(2) $T_C = 125°C$	0.57/0.85/0.9 $T_C = 125°C$	0.85 $T_C = 125°C$	0.48(2) $T_C = 25°C$	0.48(2) $T_C = 25°C$
T_J (Max) °C	150	150	150	150	125	125

(1)I_O is total device output current.
(2)Values are for 40 volt units, lower voltage parts exhibit lower V_F.

Devices listed in bold, italic are Motorola preferred devices.

Schottky Rectifiers (continued)

Table 4. Schottky Rectifiers (continued)

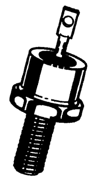
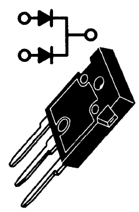
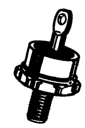
	I_O, Average Rectified Forward Current (Amperes)[1]						
	25			30			
V_{RRM} (Volts)	418B-02 D^2PAK Style 3 	221D-02 ISOLATED TO-220 Style 3 	221A-06 (TO-220AB) Style 6 		340D-01 (TO-218AC) Style 2 	340F-03 (TO-247) Style 2 	11-03 (TO-204AA) Style 4 
15	***MBRB2515L*(3)***						
20							MBR3020CT
25							
30			***MBR2535CTL***				
35	***MBRB2535CTL****	MBRF2535CT		MBR2535CT	MBR3035PT	MBR3035WT	MBR3035CT
40							
45	***MBRB2545CT***	***MBRF2545CT***		***MBR2545CT***	***MBR3045PT***	***MBR3045WT***	***MBR3045CT*** SD241
50							
60							
70							
80							
90							
100							
200							
I_{FSM} (Amperes)	150	150	150	300	400	350	400
Max V_F @ $I_{FM} = I_O$	0.41*/0.73 T_C = 125°C	0.62 @ 12.5 A T_C = 125°C	0.72[2] T_C = 125°C	0.73 T_C = 125°C	0.72 T_C = 125°C	0.72 T_C = 125°C	0.72 T_C = 125°C
T_J (Max) °C	150	150	150	150	150	150	150

(1) I_O is total device output current.
(2) Values are for 40 volt units, lower voltage parts exhibit lower V_F.
(3) Single Rectifier Device

Devices listed in bold, italic are Motorola preferred devices.

Schottky Rectifiers (continued)

Table 4. Schottky Rectifiers (continued)

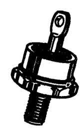
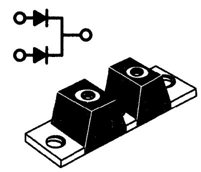
V_{RRM} (Volts)	I_O, Average Rectified Forward Current (Amperes)(1)							
	35	40		50	60		65	75
	56-03 (DO-203AA) Style 2 	340F-03 (TO-247) Style 2 	257-01 (DO-203AB) Style 2 					
15						MBR6015L		
20	MBR3520		1N5832			MBR6020L		
25						MBR6025L		
30			1N5833	1N6097		***MBR6030L***		
35	MBR3535				MBR6035		MBR6535	MBR7535
40			***1N5834***	***1N6098***				
45	***MBR3545***	***MBR4045WT***		***SD51***	***MBR6045***		***MBR6545***	***MBR7545***
50								
60								
70								
80								
90								
100								
I_{FSM} (Amperes)	600	400	800	800	800	1000	800	1000
Max V_F @ $I_{FM} = I_O$	0.55 $T_C = 25°C$	0.75 $T_C = 125°C$	0.59 $T_C = 25°C$	0.86 @ 157A $T_C = 70°C$	0.6(2) $T_C = 125°C$	0.38 $T_C = 150°C$	0.62 $T_C = 150°C$	0.6(2) $T_C = 125°C$
T_J (Max) °C	150	150	125	125	150	150	175	150

(1) I_O is total device output current.
(2) Values are for 40 volt units, lower voltage parts exhibit lower V_F.

Devices listed in bold, italic are Motorola preferred devices.

Schottky Rectifiers (continued)

Table 4. Schottky Rectifiers (continued)

V_{RRM} (Volts)	I_O, Average Rectified Forward Current (Amperes)[1]				
	80	120	200	300	600
	257-01 (DO-203AB) Style 2 	357C-03 POWERTAP™ Cathode = Mounting Plate Anode = Terminal 			
15			MBR20015CTL		
20			MBR20020CTL		
25			MBR20025CTL		
30			***MBR20030CTL***		
35	MBR8035	MBR12035CT	MBR20035CT	MBR30035CT	***MBR60035CTL***
40					
45	***MBR8045***	***MBR12045CT***	***MBR20045CT***	***MBR30045CT***	
50		MBR12050CT	MBR20050CT	MBR30050CT	
60		***MBR12060CT***	***MBR20060CT***	***MBR30060CT***	
70					
80					
90					
100					
200					
I_{FSM} (Amperes)	1000	800	1500	800	4000
Max V_F @ $I_{FM} = I_O$	0.59 T_C = 150°C	0.62 T_C = 175°C	0.39/0.71 T_C = 150°C/125°C	0.62 T_C = 175°C	0.50 T_C = 100°C
T_J (Max) °C	175	175	175	175	150

(1) I_O is total device output current.

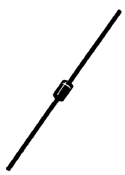
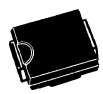
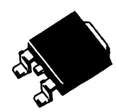
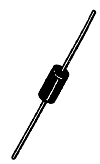
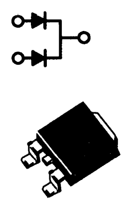
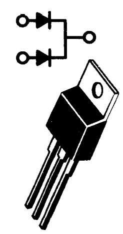
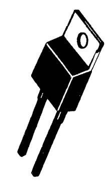
Devices listed in bold, italic are Motorola preferred devices.

Ultrafast Recovery Rectifiers

The Ultrafast Recovery Rectifiers, with reverse times of 25 to 100 nanoseconds, are expanding the SWITCHMODE rectifier family. They complement the broad array of Schottky devices for use in the higher voltage outputs and internal circuitry of switching power supplies as operating frequencies increase from 20 kHz to 250 kHz and beyond. Additional package styles and operating current levels are planned.

All devices are connected cathode-to-case or cathode-to-heatsink, except where noted. Contact your Motorola representative for more information.

Table 5. Ultrafast Recovery Rectifiers

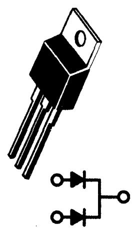
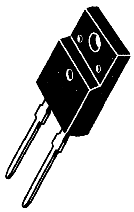
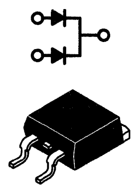
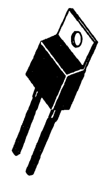
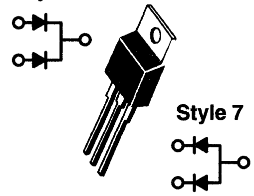
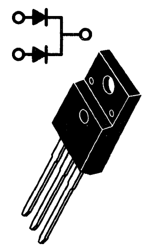
	I_O, Average Rectified Forward Current (Amperes)(1)							
	1		3		4	6		8
V_{RRM} (Volts)	59-04 Plastic Cathode = Polarity Band 	403-03 SMC Cathode = Notch 		369A-13 DPAK Style 3 	267-03 Plastic Cathode = Polarity Band 	369A-13 DPAK Style 3 	221A-06 (TO-220AB) Style 6 	221B-02 (TO-220AC) Style 1 
50	MUR105	MURS105T3	MURS305T3	MURD305	MUR405	MURD605CT	MUR605CT	MUR805
100	MUR110	MURS110T3	MURS310T3	MURD310	MUR410	MURD610CT	MUR610CT	MUR810
150	MUR115	MURS115T3	MURS315T3	MURD315	MUR415	MURD615CT	MUR615CT	MUR815
200	***MUR120***	***MURS120T3***	***MURS320T3***	***MURD320***	***MUR420***	***MURD620CT***	***MUR620CT***	***MUR820***
300	MUR130	MURS130T3	MURS330T3		MUR430			MUR830
400	MUR140	MURS140T3	MURS340T3		MUR440			MUR840
500	MUR150	MURS150T3	MURS350T3		MUR450			MUR850
600	***MUR160***	***MURS160T3***	***MURS360T3***		***MUR460***			***MUR860***
700	MUR170E				MUR470E			MUR870E
800	MUR180E				MUR480E			MUR880E
900	MUR190E				MUR490E			MUR890E
1000	***MUR1100E***				***MUR4100E***			***MUR8100E***
I_{FSM} (Amperes)	35	40	75	75	125	63	75	100
t_{rr} nsec	25/50/75	25/50	25/50	35	25/50/75	35	35	35/60/100
T_J (Max) °C	175	175	175	175	175	175	175	175

(1) I_O is total device output current.

Devices listed in bold, italic are Motorola preferred devices.

Ultrafast Recovery Rectifiers (continued)

Table 5. Ultrafast Recovery Rectifiers (continued)

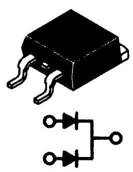
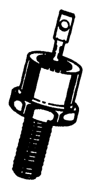
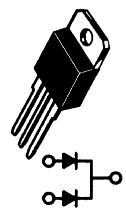
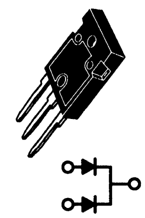
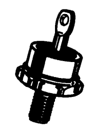
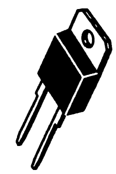
V_{RRM} (Volts)	I_O, Average Rectified Forward Current (Amperes)(1)						
	8			15	16		
	221A-06 (TO-220AB) Style 6 	221E-01 Style 1 	418B-02 D2PAK Style 3 	221B-02 (TO-220AC) Style 1 	221A-06 (TO-220AB) Style 6 	Style 7	221D-02 Style 3 
50				MUR1505	MUR1605CT	MUR1605CTR	
100				MUR1510	MUR1610CT	MUR1610CTR	
150				MUR1515	MUR1615CT	MUR1615CTR	
200		***MURF820***		***MUR1520***	***MUR1620CT***	***MUR1620CTR***	***MURF1620CT***
300				MUR1530	MUR1630CT		
400	***MURH840CT***		***MURHB840CT***	MUR1540	MUR1640CT		
500				MUR1550	MUR1650CT		
600	***MURH860CT***			***MUR1560***	***MUR1660CT***		***MURF1660CT***
700							
800							
900							
1000							
I_{FSM} (Amperes)	100	100	100	200	100	100	100
t_{rr} nsec	28	35	28	35/60	35/85	35	35/85
T_J (Max) °C	175	175	175	175	175	175	175

(1) I_O is total device output current.

Devices listed in bold, italic are Motorola preferred devices.

Ultrafast Recovery Rectifiers (continued)

Table 5. Ultrafast Recovery Rectifiers (continued)

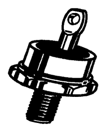
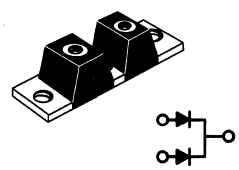
V_{RRM} (Volts)	I_O, Average Rectified Forward Current (Amperes)(1)						
	16	25	30			50	60
	418B-02 D2PAK Style 3 	56-03 (DO-203AA) Style 2 	340D-01 (TO-218AC) Style 2 		340F-03 (TO-247) 	257-01 (DO-203AB) Style 2 	340E-01 (TO-218) Style 1 
50		MUR2505	R710XPT	MUR30005PT		MUR5005	
100		MUR2510	R711XPT	MUR3010PT		MUR5010	
150		MUR2515		MUR3015PT		MUR5015	
200	***MURB1620CT***	***MUR2520***	***R712XPT***	***MUR3020PT***	MUR3020WT	***MUR5020***	MUR6020
300				MUR3030PT			MUR6030
400			R714XPT	***MUR3040PT***	MUR3040WT		***MUR6040***
500				MUR3050PT			
600	***MURB1660CT***			***MUR3060PT***	***MUR3060WT***		
700							
800							
900							
1000							
I_{FSM} (Amperes)	100	500	150	400	350	600	600
t_{rr} nec	35/85	50	100	35	60	50	100
T_J (Max) °C	175	175	150	175	175	175	175

(1)I_O is total device output current.

Devices listed in bold, italic are Motorola preferred devices.

Ultrafast Recovery Rectifiers (continued)

Table 5. Ultrafast Recovery Rectifiers (continued)

V_{RRM} (Volts)	I_O, Average Rectified Forward Current (Amperes)(1)		
	70	100	200
	257-01 (DO-203AB) Style 2 	357C-03 POWERTAP Cathode = Mounting Plate Anode = Terminal 	
50	MUR7005		
100	MUR7010		
150	MUR7015		
200	***MUR7020***	***MUR10020CT***	***MUR20020CT***
300			
400			***MUR20040CT***
500			
600			
700			
800			
900			
1000			
I_{FSM} (Amperes)	1000	400	800
t_{rr} nec	50	50	50
T_J (Max) °C	175	175	175

(1) I_O is total device output current.

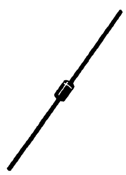
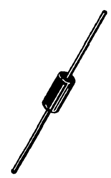
Devices listed in bold, italic are Motorola preferred devices.

Fast Recovery Rectifiers

Fast Recovery Rectifiers are available for designs that require a power rectifier with maximum switching times ranging from 200 ns to 750 ns. These devices are offered in current ranges of 1 to 30 amperes and in voltages to 600 volts.

All devices are connected cathode-to-case or cathode-to-heatsink, where applicable. Reverse polarity may be available on some devices upon special request. Contact your Motorola representative for more information.

Table 6. Fast Recovery Rectifiers

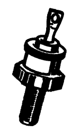
	I_O, Average Rectified Forward Current (Amperes)(1)				
	1	3		5	6
V_{RRM} (Volts)	59-03 Plastic Cathode = Polarity Band 	60-01 Metal Style 1 	267-03 Plastic Cathode = Polarity Band 	194-04 Plastic Style 1 	245A-02 (DO-203AA) Metal Style 2 
50	1N4933(3)	MR830	MR850	MR820	1N3879
100	1N4934(3)	MR831	MR851	MR821	1N3880
200	***1N4935(3)***	***MR832***	***MR852***	***MR822***	***1N3881***
400	1N4936(3)	MR834	MR854	MR824	1N3883
600	***1N4937(3)***	***MR836***	***MR856***	***MR826***	***MR1366***
I_{FSM} (Amps)	30	100	100	300	150
T_A @ Rated I_O (°C)	75	—	90(8)	55(8)	—
T_C @ Rated I_O (°C)	—	100	—	—	100
T_J (Max) °C	150	150	175	175	150
t_{rr} (µs)	0.2	0.2	0.2	0.2	0.2

(1)I_O is total device output.
(3)Package Size: 0.120″ max diameter by 0.260″ max length.
(8)Must be derated for reverse power dissipation. See data sheet.

Devices listed in bold, italic are Motorola preferred devices.

Fast Recovery Rectifiers (continued)

Table 6. Fast Recovery Rectifiers (continued)

V_{RRM} (Volts)	I_O, Average Rectified Forward Current (Amperes)[1]		
	12	20	30
	245A-02 (DO-203AA) Metal Style 2 	42A-01 (DO-203AB) Metal Style 2 	
50	1N3889	1N3899	1N3909
100	1N3890	1N3900	1N3910
200	***1N3891***	***1N3901***	***1N3911***
400	1N3893	1N3903	1N3913
600	***MR1376***	***MR1386***	***MR1396***
I_{FSM} (Amps)	200	250	300
T_A @ Rated I_O (°C)	—	—	—
T_C @ Rated I_O (°C)	100	100	100
T_J (Max) °C	150	150	150
t_{rr} (μs)	0.2	0.2	0.2

(1)I_O is total device output.
(4)Meets mounting configuration of TO-220 outline.

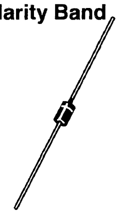
Devices listed in bold, italic are Motorola preferred devices.

General-Purpose Rectifiers

Motorola offers a wide variety of low-cost devices, packaged to meet diverse mounting requirements.

All devices are connected cathode-to-case or cathode-to-heatsink, where applicable. Reverse polarity may be available on some devices upon special request. Contact your Motorola representative for more information.

Table 7. General-Purpose Rectifiers

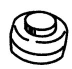
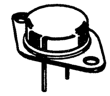
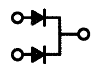
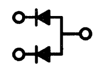
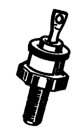
	I_O, Average Rectified Forward Current (Amperes)(1)					
	1	3		6	12	20
V_{RRM} (Volts)	59-03 (DO-41) Plastic Cathode = Polarity Band 	60-01 Metal Style 1 	267-03 Plastic Cathode = Polarity Band 	194-04 Plastic Style 1 	245A-02 (DO-203AA) Metal Style 2 	
50	1N4001(3)	1N4719	1N5400	MR750	MR1120 1N1199,A,B	MR2000
100	1N4002(3)	1N4720	1N5401	MR751	MR1121 1N1200,A,B	MR2001
200	1N4003(3)	1N4721	1N5402	MR752	MR1122 1N1202,A,B	MR2002
400	***1N4004***(3)	***1N4722***	***1N5404***	***MR754***	***MR1124*** ***1N1204,A,B***	***MR2004***
600	1N4005(3)	1N4723	***1N5406***	MR756	MR1126 1N1206,A,B	MR2006
800	1N4006(3)	1N4724	—	MR758	MR1128	MR2008
1000	***1N4007***(3)	***1N4725***		***MR760***	***MR1130***	***MR2010***
I_{FSM} (Amps)	30	300	200	400	300(9)	400
T_A @ Rated I_O (°C)	75	75	T_L = 105	60	—	—
T_C @ Rated I_O (°C)	—	—	—	—	150	150
T_J (Max) °C	175	175	175	175	190	175

(1) I_O is total device output.
(3) Package Size: 0.120″ max diameter by 0.260″ max length.
(9) IFSM is for MR1120 series, 1N1199 = 100, -A = 240, -B = 250.

Devices listed in bold, italic are Motorola preferred devices.

General-Purpose Rectifiers (continued)

Table 7. General-Purpose Rectifiers (continued)

V_{RRM} (Volts)	I_O, Average Rectified Forward Current (Amperes)(1)			
	25	30		40
	193-04 Plastic(10) Cathode = Polarity Band 	1-07 (TO-204AA) Metal Styles 8 and 9  		42A-01 (DO-203AB) Metal Style 2 
50	MR2500			1N1183A
100	MR2501	***MR4422CT***	***MR4422CTR***	1N1184A
200	MR2502			1N1186A
400	***MR2504***			1N1188A
600	MR2506			***1N1190A***
800	MR2508			
1000	***MR2510***			
I_{FSM} (Amps)	400	400	400	800
T_A @ Rated I_O (°C)	—	—	—	—
T_C @ Rated I_O (°C)	150	—	—	150
T_J (Max) °C	175	150	150	190

(1) I_O is total device output.
(10) Request data sheet for mounting information.

Devices listed in bold, italic are Motorola preferred devices.

Thyristors and Triggers

In Brief . . .

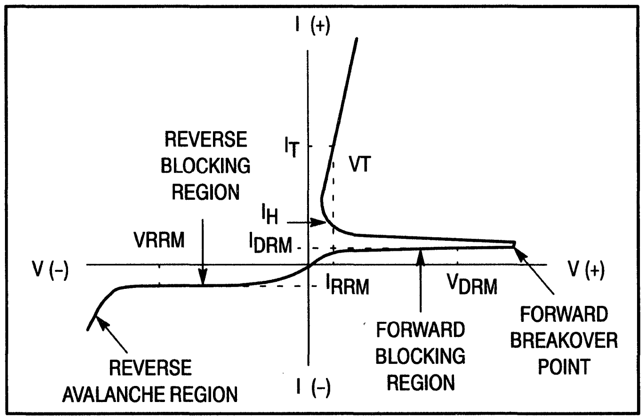
Motorola's broad line of Thyristors include. . . .

- *A full line of TRIACs and SCRs covering a forward current range from 0.5 to 55 amperes and blocking voltages from 15 to 800 volts. The TRIAC line also includes optically-coupled TRIAC drivers from Motorola's Optoelectronic product line.*
- *A full line of TRIACs and SCRs covering a forward current range from 0.5 to 55 amperes and blocking voltages from 15 to 800 volts. The TRIAC line also includes optically-coupled TRIAC drivers from Motorola's Optoelectronic product line.*
- *Two basic package categories — plastic for lowest cost which includes the fully insulated plastic Case 221C-02 (TO-220 Isolated) and metal for hermetically-sealed requirements in high-reliability projects.*
- *An extensive line of trigger devices that includes SIDACs, PUTs and SBS.*

Then there are the special applications devices for Ignition circuits and Crowbar applications. Also included are isolated packaged devices for appliances and surface mount packages for surface mounting in space-saving requirements.

Finally there is the continued Motorola investment in discrete-product R & D producing new capabilities such as transient SIDACs for use in circuits sensitive to high voltage transients.

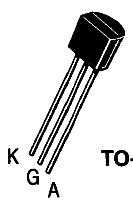
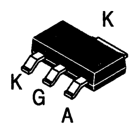
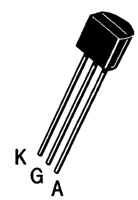
Page



SCRs

Silicon Controlled Rectifiers

Table 1. SCRs — General Purpose Metal/Plastic Packages
0.8 to 55 Amperes RMS, 25 to 800 Volts

V_{DRM} V_{RRM} (Volts)	On-State (RMS) Current			
	0.8 AMP			1.5 AMPS
	T_C = 58°C		T_C = 80°C	T_C = 50°C
	 CASE 29-04 TO-226AA (TO-92) STYLE 10		 CASE 318E-04 SOT-223 STYLE 10	 CASE 29-04 TO-226AA (TO-92) STYLE 10
	Sensitive Gate			
25	MCR102 2N5060	BRX44/BRY55-30(4)		
50	MCR103 2N5061	BRX45/BRY55-60(4)		***MCR22-2***
100	***MCR100-3*** ***2N5062***	BRX46/BRY55-100(4)		***MCR22-3***
200	***MCR100-4*** ***2N5064***	BRX47/BRY55-200(4)	***MCR08BT1***	***MCR22-4***
400	***MCR100-6***	BRX49/BRY55-400(4)	***MCR08DT1***	***MCR22-6***
500		BRY55-500(4)		
600	***MCR100-8***	BRY55-600(4)	***MCR08MT1***	***MCR22-8***

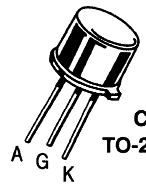
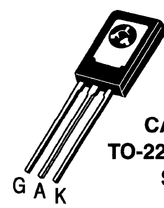
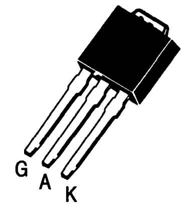
Maximum Electrical Characteristics

I_{TSM} (Amps) 60 Hz	10	15 150(3)	10	15 150(3)
I_{GT} (mA)	0.2			
V_{GT} (V)	0.8			
T_J Operating Range (°C)	−65 to+110	−40 to+125	−40 to+110	−40 to+125

(3)Exponential decay 2 µs wide at 5 time constants, f = 12 Hz.
(4)European Part Numbers. Package is Case 29 with Leadform 18. Case style is 3.

Devices listed in bold, italic are Motorola preferred devices.

Table 1. SCRs — General Purpose Metal/Plastic Packages (continued)

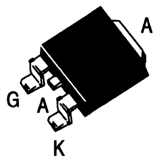
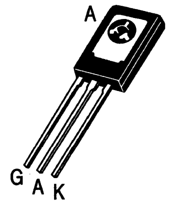
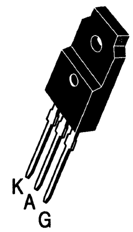
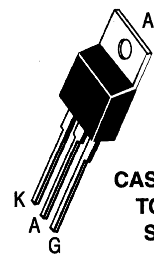
V_{DRM} V_{RRM} (Volts)50	On-State (RMS) Current					
	1.6 AMPS			4 AMPS		
	T_C = 80°C		T_C = 65°C	T_C = 93°C	T_C = 30°C	
	 CASE 79-04 TO-205AD (TO-39) STYLE 3			 CASE 77-07 TO-225AA (TO-126) STYLE 2		 CASE 369-07 STYLE 5
		Sensitive Gate				
50	2N1595	2N2323		***MCR106-2*** ***2N6237***	***C106F***	
100	2N1596	2N2324		MCR106-3 ***2N6238***	***C106A***	***MCR703A1***
200	2N1597	2N2326	MCR1906-4	***MCR106-4*** ***2N6239***	***C106B***	***MCR704A1***
400	2N1599	2N2329	MCR1906-6	***MCR106-6*** ***2N6240***	***C106D***	***MCR706A1***
600			MCR1906-8	***MCR106-8*** ***2N6241***	***C106M***	***MCR708A1***
800						

Maximum Electrical Characteristics

I_{TSM} (Amps) 60 Hz	15			25	20	25
I_{GT} (mA)	10	0.2	1	0.2		0.075
V_{GT} (V)	3	0.8	1		0.8	1
T_J Operating Range (°C)	−65 to +125		−65 to +110	−40 to +110		

Devices listed in bold, italic are Motorola preferred devices.

Table 1. SCRs — General Purpose Metal/Plastic Packages (continued)

V_{DRM} V_{RRM} (Volts)	On-State (RMS) Current				
	4 AMPS	6 AMPS	8 AMPS		
	T_C = 30°C		T_C = 70°C	T_C = 75°C	
	 CASE 369A STYLE 5	 CASE 77-07 TO-225AA (TO-126) STYLE 2	 CASE 221C-02 STYLE 2	 CASE 221A-04 TO-220AB STYLE 3	
	Surface Mount	Sensitive Gate	Isolated		
50		MCR506-2	***MCR218-2FP***	***MCR218-2***	***C122F1***
100	***MCR703A***(5)	MCR506-3		***MCR218-3***	***C122A1***
200	***MCR704A***(5)	MCR506-4	***MCR218-4FP***	***MCR218-4***	***C122B1***
400	***MCR706A***(5)	MCR506-6	***MCR218-6FP***	***MCR218-6***	***C122D1***
600	***MCR708A***(5)	MCR506-8	MCR218-8FP	***MCR218-8***	***C122M1***
800			MCR218-10FP	MCR218-10	***C122N1***

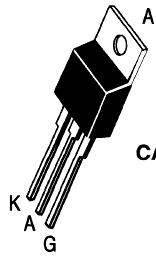
Maximum Electrical Characteristics

I_{TSM} (Amps) 60 Hz	25	40	80		90
I_{GT} (mA)	0.075	0.2	25		25
V_{GT} (V)	1		1.5		
T_J Operating Range (°C)	−40 to +110		−40 to +125		−40 to +100

(5)Available in tape and reel — add RL suffix to part number.
Indicates UL Recognized — File #E69369

Devices listed in bold, italic are Motorola preferred devices.

Table 1. SCRs — General Purpose Metal/Plastic Packages (continued)



CASE 221A-04
TO-220AB
STYLE 3

V_{DRM} V_{RRM} (Volts)	On-State (RMS) Current				
	8 AMPS	10 AMPS		12 AMPS	
	T_C = 83°C	T_C = 75°C		T_C = 85°C	T_C = 90°C
	Sensitive Gate				
50	***MCR72-2***	MCR310-2	S2800F	MCR68-2	***2N6394***
100	***MCR72-3***	***MCR310-3***	S2800A	MCR68-3	***2N6395***
200	***MCR72-4***	***MCR310-4***	S2800B		***2N6396***
400	***MCR72-6***	***MCR310-6***	S2800D	MCR68-6	***2N6397***
600	***MCR72-8***	MCR310-8	S2800M		***2N6398***
800	MCR72-10	MCR310-10	S2800N		***2N6399***

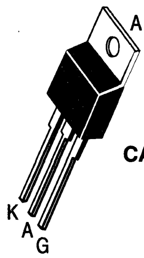
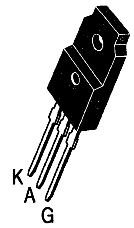
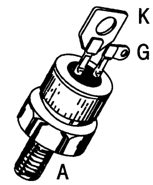
Maximum Electrical Characteristics

I_{TSM} (Amps) 60 Hz	100			300(2)	100
I_{GT} (mA)	0.2		15	30	
V_{GT} (V)	1.5				
T_J Operating Range (°C)	−40 to +110		−40 to +100	−40 to +125	

(2)Peak capacitor discharge current for t_W = 1 ms. t_W is defined as five time constants of an exponentially decaying current pulse (crowbar applications).

Devices listed in bold, italic are Motorola preferred devices.

Table 1. SCRs — General Purpose Metal/Plastic Packages (continued)

V_{DRM} V_{RRM} (Volts)	On-State (RMS) Current				
	16 AMPS	25 AMPS			
	T_C = 90°C	T_C = 85°C			T_C = 65°C
	 CASE 221A-04 TO-220AB STYLE 3			 CASE 221C-02 STYLE 2	
				Isolated	CASE 263-04 STYLE 1
50	2N6400	***2N6504***	MCR69-2	***MCR225-2FP***	2N682
100	2N6401	***2N6505***	MCR69-3		2N683
200	2N6402	***2N6506***		***MCR225-4FP***	2N685
400	2N6403	***2N6507***	MCR69-6	***MCR225-6FP***	2N688
600	2N6404	***2N6508***		***MCR225-8FP***	2N690
800	2N6405	***2N6509***		***MCR225-10FP***	2N692

Maximum Electrical Characteristics

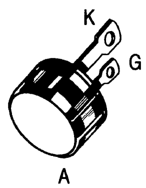
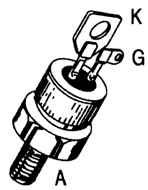
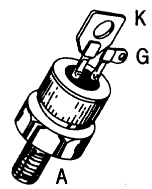
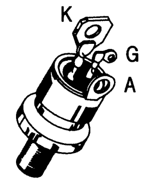
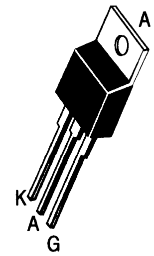
I_{TSM} (Amps) 60 Hz	160	300	750(2)	300	150
I_{GT} (mA)	30	40	30	40	
V_{GT} (V)	1.5	1.5			2
T_J Operating Range (°C)	−40 to +125	−40 to +125			−65 to +125

(2)Peak capacitor discharge current for t_w = 1 ms. t_w is defined as five time constants of an exponentially decaying current pulse (crowbar applications).

Indicates UL Recognized — File #E69369

Devices listed in bold, italic are Motorola preferred devices.

Table 1. SCRs — General Purpose Metal/Plastic Packages (continued)

	On-State (RMS) Current				
	25 AMPS	35 AMPS			40 AMPS
	$T_C = 70°C$	$T_C = 65°C$			$T_C = 80°C$
V_{DRM} V_{RRM} (Volts)	 CASE 174-04 STYLE 1	 CASE 263-04 STYLE 1	 CASE 263-04 STYLE 1	 CASE 311-02 STYLE 1 Isolated	 CASE 221A-04 TO-220AB STYLE 3
50			MCR70-2A		
100	2N3870		MCR70-3A	2N6171	
200	2N3871	MCR3935-4A		2N6172	***MCR264-4***
400	2N3872	MCR3935-6A	MCR70-6A	2N6173	***MCR264-6***
600	2N3873	MCR3935-8A		2N6174	***MCR264-8***
800	MCR3835-10	MCR3935-10A			***MCR264-10***

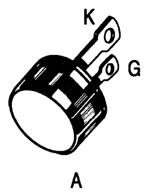
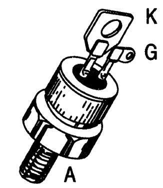
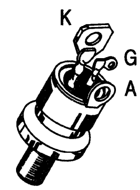
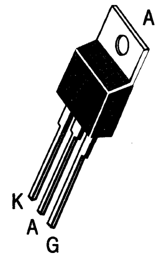
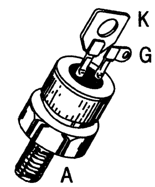
Maximum Electrical Characteristics

I_{TSM} (Amps) 60 Hz	350	350 850(2)	350	400
I_{GT} (mA)	40	30	40	50
V_{GT} (V)	MCR3835/MCR3935/2N 1.5/1.5/1.6	1.5	1.6	1.5
T_J Operating Range (°C)	−40 to +125			

(2)Peak capacitor discharge current for t_w = 1 ms. t_w is defined as five time constants of an exponentially decaying current pulse (crowbar applications).

Devices listed in bold, italic are Motorola preferred devices.

Table 1. SCRs — General Purpose Metal/Plastic Packages (continued)

	On-State (RMS) Current				
	55 AMPS				
	T_C = 75°C		T_C = 70°C		T_C = 85°C
V_{DRM} V_{RRM} (Volts)	 CASE 174-04 STYLE 1	 CASE 263-04 STYLE 1	 CASE 311-02 STYLE 1 Isolated	 CASE 221A-04 TO-220AB STYLE 3	 CASE 263-04 STYLE 1
50	MCR63-2A	MCR64-2		***MCR265-2***	MCR71-2
100	MCR63-3A	MCR64-3	MCR65-3		MCR71-3
200	MCR63-4A	MCR64-4	MCR65-4	***MCR265-4***	
400	MCR63-6A	MCR64-6	MCR65-6	***MCR265-6***	MCR71-6
600	MCR63-8A	MCR64-8	MCR65-8	***MCR265-8***	
800	MCR63-10A	MCR64-10	MCR65-10	***MCR265-10***	

Maximum Electrical Characteristics

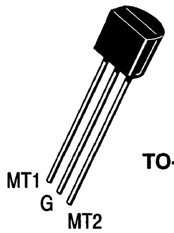
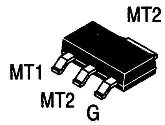
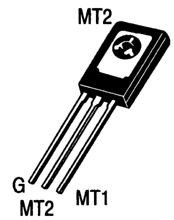
I_{TSM} (Amps) 60 Hz	550				550 1700(2)
I_{GT} (mA)	40			50	30
V_{GT} (V)	3			1.5	
T_J Operating Range (°C)	−40 to +125				

(2)Peak capacitor discharge current for t_w = 1 ms. t_w is defined as five time constants of an exponentially decaying current pulse (crowbar applications).

Devices listed in bold, italic are Motorola preferred devices.

TRIACs

Table 2. TRIACs — General Purpose Metal/Plastic Packages
0.6 to 40 Amperes, 200 to 800 Volts

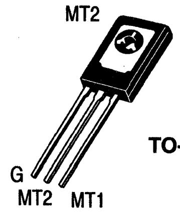
V_{DRM} (Volts)	On-State (RMS) Current				
	0.6 AMP			0.8 AMPS	2.5 AMPS
	$T_C = 50°C$			$T_C = 80°C$	$T_C = 70°C$
	 CASE 29-04 TO-226AA (TO-92) STYLE 12			 CASE 318E-04 STYLE 11 SOT-223	 CASE 77-07 TO-225AA (TO-126) STYLE 5
	Sensitive Gate				
200	***MAC97-4***	***MAC97A4***	MAC97B4	***MAC08BT1***	***T2322B***
400	***MAC97-6***	***MAC97A6***	MAC97B6	***MAC08DT1***	***T2322D***
600	***MAC97-8***	***MAC97A8***	MAC97B8	***MAC08MT1***	***T2322M***

Maximum Electrical Characteristics

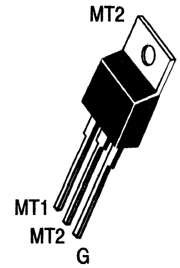
I_{TSM} (Amps)	8			10	25
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 10 10 10 10	 5 5 5 7	 3 3 3 5	 10 10 10 10	 10 10 10 10
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 2 2 2 2.5			0.8 2 2 2 2	 2.2 2.2 2.2 2.2
T_J Operating Range (°C)	–40 to +110				

Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)



CASE 77-07
TO-225AA (TO-126)
STYLE 5



CASE 221A-04
TO-220AB
STYLE 4

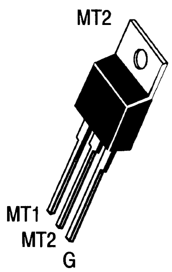
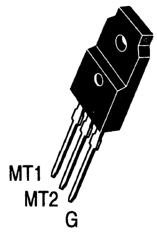
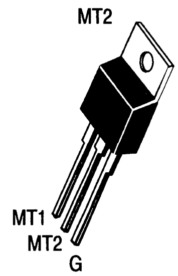
V_{DRM} (Volts)	On-State (RMS) Current				
	2.5 AMPS	4 AMPS			6 AMPS
	T_C = 70°C	T_C = 85°C			T_C = 80°C
	CASE 77-07 TO-225AA (TO-126) STYLE 5		Sensitive Gate		CASE 221A-04 TO-220AB STYLE 4
200	***T2323B***	***2N6071***	***2N6071A***	***2N6071B***	T2500B
400	***T2323D***	***2N6073***	***2N6073A***	***2N6073B***	T2500D
600	***T2323M***	***2N6075***	***2N6075A***	***2N6075B***	T2500M
800					T2500N

Maximum Electrical Characteristics

I_{TSM} (Amps)	25	30			60
I_{GT} @ 25°C (mA)					
MT2(+)G(+)	25	30	5	3	25
MT2(+)G(−)	40	—	5	3	60
MT2(−)G(−)	25	30	5	3	25
MT2(−)G(+)	40	—	10	5	60
V_{GT} @ 25°C (V)		@ −40°C	@ −40°C		
MT2(+)G(+)	2.2	2.5	2.5		2.5
MT2(+)G(−)	2.2	—	2.5		2.5
MT2(−)G(−)	2.2	2.5	2.5		2.5
MT2(−)G(+)	2.2	—	2.5		2.5
T_J Operating Range (°C)	−40 to +110		−40 to +100		

Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)

V_{DRM} (Volts)	On-State (RMS) Current				
	6 AMPS			8 AMPS	
	$T_C = 80°C$				
	 CASE 221A-04 TO-220AB STYLE 4	 CASE 221C-02 STYLE 3 Isolated ®	 CASE 221A-06 TO-220AB STYLE 4		
200	T2801B	T2500BFP	SC141B	SC143B	***MAC218-4*** ***MAC218A4***
400	T2801D	***T2500DFP***	SC141D	SC143D	***MAC218-6*** ***MAC218A6***
600	T2801M	T2500MFP	SC141M	SC143M	***MAC218-8*** ***MAC218A8***
800		T2500NFP	SC141N		MAC218-10 ***MAC218A10***

Maximum Electrical Characteristics

I_{TSM} (Amps)	80	100	80	100	
I_{GT} @ 25°C (mA)					
MT2(+)G(+)	80	25	50		50
MT2(+)G(−)	—	60	50		50
MT2(−)G(−)	80	25	50		50
MT2(−)G(+)	—	60	—		75(1)
V_{GT} @ 25°C (V)					
MT2(+)G(+)	2.5		2.5		2
MT2(+)G(−)	2.5		2.5		2
MT2(−)G(−)	2.5		2.5		2
MT2(−)G(+)	2.5		—		2.5(1)
T_J Operating Range (°C)	−40 to +100		−40 to +110		−40 to +125

(1) Applied to A-version only. Non A-version is unspecified.
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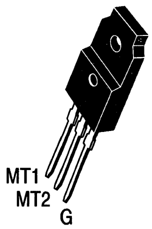
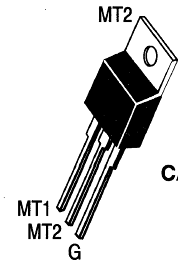
Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)

V_{DRM} (Volts)	On-State (RMS) Current 8 AMPS $T_C = 80°C$						
	 CASE 221C-02 STYLE 3	 CASE 221A-04 TO-220AB STYLE 4					
	Isolated ℛ	High Noise Immunity					
200	***MAC218-4FP*** ***MAC218A4FP***	***MAC219-4***			2N6342 ***2N6346***	T2800B	T2802B
400	***MAC218-6FP*** ***MAC218A6FP***	***MAC219-6***			***2N6343*** ***2N6347***	T2800D	T2802D
500			***MAC137-500***	***MAC137G-500***			
600	***MAC218-8FP*** ***MAC218A8FP***	MAC219-8	***MAC137-600***	***MAC137G-600***	***2N6344*** ***2N6348***	T2800M	T2802M
800	***MAC218-10FP*** ***MAC218A10FP***	***MAC219-10***	***MAC137-800***	***MAC137G-800***	2N6345 ***2N6349***		

Maximum Electrical Characteristics

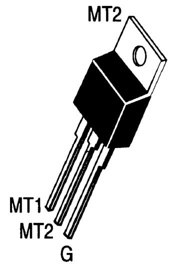
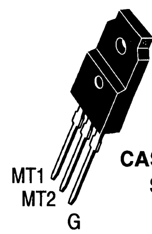
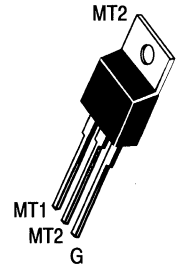
I_{TSM} (Amps)	100		60		100		
I_{GT} @ 25°C (mA) **MT2(+)G(+)** **MT2(+)G(−)** **MT2(−)G(−)** **MT2(−)G(+)**	 50 50 50 75(1)	 100 100 100 —	 35 35 35 70	 50 50 50 100	 50 75(6) 50 75(6)	 25 60 25 60	 50 — 50 —
V_{GT} @ 25°C (V) **MT2(+)G(+)** **MT2(+)G(−)** **MT2(−)G(−)** **MT2(−)G(+)**	 2 2 2 2.5(1)	 2 2 2 —	 1.5 1.5 1.5 1.5		 2 2.5(6) 2.5 2.5(6)	 2.5 2.5 2.5 2.5	 2.5 — 2.5 —
T_J Operating Range (°C)	−40 to +125					−40 to +100	

(1) Applied to A-version only. Non A-version is unspecified.
(6) Denotes 2N6346-49 Series only.

ℛ Indicates UL Recognized — File #E69369

Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)

V_{DRM} (Volts)	On-State (RMS) Current				
	8 AMPS				10 AMPS
	T_C = 80°C				T_C = 70°C
	 CASE 221A-04 TO-220AB STYLE 4		 CASE 221C-02 STYLE 3		 CASE 221A-04 TO-220AB STYLE 4
			Isolated		
	Sensitive Gate				
200	***MAC228-4*** ***MAC228A4***	***MAC229-4*** ***MAC229A4***	***MAC228-4FP*** ***MAC228A4FP***	***MAC229-4FP*** ***MAC229A4FP***	***MAC210-4*** ***MAC210A4***
400	***MAC228-6*** ***MAC228A6***	***MAC229-6*** ***MAC229A6***	***MAC228-6FP*** ***MAC228A6FP***	***MAC229-6FP*** ***MAC229A6FP***	***MAC210-6*** ***MAC210A6***
600	***MAC228-8*** ***MAC228A8***	***MAC229-8*** ***MAC229A8***	***MAC228-8FP*** ***MAC228A8FP***	***MAC229-8FP*** ***MAC229A8FP***	***MAC210-8*** ***MAC210A8***
800	MAC228-10 ***MAC228A10***	***MAC229-10*** ***MAC229A10***	***MAC228-10FP*** ***MAC228A10FP***	***MAC229-10FP*** ***MAC229A10FP***	***MAC210-10*** ***MAC210A10***

Maximum Electrical Characteristics

I_{TSM} (Amps)	80				100
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 5 5 5 10(1)	 10 10 10 20(1)	 5 5 5 10(1)	 10 10 10 20(1)	 50 50 50 75(1)
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 2 2 2 2.5(1)				
T_J Operating Range (°C)	–40 to +110				–40 to +125

(1) Applied to A-version only. Non A-version is unspecified.

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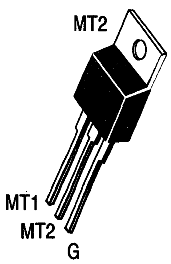
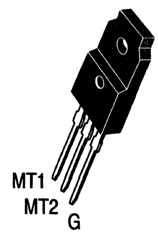
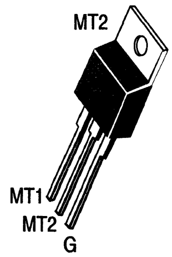
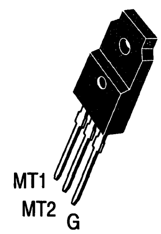
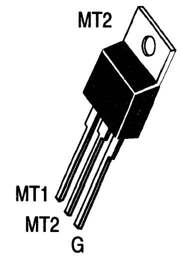
Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)

	On-State (RMS) Current				
	10 AMPS		12 AMPS		
	T_C = 80°C	T_C = 70°C	T_C = 75°C	T_C = 85°C	T_C = 85°C
					
	CASE 221A-04 TO-220AB STYLE 4	**CASE 221C-02 STYLE 3**	**CASE 221A-04 TO-220AB STYLE 4**	**CASE 221C-02 STYLE 3**	**CASE 221A-04 TO-220AB STYLE 4**
V_{DRM} (Volts)		Isolated UL	Sensitive Gate	Isolated UL	High Noise Immunity
200	SC146B	***MAC210-4FP*** ***MAC210A4FP***	MAC310-4 ***MAC310A4***	***MAC212-4FP*** ***MAC212A4FP***	***MAC212-4*** ***MAC212A4***
400	SC146D	***MAC210-6FP*** ***MAC210A6FP***	MAC310-6 ***MAC310A6***	***MAC212-6FP*** ***MAC212A6FP***	***MAC212-6*** ***MAC212A6***
600	SC146M	***MAC210-8FP*** ***MAC210A8FP***	MAC310-8 MAC310A8	***MAC212-8FP*** ***MAC212A8FP***	MAC212-8 ***MAC212A8***
800	SC146N	***MAC210-10FP*** ***MAC210A10FP***	***MAC310-10*** ***MAC310A10***	***MAC212-10FP*** ***MAC212A10FP***	***MAC212-10*** ***MAC212A10***

Maximum Electrical Characteristics

I_{TSM} (Amps)	120	100			
I_{GT} @ 25°C (mA) **MT2(+)G(+)** **MT2(+)G(−)** **MT2(−)G(−)** **MT2(−)G(+)**	 50 50 50 —	 50 50 50 75(1)	 5 5 5 10(1)	 50 50 50 75(1)	 50 50 50 75(1)
V_{GT} @ 25°C (V) **MT2(+)G(+)** **MT2(+)G(−)** **MT2(−)G(−)** **MT2(−)G(+)**	 2.5 2.5 2.5 —	 2 2 2 2.5(1)	 2 2 2 2.5(1)	 2 2 2 2.5(1)	 2 2 2 2.5(1)
T_J Operating Range (°C)	−40 to +125				

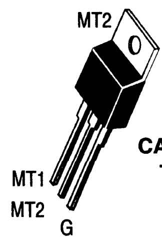
(1) Applied to A-version only. Non A-version is unspecified.

UL Indicates UL Recognized — File #E69369

Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)

	On-State (RMS) Current						
	12 AMPS				15 AMPS		
	$T_C = 85°C$	$T_C = 80°C$				$T_C = 90°C$	$T_C = 90°C$
V_{DRM} (Volts)	High Noise Immunity				High Noise Immunity		
200	***MAC213-4***	SC149B	2N6342A	2N6346A		***MAC15-4*** ***MAC15A4***	***MAC16-4***
400	***MAC213-6***	SC149D	2N6343A	2N6347A	***MACH15D***	MAC15-6 MAC15A6	***MAC16-6***
600	MAC213-8	SC149M	2N6344A	2N6348A	***MACH15M***	MAC15-8 MAC15A8	***MAC16-8***
800	MAC213-10		2N6345A	2N6349A	***MACH15N***	MAC15-10 MAC15A10	MAC16-10



CASE 221A-04
TO-220AB
STYLE 4

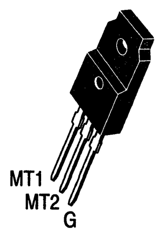
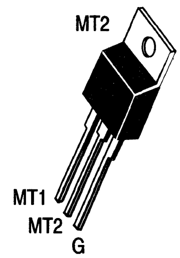
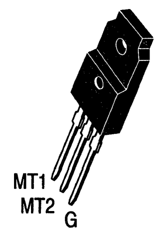
Maximum Electrical Characteristics

I_{TSM} (Amps)		120			150		
I_{GT} @ 25°C (mA)							
MT2(+)G(+)	100	50	50	50	35	50	100
MT2(+)G(–)	100	50	—	75	35	50	100
MT2(–)G(–)	100	50	50	50	35	50	100
MT2(–)G(+)	—	—	—	75	—	75(1)	—
V_{GT} @ 25°C (V)							
MT2(+)G(+)	2	2.5	2	2	1.5	2	2
MT2(+)G(–)	2	2.5	—	2.5	1.5	2	2
MT2(–)G(–)	2	2.5	2	2	1.5	2	2
MT2(–)G(+)	—	—	—	2.5	—	2.5(1)	—
T_J Operating Range (°C)		–40 to +125					

(1) Applied to A-version only. Non A-version is unspecified.

Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)

	On-State (RMS) Current				
	15 AMPS	20 AMPS		25 AMPS	
	T_C = 90°C	T_C = 75°C	T_C = 75°C		T_C = 80°C
	 CASE 221C-02 STYLE 3		 CASE 221A-04 TO-220AB STYLE 4		 CASE 221C-02 STYLE 3
V_{DRM} (Volts)	Isolated UL			High Noise Immunity	Isolated UL
200	***MAC15-4FP*** ***MAC15A4FP***	***MAC320-4FP*** ***MAC320A4FP***	***MAC320-4*** ***MAC320A4***	***MAC321-4***	***MAC223-4FP*** ***MAC223A4FP***
400	***MAC15-6FP*** ***MAC15A6FP***	***MAC320-6FP*** ***MAC320A6FP***	***MAC320-6*** ***MAC320A6***	***MAC321-6***	***MAC223-6FP*** ***MAC223A6FP***
600	***MAC15-8FP*** ***MAC15A8FP***	***MAC320-8FP*** ***MAC320A8FP***	***MAC320-8*** ***MAC320A8***	***MAC321-8***	***MAC223-8FP*** ***MAC223A8FP***
800	***MAC15-10FP*** ***MAC15A10FP***	***MAC320-10FP*** ***MAC320A10FP***	***MAC320-10*** ***MAC320A10***	MAC321-10	***MAC223-10FP*** ***MAC223A10FP***

Maximum Electrical Characteristics

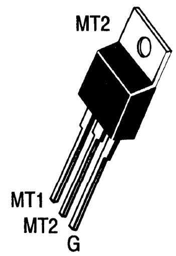
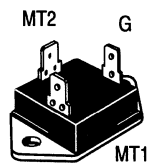
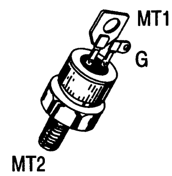
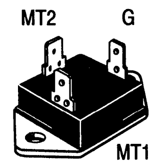
I_{TSM} (Amps)	150		250
I_{GT} @ 25°C (mA) **MT2(+)G(+)** **MT2(+)G(−)** **MT2(−)G(−)** **MT2(−)G(+)**	 50 50 50 75(1)	 100 100 100 —	 50 50 50 75(1)
V_{GT} @ 25°C (V) **MT2(+)G(+)** **MT2(+)G(−)** **MT2(−)G(−)** **MT2(−)G(+)**	 2 2 2 2.5(1)	 2 2 2 —	 2 2 2 2.5(1)
T_J Operating Range (°C)	−40 to +125		

(1) Applied to A-version only. Non A-version is unspecified.

UL Indicates UL Recognized — File #E69369

Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)

	On-State (RMS) Current			
	25 AMPS		30 AMPS	35 AMPS
	$T_C = 80°C$	$T_C = 85°C$	$T_C = 60°C$	$T_C = 58°C$
V_{DRM} (Volts)	 CASE 221A-04 TO-220AB STYLE 4	 CASE 383-01 STYLE 1 Isolated ®	 CASE 263-04 STYLE 2	 CASE 383-01 STYLE 1 Isolated ®
200	***MAC223-4*** ***MAC223A4***	MAC625-4	T6411B	MAC635-4
400	***MAC223-6*** ***MAC223A6***	MAC625-6	T6411D	MAC635-6
600	***MAC223-8*** ***MAC223A8***	MAC625-8	T6411M	MAC635-8
800	***MAC223-10*** ***MAC223A10***		T6411N	

Maximum Electrical Characteristics

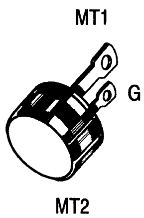
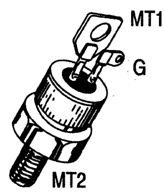
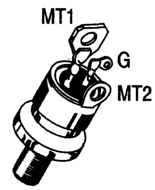
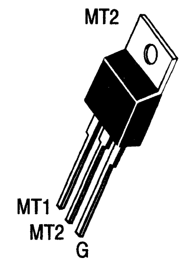
I_{TSM} (Amps)	250		300	330
I_{GT} @ 25°C (mA) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 50 50 50 75(1)	 50 50 50 —	 50 80 50 80	 50 50 50 —
V_{GT} @ 25°C (V) MT2(+)G(+) MT2(+)G(–) MT2(–)G(–) MT2(–)G(+)	 2 2 2 2.5(1)	 3 3 3 —	 2.5 2.5 2.5 2.5	 3 3 3 —
T_J Operating Range (°C)	–40 to +125		–65 to +100	–40 to +125

(1) Applied to A-version only. Non A-version is unspecified.

® Indicates UL Recognized — File #E69369

Devices listed in bold, italic are Motorola preferred devices.

Table 2. TRIACs (continued)

V_{DRM} (Volts)	On-State (RMS) Current 40 AMPS $T_C = 70°C$	$T_C = 65°C$	$T_C = 60°C$	$T_C = 75°C$
	 **CASE 174-04 STYLE 3**	 **CASE 263-04 STYLE 2**	 **CASE 311-02 STYLE 2 Isolated**	 **CASE 221A-04 TO-220AB STYLE 4**
200	MAC6400B	2N5444 T6410B	T6420B	***MAC224-4*** ***MAC224A4***
400	MAC6400D	2N5445 T6410D	T6420D	***MAC224-6*** ***MAC224A6***
600	MAC6400M	2N5446 T6410M	T6420M	***MAC224-8*** ***MAC224A8***
800	MAC6400N	T6410N	T6420N	MAC224-10 ***MAC224A10***

Maximum Electrical Characteristics

I_{TSM} (Amps)	300				350
I_{GT} @ 25°C (mA)		2N5444-46	T6410		
MT2(+)G(+)	2.5	2	2.5	2.5	2
MT2(+)G(−)	2.5	2	2.5	2.5	2
MT2(−)G(−)	2.5	2	2.5	2.5	2
MT2(−)G(+)	2.5	2.5	2.5	2.5	2.5(1)
T_J Operating Range (°C)	−65 to +125	−65 to +110			−40 to +125

(1)Applied to A-version only. Non A-version is unspecified.

Devices listed in bold, italic are Motorola preferred devices.

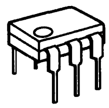
TRIACS (continued)

Optically Isolated TRIACs

Triac Driver/Triac Combinations

This series of Triac Drivers consists of infrared LEDs optically coupled to photodetectors with Triac output. 7500 V isolation between input and output allows safe, economical triggering of higher power triacs from logic sources with output as low as 3 volts, 10 mA. Associated voltage-compatible triacs provide matched pairs for a variety of voltage/current requirements.

Table 3. TRIAC Drivers



CASE 730A

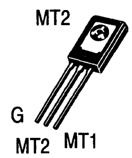
Peak Blocking Voltage Volts	LED Trigger Current I_{FT} mA, Max	Device
250	30	MOC3009
	15	MOC3010
	10	MOC3011
400	30	MOC3020
	15	MOC3021

For Zero Crossover Firing

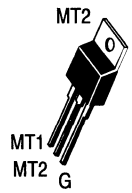
Peak Blocking Voltage Volts	LED Trigger Current I_{FT} mA, Max	Device
250	30	MOC3030
	15	MOC3031
400	30	MOC3040
	15	MOC3031
600	30	MOC3060
	15	MOC3061

Indicates UL Recognized — File #E54915

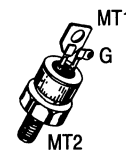
Table 4. TRIACs



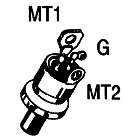
CASE 77-07
TO-225AA
(TO-126)



CASE 221A-04
TO-220AB



CASE 263-04



CASE 311-02
(ISOLATED)

Output Current I_{RMS} A, Max	Peak Blocking Voltage Volts 250	400	600	Case
4	MAC3010-4	MAC3020-4	—	77
8	MAC3010-8	MAC3020-8	—	221A
15	MAC3010-15	MAC3020-15	—	221A
25	MAC3010-25	MAC3020-25	—	221A
40	MAC3010-40	MAC3020-40	—	2633

For Zero Crossover Firing

Output Current I_{RMS} A, Max	250	400	600	Case
4	MAC3030-4	MAC3040-4	MAC3060-4	77
8	MAC3030-8	MAC3040-8	MAC3060-8	221A
15	MAC3030-15	MAC3040-15	MAC3060-15	221A
25	MAC3030-25	MAC3040-25	MAC3060-25	221A
40	MAC3030-40	MAC3040-40	—	263
40	MAC3030-40I	MAC3040-40I	—	311

Devices listed in bold, italic are Motorola preferred devices.

Thyristor Triggers

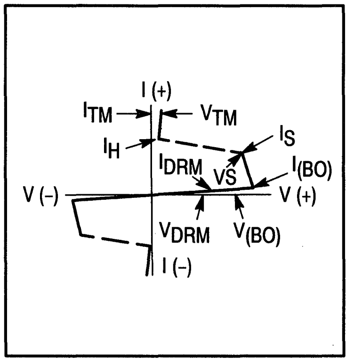


Table 5. SIDACs

High voltage trigger devices similar in operation to a Triac. Upon reaching the breakover voltage in either direction, the device switches to a low-voltage on-state.

Device Type	I_{TSM} Amps	V_{BO} Volts Min	V_{BO} Volts Max
Case 267-03/1			
MKP3V110	20	100	120
MKP3V120	20	110	130
MKP3V130	20	120	140
MKP3V240	20	220	250
MKP3V260	20	240	270
MKP3V270	20	250	280
Case 59-04/1			
MKP1V120	4	110	130
MKP1V130	4	120	140
MKP1V140	4	130	150
MKP1V240	4	220	250
MKP1V260	4	240	270
MKP1V270	4	250	280

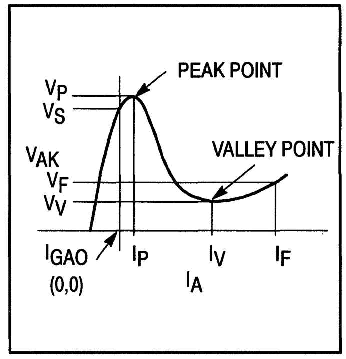


Table 6. Programmable Unijunction Transistor — PUT

Similar to UJTs, except that I_V, I_P and intrinsic standoff voltage are programmable (adjustable) by means of external voltage divider. This stabilizes circuit performance for variations in device parameters. General operating frequency range is from 0.01 Hz to 10 kHz, making them suitable for long-duration timer circuits.

Device Type	I_P R_G = 10 kΩ µA Max	I_P R_G = 1 MΩ µA Max	I_{GAO} @ 40 V nA Max	I_V R_G = 10 kΩ µA Min	I_V R_G = 1 MΩ µA Max
Plastic TO-92 (Case 29-04/16)					
2N6027	5	2	10	70	50
2N6028	1	0.15	10	25	25

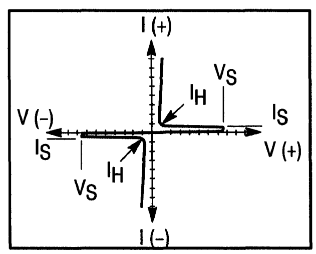


Table 7. Silicon Bidirectional Switch (SBS)

This versatile trigger device exhibits highly symmetrical bidirectional switching characteristics which can be modified by means of a gate lead. Requires a gate trigger current of only 250 µAdc for triggering.

Device Type	V_S Volts Min	V_S Volts Max	I_S µA Max	I_H mA Max
Plastic TO-92/TO-226AA (Case 29-04/12)				
MBS4991	6	10	500	1.5
MBS4992	7.5	9	120	0.5
MBS4993	7.5	9	250	0.75

Devices listed in bold, italic are Motorola preferred devices.

Optoelectronic Devices

In Brief . . .

Motorola's families of optoelectronic components encompass red and infrared GaAs emitters and silicon detectors that are well matched for a variety of applications.

Optoisolators

Motorola's "Global" 6-Pin Dual In-line Package (DIP) devices use infrared emitting diodes that are optically coupled to a wide selection of output (Transistor, Darlington, Triac, and Schmitt trigger) silicon detectors. These devices are guaranteed to provide at least 7500 volts of isolation between the input and output and are 100% VISO tested. The entire line of Motorola 6-Pin DIP packages are recognized by all major safety regulatories including UL and VDE. This extensive line of regulatory approvals attest to their suitability for use under the most stringent conditions. Motorola also offers a line of SOIC-8 small outline, surface mount devices that are UL approved and ideally suited for high density applications.

Emitters and Detectors

Motorola emitters (LEDs) are manufactured to operate at wavelengths of 660, 850 or 940 nanometers (nm).

The 940 nm emitters are least expensive. They are well suited for applications where close proximity to the detector tolerates a moderate mismatch in spectral response in exchange for lower cost.

The 850 nm emitters have peak emission which almost exactly matches that of silicon detectors. These emitters are widely used where efficiency and high speeds are of primary importance.

The 660 nm are visible and well matched to the characteristics of low-cost plastic fiber and find wide use in fiber optics communications.

Coupled with a line of silicon photodetectors with outputs tailored for specific applications (diodes, transistors, Darlingtons, triacs and Schmitt triggers), Motorola's product line offers the engineer a choice of components that can result in optimum system design.

Fiber Optics

Low cost components offer 10 MHz bandwidth for short distance communications. High performance emitter detector components provide transmission up to several kilometers with bandwidths in excess of 100 MHz.

Optointerrupters

Infrared LEDs facing photodetectors in a wide range of slotted packages permit custom design of systems to virtually any physical requirement. A wide selection of outputs (transistor, Darlington, logic, etc.) offers an excellent match for a variety of applications.

Chips

A number of LED and detector functions are available in chip form for hybrid system designs.

Page

Optoisolators

Safety Standard Approvals for 6-pin Optoisolators

	VDE	UL	CSA	SETI	SEMKO	DEMKO	NEMKO	BABT
MOCXXXX	* (1)	*	*	*	*	*	*	Δ
SOCXXXX	* (1)	*	*	*	*	*	*	Δ
4NXXXXXX	* (1)	*	*	*	*	*	*	Δ
H1XXXXXX	* (1)	*	*	*	*	*	*	Δ
MCXXXXXX	* (1)	*	*	*	*	*	*	Δ
TIXXXXXX	* (1)	*	*	*	*	*	*	Δ
CNXXXXXX	* (1)	*	*	*	*	*	*	Δ

* = Approved
Δ = Pending Approval

Regulatory Approval Certification Index

Regulatory Agency	Certificate File Number
VDE0883	41853 (expired 12/31/91)
VDE0884(1)	62054 (replaces VDE0883)
UL (isolation)	E54915
UL (flammability)	E-8436
CSA	LR93592
SETI	41990
SEMKO	9313138
DEMKO	Approved per SEMKO
NEMKO	A99177
BABT	Applied for

Motorola's 8-Pin surface mount optocouplers are approved by UL only and have a guaranteed Isolation Voltage of 2500 Vac(rms).
All Motorola 6-Pin optocouplers are 100% tested for Isolation Voltage and are guaranteed to 7500 Vac(peak).
UL Flammability Rating = 94VO (File number E-8436) for all optocouplers.
(1)VDE 0884 testing is an option; the suffix letter "V" must be added to the standard part number (see page 5.6-3).

VDE Approved Optoisolators

VDE has approved Motorola's entire portfolio of 6-pin DIP optoisolators against their new components standard VDE 0884 which replaces VDE 0883. The VDE 0884 components standard requires additional electrical testing to a stringent isolation partial discharge test.

The VDE 0883 specification expired 12/31/91. Motorola optoisolators can now be ordered to comply with the VDE 0884 specification.

VDE approval is based on mechanical and electrical performance of the Motorola package, shown in Figure 3. This 6-Pin DIP package incorporates specially developed materials and assembly processes optimizing thermal and moisture stability while maintaining the high level of LED life and isolation voltage. All Motorola 6-pin DIP optoisolators are made in this package, and have these approvals.

VDE 0884 Component Standard (replaces VDE 0883)

Electrical ratings in this standard are:
Input-to-Output Voltage, 1 second
V_{Pr1} = 1.6 V_{IDRM}, Partial Discharge < 5 picocouloumbs,
V_{Pr1} = 1280 V(pk)
Maximum operating peak voltage, V_{IDRM} = 800 V(pk)
Isolation resistance: V_{I-O} = 500 Vdc, 10^{11} Ω, T_A = 100°C.

The isolation partial discharge test V_{Pr1}, is performed after the completion of the high voltage withstand (hipot) tests.

VDE 0883 Component Standard (expired 12/31/91)

Electrical ratings in this standard were:
Isolation withstand voltages:
3750 V_{RMS}, 1 min, T_A = 100°C
5300 Vdc, 1 min, T_A = 100°C
Isolation surge withstand voltage:
10 kV per IEC 65, 50 discharges
Isolation resistance:
10^{11} Ω, 500 Vdc, T_A = 100°C

VDE 0884/8.87

VDE 0884/8.87 testing is an option; the suffix letter "V" must be added to the standard part number.

Standard through hole — MOC3063V
.4″ wide spaced leadform — MOC3063TV (to satisfy 8 mm spacing requirement)
Standard-profile surface mount — MOC3063SV
Low-profile surface mount — MOC3063FV
Tape and Reel for surface mount — MOC3063S/FR2V

Optoisolators, a block diagram of which is shown in Figure 1, are devices which contain at least one emitter, which is optically coupled to a photo-detector through some sort of an insulating medium. This arrangement permits the passage of information from one circuit, which contains the emitter, to the other circuit containing the detector.

Because this information is passed optically across an insulating gap, the transfer is one-way; that is, the detector cannot affect the input circuit. This is important because the emitter may be driven by a low voltage circuit utilizing an MPU or logic gates, while the output photo-detector may be part of a high voltage DC or even an ac load circuit. The optical isolation prevents interaction or even damage to the input circuit to be caused by the relatively hostile output circuit.

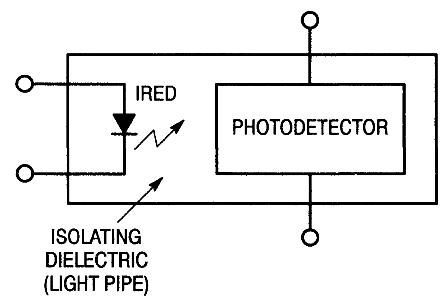


Figure 1. Block Diagram of Optoisolator

Various geometric designs have been used over the years for the internal light cavity between the emitter and detector. Motorola is the industry leader in isolation technology. All 6-pin optoisolators are guaranteed to meet or exceed 7500 Vac (pk) input-to-output isolation. See Figure 2.

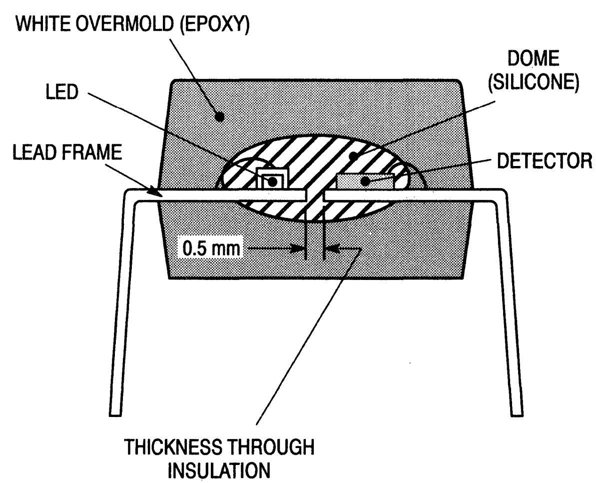


Figure 2. Geometric Design for Optoisolators

Optoisolators: VDE Approved Optoisolators (continued)

Equipment Standards Compliance

With the approval of the Motorola package to these component standards, combined with its VDE approval ratings, a wide range of Equipment Standards are covered. The table below summarizes these Equipment Standard coverages.

Two levels of electrical interface, or insulation, are used: 1. Reinforced, or safe, insulation; 2. Basic insulation.

Reinforced Insulation (sometimes referred to as "safe electrical isolation") is required in an optoisolator interfacing between a hazardous voltage circuit, like an ac line, and a **touchable s**afe **ex**tra **l**ow **v**oltage (SELV) circuit.

Basic Insulation is required in an optoisolator which interfaces between a hazardous voltage circuit and a **non-touchable, ex**tra **l**ow **v**oltage (ELV) circuit.

The 6-pin DIP optoisolators are suitable for both levels of electrical interface. The smaller SOIC-8 optoisolators comply with Basic Insulation standards only.

Mechanical ratings are shown in the table below.

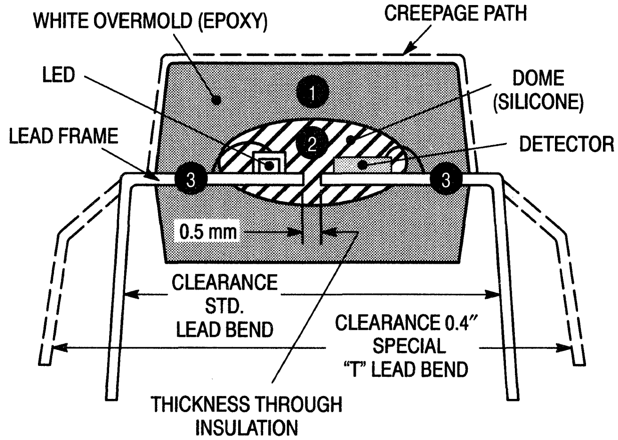


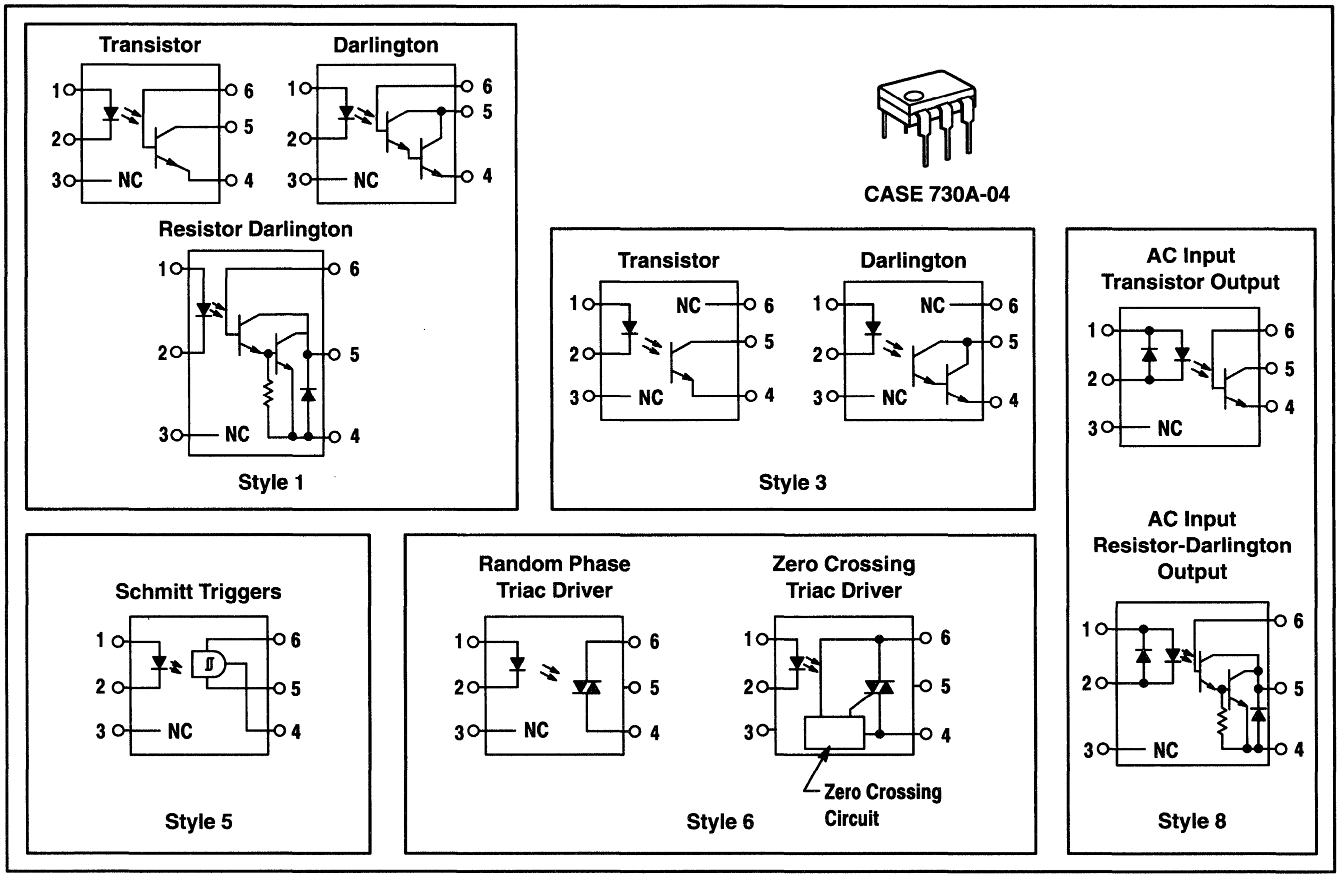
Figure 3. "DOME" Package

Table 1. Examples for Safety Applications for Motorola VDE Approved Optoisolators

Standard (2) VDE	DIN IEC	Equipment	Requirements for reinforced (double) or safe insulation for equipment with an operating voltage up to 250 Vrms (line voltage to ELV or SLV interfaces) Creepage	Clearance (1)	Isolation Barrier	Dielectric Strength	Isolation Resistance
			[mm]	[mm]	[mm]	[kV RMS]	[Ω]
0806	950	Office Machines	8.0	8.0	0.5	3.75	7×10^6
0805	950	Data Processing	8.0	8.0	—	3.75	7×10^6
0804	—	Telecommunication	8.0	8.0	—	2.5	2×10^6
0860	65	Electrical Household	6.0	6.0	0.4	3.0 (10)*	4×10^6
0113	204	Industrial Controls	8.0	8.0	—	2.5	1×10^6
0160	—	Power Installations with Electronic Equipment	8.0	8.0	—	2.7	1×10^6
0832	—	Traffic Light Controls	8.0	8.0	—	2.5	4×10^6
0883	—	Alarm Systems	8.0	8.0	—	2.5	2×10^6
0831	—	Electrical Signal System for Railroads	8.0	8.0	—	2.0	2×10^6
0110	—	General Std. for Electrical Equipment	8.0	8.0	—	2.0	—
0883	—	Optoisolator Component Standard (obsolete 12/31/91)	8.5	8.3 (10) (1)	0.5	3.75 (10)*	10×10^{11}
0884(4)	—	Optoisolator Component Standard (replaces VDE0883)	>7.5	>7.5	0.5	—	10×10^{12}
			VDE Rating for Motorola 6-pin DIP Optoisolators				

All Motorola 6-pin DIP Optoisolators meet or exceed the requirements of above listed VDE and DIN IEC Standards.
* Impulse discharge withstand voltage.
(1) To satisfy 8.0 mm creepage path on a PC board Motorola offers a special lead bend of 0.4 inch on all 6-pin dual-in-line optoisolators. Order by attaching "T" to the end of the Motorola part number.
(2) VDE standards (translated into English language) and IEC standards can be ordered from the American National Standard Institute ANSI, 1430 Broadway, N.Y., N. Y. 10018, Sales Department, 212-642-4900.
(3) Creepage path distances are measured from lead to lead across the top, bottom and ends of the package body.
(4) VDE 0884 testing is an option; the suffix letter "V" must be added to the standard number. (See page 5.6-3.)

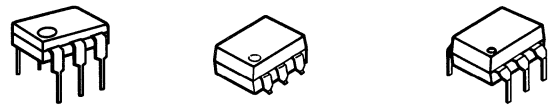
6-Pin Dual In-line Package



An optoisolator consists of a gallium arsenide infrared emitting diode, IRED, optically coupled to a monolithic silicon photodetector in a wide array of standard devices and encourages the use of special designs and selections for special applications. All Motorola optoisolators have V_{ISO} rating of 7500 Vac(pk), exceeding all other industry standard ratings.

Motorola offers global regulatory approvals, including UL, NEMKO, BABT*, SETI, SEMKO, DEMKO and CSA. VDE(1) approved per standard 0884/8.87, with additional approvals to DIN IEC950 and IEC380/VDE 0806, IEC435/VDE 0805, IEC65/VDE 0860, VDE 110b, also covering all other standards with equal or less stringent requirements, including IEC204/VDE 0113, VDE 0160, VDE 0832, VDE 0833.

(1) VDE 0884/8.87 testing is an option; the suffix "V" must be added to the standard part number (see page 5.6-3).
* Approval pending.



CASE 730A-04

F or S
(F) CASE 730F-04
Surface-mountable gull-wing low-profile option
(S) CASE 730C-04
Surface-mountable gull-wing option

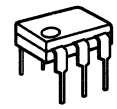
T
(T) CASE 730D-05
Wide-spaced (0.400,) lead form option

Optoisolator Lead Form Options

All Motorola 6-pin, dual in-line optoisolators are available in either a surface-mountable, gull-wing lead form or a wide-spaced 0.400″ lead form, which is used to satisfy 8 mm PC board spacing requirements.

- Attach "F" to any Motorola 6-pin, dual in-line part number for low-profile, surface-mountable, gull-wing lead form.
- Attach "S" to any Motorola 6-pin, dual inline part number for surface-mountable, gull-wing lead form.
- Attach "T" to any Motorola 6-pin, dual in-line part number for wide-spaced 0.400" lead form.

Optoisolators: 6-Pin Dual In-line Package (continued)



CASE 730A-04

Table 2. Transistor Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 1)

Device	Current Transfer Ratio (CTR) % Min	@ I_F mA	V_{CE} Volts	$V_{CE(sat)}$ Volts Max	@ I_F mA	I_C mA	t_r/t_f or $t_{on}*/t_{off}*$ Typ µs	@ I_C mA	V_{CC} Volts	R_L Ω	I_F mA	$V_{(BR)CEO}$ Volts Min	V_F Volts Max	@ I_F mA
TIL112	2	10	5	0.5	50	2	2/2	2	10	100		20	1.5	10
TIL111	8	16	0.4	0.4	16	2	5/5	2	10	100		30	1.4	16
4N27	10	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
4N28	10	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
4N38,A	10	10	10	1	20	4	1.6/2.2	10	10	100		80	1.5	10
H11A4	10	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.5	10
4N25,A	20	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
4N26	20	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
H11A2	20	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.5	10
H11A3	20	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.5	10
H11A520	20	10	10	0.4	20	2	5*/5*	2	10	100		30	1.5	10
H11AV3	20	10	10	0.4	20	2	5*/4*	2	10	100		70	1.5	10
MCT2	20	10	10	0.4	16	2	1.2/1.3		5	2k	15	30	1.5	20
MCT2E	20	10	10	0.4	16	2	1.2/1.3	2	10	100		30	1.5	20
TIL116	20	10	10	0.4	15	2.2	5/5	2	10	100		30	1.5	60
H11A5	30	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.7	10
CNX35	40–160	10	0.4	0.4	10	2	3/3*	2	5	100		30	1.5	10
CNX36	80–200	10	0.4	0.4	10	4	8/6*	2	5	100		30	1.5	10
CNX83	40	10	0.4	0.4	10	4	3/3″	2	5	100		50	1.5	10
CNY17-1	40–80	10	5	0.4	10	2.5	1.6/2.3″		5	75	10	70	1.65	60
MCT271	45–90	10	10	0.4	16	2	4.9*/4.5*	2	5	100		30	1.5	20
MOC8100	50	1	5	0.5	1	0.1	3.8/5.6	2	10	100		30	1.4	1
H11A1	50	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.5	10
H11A550	50	10	10	0.4	20	2	5*/5*	2	10	100		30	1.5	10
H11AV2	50	10	10	0.4	20	2	5*/4*	2	10	100		70	1.5	10
TIL117	50	10	10	0.4	10	0.5	5/5	2	10	100		30	1.4	16
TIL126	50	10	10	0.4	10	1	2/2	2	10	100		30	1.4	10
SL5501	45–250	10	0.4	0.4	20	2	20*/50*		5	1k	16	30	1.3	20
CNY17-2	63–125	10	5	0.4	10	2.5	1.6/2.3		5	75	10	70	1.65	60
MCT275	70–210	10	10	0.4	16	2	4.5*/3.5*	2	5	100		80	1.5	20
MCT272	75–150	10	10	0.4	16	2	6*/5.5*	2	5	100		30	1.5	20
4N35	100	10	10	0.3	10	0.5	3.2/4.7	2	10	100		30	1.5	10
4N36	100	10	10	0.3	10	0.5	3.2/4.7	2	10	100		30	1.5	10
4N37	100	10	10	0.3	10	0.5	3.2/4.7	2	10	100		30	1.5	10
H11A5100	100	10	10	0.4	20	2	5*/5*	2	10	100		30	1.5	10
CNY17-3	100–200	10	5	0.4	10	2.5	1.6/2.3		5	75	10	70	1.65	60
SL5500	50–300	10	0.4	0.4	50	10	20*/50*		5	1k	16	30	1.3	20
H11AV1	100–300	10	10	0.4	20	2	5*/4*	2	10	100		70	1.5	10
MCT273	125–250	10	10	0.4	16	2	7.6*/6.6*	2	5	100		30	1.5	20
MCT274	225–400	10	10	0.4	16	2	9.1*/7.9*	2	5	100		30	1.5	20

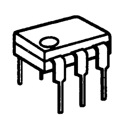
Table 3. Transistor Output with No Base Connection

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 3)

MOC8101	50–80	10	10	0.4	5	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8102	73–117	10	10	0.4	5	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8103	108–173	10	10	0.4	5	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8104	160–256	10	10	0.4	5	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8111	20	10	10	0.4	10	0.5	3.2/4.7	2	10	100		30	1.5	10
CNX82	40	10	0.4	0.4	10	4	3/3*	2	5	100		50	1.5	10
MOC8112	50	10	10	0.4	10	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8113	100	10	10	0.4	10	0.5	3.2/4.7	2	10	100		30	1.5	10

Devices listed in bold, italic are Motorola preferred devices.

Optoisolators: 6-Pin Dual In-line Package **(continued)**



CASE 730A-04

Table 4. AC Input – Transistor Output

Pinout: 1-LED 1 Anode/LED 2 Cathode, 2-LED 1 Cathode/LED 2 Anode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 8)

	Current Transfer Ratio (CTR)			$V_{CE(sat)}$			t_r/t_f or $t_{on}*/t_{off}*$ Typ					$V_{(BR)CEO}$	V_F	
Device	% Min	@ I_F mA	V_{CE} Volts	Volts Max	@ I_F mA	I_C mA	µs	@ I_C mA	V_{CC} Volts	R_L Ω	I_F mA	Volts Min	Volts Max	@ I_F mA
H11AA1	20	±10	10	0.4	±10	0.5						30	1.5	±10
H11AA2	10	±10	10	0.4	±10	0.5						30	1.8	±10
H11AA3	50	±10	10	0.4	±10	0.5						30	1.5	±10
H11AA4	100	±10	10	0.4	±10	0.5						30	1.5	±10

Table 5. AC Input – Resistor Darlington Output

Pinout: 1-LED 1 Anode/LED 2 Cathode, 2-LED 1 Cathode/LED 2 Anode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 8)

MOC8060	1000	±10	10	2	±10	100						50	1.5	±10

Table 6. Darlington Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 1)

4N31	50	10	10	1.2	8	2	0.6*/17*	50	10		200	30	1.5	10
4N29,A	100	10	10	1	8	2	0.6*/17*	50	10		200	30	1.5	10
4N30	100	10	10	1	8	2	0.6*/17*	50	10		200	30	1.5	10
H11B255	100	10	5	1	50	50	125*/100*	10	10	100		55	1.5	20
MCA230	100	10	5	1	50	50	10/35		10	100	50	30	1.5	20
MCA255	100	10	5	1	50	50	10/35		10	100	50	55	1.5	20
H11B2	200	1	5	1	1	1	1/2	10	10	100		25	1.5	10
MCA231	200	1	1	1.2	10	50	80	10	10	100		30	1.5	20
TIL113	300	10	1.25	1	50	125	300	125	15	100		30	1.5	10
4N32,A	500	10	10	1	8	2	0.6*/45*	50	10		200	30	1.5	10
4N33	500	10	10	1	8	2	0.6*/45*	50	10		200	30	1.5	10
H11B1	500	1	5	1	1	1	1/2	10	10	100		25	1.5	10
MOC8080	500	10	5	1	1	1	1/2		10	100	5	55	1.5	10

Table 7. Darlington Output with No Base Connection

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-N.C. (Style 3)

MOC119	300	10	2	1	10	10	1/2	2.5	10	100		30	1.5	10
TIL119	300	10	2	1	10	10	300	2.5	10	100		30	1.5	10
MOC8030	300	10	1.5				1/2		50	100	10	80	2	10
MOC8020	500	10	5				1/2		50	100	10	50	2	10
MOC8050	500	10	1.5				1/2		50	100	10	80	2	10
MOC8021	1000	10	5				1/2		50	100	10	50	2	10

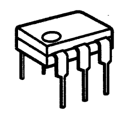
Table 8. Resistor Darlington Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 1)

H11G1	1000	10	1	1	1	1	5*/100*		5	100	10	100	1.5	10
H11G2	1000	10	1	1	1	1	5*/100*		5	100	10	80	1.5	10
H11G3	200	1	5	1.2	50	20	5*/100*		5	100	10	55	1.5	10

Devices listed in bold, italic are Motorola preferred devices.

Optoisolators: 6-Pin Dual In-line Package **(continued)**



CASE 730A-04

Table 9. High Voltage Transistor Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 1)

Device	Current Transfer Ratio (CTR) % Min	@ I_F mA	V_{CE} Volts	$V_{CE(sat)}$ Volts Max	@ I_F mA	I_C mA	t_r/t_f or $t_{on}*/t_{off}*$ Typ µs	@ I_C mA	V_{CC} Volts	R_L Ω	I_F mA	$V_{(BR)CEO}$ Volts Min	V_F Volts Max	@ I_F mA
MOC8204	20	10	10	0.4	10	0.5	5*/5*	2	10	100		400	1.5	10
H11D1	20	10	10	0.4	10	0.5	5*/5*	2	10	100		300	1.5	10
H11D2	20	10	10	0.4	10	0.5	5*/5*	2	10	100		300	1.5	10

Table 10. Triac Driver Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Main Terminal, 5-Substrate, 6-Main Terminal (Style 6)

Device	Peak Blocking Voltage Min	LED Trigger Current-I_{FT} (V_{TM} = 3 V) mA Max	Zero Crossing Inhibit Voltage (at rated I_{FT}) Volts Max	Operating Voltage Vac Pk	dv/dt V/µs Typ
MOC3009	250	30	—	125	10
MOC3010	250	15	—	125	10
MOC3011	250	10	—	125	10
MOC3012	250	5	—	125	10
MOC3020	400	30	—	125/220	10
MOC3021	400	15	—	125/220	10
MOC3022	400	10	—	125/220	10
MOC3023	400	5	—	125/220	10
MOC3031	250	15	20	125	2000
MOC3032	250	10	20	125	2000
MOC3033	250	5	20	125	2000
MOC3041	400	15	20	125/240	2000
MOC3042	400	10	20	125/240	2000
MOC3043	400	5	20	125/240	2000
MOC3061	600	15	20	280	1500
MOC3062	600	10	20	280	1500
MOC3063	600	5	20	280	1500
MOC3081	800	15	20	320	1500
MOC3082	800	10	20	320	1500
MOC3083	800	5	20	320	1500

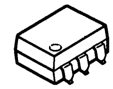
Table 11. Schmitt Trigger Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Output, 5-Ground, 6-V_{CC} (Style 5)

Device	Threshold Current On mA Max	Threshold Current Off mA Min	$I_{F(off)}/I_{F(on)}$ Min	$I_{F(off)}/I_{F(on)}$ Max	V_{CC} Min	V_{CC} Max	t_r, t_f µs Typ	V_{ISO} Vac Pk
H11L1	1.6	0.3	0.5	0.9	3	15	0.1	7500
H11L2	10	0.3	0.5	0.9	3	15	0.1	7500
MOC5007	1.6	0.3	0.5	0.9	3	15	0.1	7500
MOC5008	4	0.3	0.5	0.9	3	15	0.1	7500
MOC5009	10	0.3	0.5	0.9	3	15	0.1	7500

Devices listed in bold, italic are Motorola preferred devices.

6-Pin Surface Mount



(S) CASE 730C-04
(F) CASE 730F-04

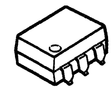
Table 12. Transistor Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 1)

Device	Current Transfer Ratio (CTR) % Min	@ I_F mA	V_{CE} Volts	$V_{CE(sat)}$ Volts Max	@ I_F mA	I_C mA	t_r/t_f or $t_{on}*/t_{off}*$ Typ µs	@ I_C mA	V_{CC} Volts	R_L Ω	I_F mA	$V_{(BR)CEO}$ Volts Min	V_F Volts Max	@ I_F mA
TIL112S,F	2	10	5	0.5	50	2	2/2	2	10	100		20	1.5	10
TIL111S,F	8	16	0.4	0.4	16	2	5/5	2	10	100		30	1.4	16
4N27S,F	10	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
4N28S,F	10	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
4N38S,F	10	10	10	1	20	4	1.6/2.2	10	10	100		80	1.5	10
H11A4S,F	10	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.5	10
4N25S,F	20	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
4N25AS,F	20	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
4N26S,F	20	10	10	0.5	50	2	1.2/1.3	10	10	100		30	1.5	10
H11A2S,F	20	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.5	10
H11A3S,F	20	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.5	10
H11A520S,F	20	10	10	0.4	20	2	5*/5*	2	10	100		30	1.5	10
H11AV3S,F	20	10	10	0.4	20	2	5*/4*	2	10	100		70	1.5	10
MCT2S,F	20	10	10	0.4	16	2	1.2/1.3		5	2k	15	30	1.5	20
MCT2ES,F	20	10	10	0.4	16	2	1.2/1.3	2	10	100		30	1.5	20
TIL116S,F	20	10	10	0.4	15	2.2	5/5	2	10	100		30	1.5	60
H11A5S,F	30	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.7	10
CNX35S,F	40–160	10	0.4	0.4	10	2	3/3*	2	5	100		30	1.5	10
CNX36S,F	80–200	10	0.4	0.4	10	4	8/6*	2	5	100		30	1.5	10
CNX83S,F	40	10	0.4	0.4	10	4	3/3*	2	5	100		50	1.5	10
CNY17-1S,F	40–80	10	5	0.4	10	2.5	1.6/2.3		5	75	10	70	1.65	60
MCT271S,F	45–90	10	10	0.4	16	2	4.9*/4.5*	2	5	100		30	1.5	20
MOC8100S,F	50	1	5	0.5	1	0.1	3.8/5.6	2	10	100		30	1.4	1
H11A1S,F	50	10	10	0.4	10	0.5	1.2/1.3	2	10	100		30	1.5	10
H11A550S,F	50	10	10	0.4	20	2	5*/5*	2	10	100		30	1.5	10
H11AV2S,F	50	10	10	0.4	20	2	5*/4*	2	10	100		70	1.5	10
TIL117S,F	50	10	10	0.4	10	0.5	5/5	2	10	100		30	1.4	16
TIL126S,F	50	10	10	0.4	10	1	2/2	2	10	100		30	1.4	10
SL5501S,F	45–250	10	0.4	0.4	20	2	20*/50*		5	1k	16	30	1.3	20
CNY17-2S,F	63–125	10	5	0.4	10	2.5	1.6/2.3		5	75	10	70	1.65	60
MCT275S,F	70–210	10	10	0.4	16	2	4.5*/3.5*	2	5	100		80	1.5	20
MCT272S,F	75–150	10	10	0.4	16	2	6*/5.5*	2	5	100		30	1.5	20
4N35S,F	100	10	10	0.3	10	0.5	3.2/4.7	2	10	100		30	1.5	10
4N36S,F	100	10	10	0.3	10	0.5	3.2/4.7	2	10	100		30	1.5	10
4N37S,F	100	10	10	0.3	10	0.5	3.2/4.7	2	10	100		30	1.5	10
H11A5100S,F	100	10	10	0.4	20	2	5*/5*	2	10	100		30	1.5	10
CNY17-3S,F	100–200	10	5	0.4	10	2.5	1.6/2.3		5	75	10	70	1.65	60
SL5500S,F	50–300	10	0.4	0.4	50	10	20*/50*		5	1k	16	30	1.3	20
H11AV1S,F	100–300	10	10	0.4	20	2	5*/4*	2	10	100		70	1.5	10
MCT273S,F	125–250	10	10	0.4	16	2	7.6*/6.6*	2	5	100		30	1.5	20
MCT274S,F	225–400	10	10	0.4	16	2	9.1*/7.9*	2	5	100		30	1.5	20

Devices listed in bold, italic are Motorola preferred devices.

Optoisolators: 6-Pin Surface Mount (continued)



(S) CASE 730C-04
(F) CASE 730F-04

Table 13. Transistor Output with No Base Connection

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-N.C. (Style 3)

Device	Current Transfer Ratio (CTR) % Min	@ I_F mA	V_{CE} Volts	$V_{CE(sat)}$ Volts Max	@ I_F mA	I_C mA	t_r/t_f or t_{on}^*/t_{off}^* Typ µs	@ I_C mA	V_{CC} Volts	R_L Ω	I_F mA	$V_{(BR)CEO}$ Volts Min	V_F Volts Max	@ I_F mA
MOC8101S,F	50–80	10	10	0.4	5	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8102S,F	73–117	10	10	0.4	5	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8103S,F	108–173	10	10	0.4	5	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8104S,F	160–256	10	10	0.4	5	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8111S,F	20	10	10	0.4	10	0.5	3.2/4.7	2	10	100		30	1.5	10
CNX82S,F	40	10	0.4	0.4	10	4	3/3*	2	5	100		50	1.5	10
MOC8112S,F	50	10	10	0.4	10	0.5	3.2/4.7	2	10	100		30	1.5	10
MOC8113S,F	100	10	10	0.4	10	0.5	3.2/4.7	2	10	100		30	1.5	10

Table 14. AC Input – Transistor Output

Pinout: 1-LED 1 Anode/LED 2 Cathode, 2-LED 1 Cathode/LED 2 Anode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 8)

H11AA1S,F	20	±10	10	0.4	±10	0.5						30	1.5	±10
H11AA2S,F	10	±10	10	0.4	±10	0.5						30	1.8	±10
H11AA3S,F	50	±10	10	0.4	±10	0.5						30	1.5	±10
H11AA4S,F	100	±10	10	0.4	±10	0.5						30	1.5	±10

Table 15. AC Input – Resistor Darlington Output

Pinout: 1-LED 1 Anode/LED 2 Cathode, 2-LED 1 Cathode/LED 2 Anode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 8)

MOC8060S,F	1000	±10	10	2	±10	100						50	1.5	±10

Table 16. Darlington Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 1)

4N31S,F	50	10	10	1.2	8	2	0.6*/17*	50	10		200	30	1.5	10
4N29S,F	100	10	10	1	8	2	0.6*/17*	50	10		200	30	1.5	10
4N30S,F	100	10	10	1	8	2	0.6*/17*	50	10		200	30	1.5	10
H11B255S,F	100	10	5	1	50	50	125*/100*	10	10	100		55	1.5	20
MCA230S,F	100	10	5	1	50	50	10/35		10	100	50	30	1.5	20
MCA255S,F	100	10	5	1	50	50	10/35		10	100	50	55	1.5	20
H11B2S,F	200	1	5	1	1	1	1/2	10	10	100		25	1.5	10
MCA231S,F	200	1	1	1.2	10	50	80	10	10	100		30	1.5	20
TIL113S,F	300	10	1.25	1	50	125	300	125	15	100		30	1.5	10
4N32S,F	500	10	10	1	8	2	0.6*/45*	50	10		200	30	1.5	10
4N33S,F	500	10	10	1	8	2	0.6*/45*	50	10		200	30	1.5	10
H11B1S,F	500	1	5	1	1	1	1/2	10	10	100		25	1.5	10
MOC8080S,F	500	10	5	1	1	1	1/2		10	100	5	55	1.5	10

Table 17. Darlington Output with No Base Connection

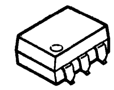
Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-N.C. (Style 3)

MOC119S,F	300	10	2	1	10	10	1/2	2.5	10	100		30	1.5	10
TIL119S,F	300	10	2	1	10	10	300	2.5	10	100		30	1.5	10
MOC8030S,F	300	10	1.5				1/2		50	100	10	80	2	10
MOC8020S,F	500	10	5				1/2		50	100	10	50	2	10
MOC8050S,F	500	10	1.5				1/2		50	100	10	80	2	10
MOC8021S,F	1000	10	5				1/2		50	100	10	50	2	10

For Surface Mountable standard leadform, Order "S" suffix devices; e.g., MOC3043S.
For low profile Surface Mountable leadform, Order "F" suffix devices; e.g., MOC5007F.
For 24 mm Tape and Reel, add R2 suffix to the 6-pin optoisolator part number; e.g., H11A1SR2. (See Tape and Reel Specifications Section for more information)

Devices listed in bold, italic are Motorola preferred devices.

Optoisolators: 6-Pin Surface Mount (continued)



(S) CASE 730C-04
(F) CASE 730F-04

Table 18. Resistor Darlington Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 1)

Device	Current Transfer Ratio (CTR) % Min	@ I_F mA	V_{CE} Volts	$V_{CE(sat)}$ Volts Max	@ I_F mA	I_C mA	t_r/t_f or t_{on}*/t_{off}* Typ µs	@ I_C mA	V_{CC} Volts	R_L Ω	I_F mA	$V_{(BR)CEO}$ Volts Min	V_F Volts Max	@ I_F mA
H11G1S,F	1000	10	1	1	1	1	5*/100*		5	100	10	100	1.5	10
H11G2S,F	1000	10	1	1	1	1	5*/100*		5	100	10	80	1.5	10
H11G3S,F	200	1	5	1.2	50	20	5*/100*		5	100	10	55	1.5	10

Table 19. High Voltage Transistor Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Emitter, 5-Collector, 6-Base (Style 1)

MOC8204S,F	20	10	10	0.4	10	0.5	5*/5*	2	10	100		400	1.5	10
H11D1S,F	20	10	10	0.4	10	0.5	5*/5*	2	10	100		300	1.5	10
H11D2S,F	20	10	10	0.4	10	0.5	5*/5*	2	10	100		300	1.5	10

Table 20. Triac Driver Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Main Terminal, 5-Substrate, 6-Main Terminal (Style 6)

Device	Peak Blocking Voltage Min	LED Trigger Current-I_{FT} (V_{TM} = 3 V) mA Max	Zero Crossing Inhibit Voltage (at rated I_{FT}) Volts Max	Operating Voltage Vac Pk	dv/dt V/µs Typ
MOC3009S,F	250	30	—	125	10
MOC3010S,F	250	15	—	125	10
MOC3011S,F	250	10	—	125	10
MOC3012S,F	250	5	—	125	10
MOC3020S,F	400	30	—	125/220	10
MOC3021S,F	400	15	—	125/220	10
MOC3022S,F	400	10	—	125/220	10
MOC3023S,F	400	5	—	125/220	10
MOC3031S,F	250	15	20	125	2000
MOC3032S,F	250	10	20	125	2000
MOC3033S,F	250	5	20	125	2000
MOC3041S,F	400	15	20	125/220	2000
MOC3042S,F	400	10	20	125/220	2000
MOC3043S,F	400	5	20	125/220	2000
MOC3061S,F	600	15	20	280	1500
MOC3062S,F	600	10	20	280	1500
MOC3063S,F	600	5	20	280	1500
MOC3081S,F	800	15	20	320/280	1500
MOC3082S,F	800	10	20	320/280	1500
MOC3083S,F	800	5	20	320/280	1500

Table 21. Schmitt Trigger Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Output, 5-Ground, 6-V_{CC} (Style 5)

Device	Threshold Current On mA Max	Current Off mA Min	$I_{F(off)}/I_{F(on)}$ Min	$I_{F(off)}/I_{F(on)}$ Max	V_{CC} Min	V_{CC} Max	t_r, t_f µs Typ	V_{ISO} Vac Pk
H11L1S,F	1.6	0.3	0.5	0.9	3	15	0.1	3535
H11L2S,F	10	0.3	0.5	0.9	3	15	0.1	3535
MOC5007S,F	1.6	0.3	0.5	0.9	3	15	0.1	

For Surface Mountable standard leadform, Order "S" suffix devices; e.g., MOC3043S.
For low profile Surface Mountable leadform, Order "F" suffix devices; e.g., MOC5007F.
For 24 mm Tape and Reel, add R2 suffix to the 6-pin optoisolator part number; e.g., H11A1SR2. (See Tape and Reel Specifications Section for more information.)

Devices listed in bold, italic are Motorola preferred devices.

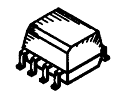
Table 21. Schmitt Trigger Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-Output, 5-Ground, 6-V_{CC} (Style 5)

Device	Threshold Current On mA Max	Current Off mA Min	$I_{F(off)}/I_{F(on)}$ Min	Max	V_{CC} Min	Max	t_r, t_f µs Typ	V_{ISO} Vac Pk
MOC5008S,F	4	0.3	0.5	0.9	3	15	0.1	
MOC5009S,F	10	0.3	0.5	0.9	3	15	0.1	

For Surface Mountable standard leadform, Order "S" suffix devices; e.g., MOC3043S.
For low profile Surface Mountable leadform, Order "F" suffix devices; e.g., MOC5007F.
For 24 mm Tape and Reel, add R2 suffix to the 6-pin optoisolator part number; e.g., H11A1SR2. (See Tape and Reel Specifications Section for more information.)

Small Outline — Surface Mount



CASE 846-01
SO-8 DEVICES

Table 22. Transistor Output

Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-N.C., 5-Emitter, 6-Collector, 7-Base, 8-N.C. (Style 1)

Device	Marking	Current Transfer Ratio % Min	@ I_F mA	V_{CE} Volts	$V_{CE(sat)}$ Volts Max	@ I_F mA	I_C mA	t_r/t_f Typ µs	@ I_C mA	V_{CC} Volts	R_L Ω	$V_{(BR)CEO}$ Volts Min	V_F Volts Max	@ I_F mA
MOC205R1/R2	M205	40–80	10	10	0.4	10	2	1.6	2	10	100	70	1.5	10
MOC206R1/R2	M206	63–125	10	10	0.4	10	2	1.6	2	10	100	70	1.5	10
MOC207R1/R2	M207	100–200	10	10	0.4	10	2	1.6	2	10	100	70	1.5	10
MOC211R1/R2	M211	20	10	10	0.4	10	2	3.2	2	10	100	30	1.5	10
MOC212R1/R2	M212	50	10	10	0.4	10	2	3.2	2	10	100	30	1.5	10
MOC213R1/R2	M213	100	10	10	0.4	10	2	3.2	2	10	100	30	1.5	10
MOC215R1/R2	M215	20	10	5	0.4	1	0.1	3.2	2	10	100	30	1.3	1
MOC216R1/R2	M216	50	10	5	0.4	1	0.1	3.2	2	10	100	30	1.3	1
MOC217R1/R2	M217	100	10	5	0.4	1	0.1	3.2	2	10	100	30	1.3	1

Table 23. Darlington Output

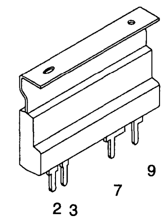
Pinout: 1-Anode, 2-Cathode, 3-N.C., 4-N.C., 5-Emitter, 6-Collector, 7-Base, 8-N.C. (Style 1)

MOC221R1/R2	M221	100	1	5	1	1	0.5	2	5	10	100	30	1.3	1
MOC222R1/R2	M222	200	1	5	1	1	0.5	2	5	10	100	30	1.3	1
MOC223R1/R2	M223	500	1	5	1	1	0.5	2	5	10	100	30	1.3	1

All devices are shipped in tape and reel format. (See Tape and Reel Specifications Section for more information.)

Devices listed in bold, italic are Motorola preferred devices.

POWER OPTO™ Isolators



CASE 417-02
PLASTIC PACKAGE

Table 24. POWER OPTO Isolator 2 Amp Zero-Cross Triac Output

Pinout: (1,4,5,6,8 No Pin), 2 – LED Cathode, 3– LED Anode, 7-Main Terminal, 9-Main Terminal)

Device	Peak Blocking Voltage (Volts) Min	Led Trigger Current If T (V_{TM} = 2 V) mA Max	On State Voltage V_{TM} (Rated I_{FT} I_{TM} = 2 A) (Volts) Max	Zero Crossing Inhibit Voltage (I_F = Rated I_{FT}) (Volts) Max	Operating Voltage Vac Pk (Volts)	dv/dt (static) v/µs V_{IN} = 200 V) (V/µs Min
MOC2A40-5/F	400	5	1–3	10	125	400
MOC2A40-10/F	400	10	1–3	10	125	400
MOC2A60-5/F	600	5	1–3	10	125/220	400
MOC2A60-10/F	600	10	1–3	10	1215/220	400

All devices are shipped in tape and reel format. (See Tape and Reel Specifications and Packaging Specifications Section for more information.
No suffix = Style 2 (Standard Heat Tab), "F" suffix = Style 1 (Flush Mount Heat Tab).

Devices listed in bold, italic are Motorola preferred devices.

Emitters/Detectors

Infrared Emitting Diodes

Motorola's infrared emitting diodes are made by the liquid phase epitaxial process for long life and stability. They provide high power output and quick response at 660 nm, 850 nm or 940 nm with low input drive current.

Table 25. Infrared Emitting Diodes

Device	Power Output µW Typ	@ I_F mA	Emission Angle Typ	Peak Emission Wavelength nm Typ	Forward Voltage Max	@ I_F mA	Case/ Style
MLED91	2500	50	60°	940	1.8	50	422A-01/1
MLED96	4000	100	60°	660	2.2	60	422A-01/4
MLED97	2500	100	60°	850	2	100	422A-01/4
MLED81	16000	100	60°	940	1.7	100	279B-01/1
MLED930	650	100	30°	940	1.5	50	209-01/1

Silicon Photodetectors

A variety of silicon photodetectors are available, varying from simple PIN diodes to complex, single chip 400 volt triac drivers. They offer choices of viewing angle and size in either economical plastic cases or rugged, hermetic metal cans. They are spectrally matched for use with Motorola infrared emitting diodes.

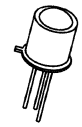
Table 26. PIN Photodiodes – Response Time = 1 ns Typ

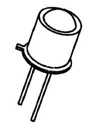
Device	Light Current @ V_R = 20 V, H = 5 mW/cm^2 µA	Dark Current @ V_R = 20 V nA (Max)	Case/ Style
MRD500	9	2	209-02/1
MRD510	2	2	210-01/1
MRD921	4	10	422A-01/1
MRD821	250	60	381-01/1

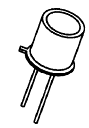
Table 27. Phototransistors

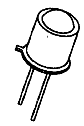
Device	Light Current @ V_{CC}=20, H=5 mW/cm^2 mA (Typ)	$V_{(BR)CEO}$ Volts (Min)	t_r/t_f @ V_{CC}=20, I_L=1000 µA µs (Typ)	Case/ Style
MRD310	3.5	50	2/2.5	82-05/1
MRD300	8	50	2/2.5	
MRD3050	0.1 Min	30	2/2.5	
MRD3056	2 Min	30	2/2.5	
			t_{on}/t_{off} @ V_{CC}=5 V	
MRD901	0.5	30	10/60	422A-01/2

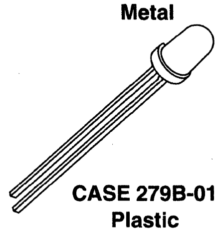
All case 422 and 422A devices are available in Tape and Reel format. Add RLRE suffix to the part number; e.g. MRD901RLRE. (See Tape and Reel Specifications Section for more information)

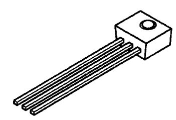

CASE 82-05
Metal

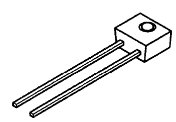

CASE 209-01
Metal


CASE 210-01
Flat Lens
Metal


CASE 209-02
Convex Lens
Metal


CASE 279B-01
Plastic


CASE 422-01
Plastic


CASE 422A-01
Plastic

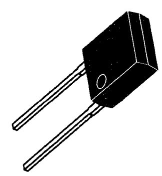

CASE 381-01
Plastic

Table 28. Photodarlingtons

Device	Light Current @ V_{CC}=5, H=0.5 mW/cm^2 mA (Typ)	$V_{(BR)CEO}$ Volts (Min)	t_r/t_f @ V_{CC}=5 V µs (Typ)	Case/ Style
MRD370	10	40	15/40	82-05/1
MRD360	20	40	15/65	
MRD911	25	60	125/150	422A-01/2

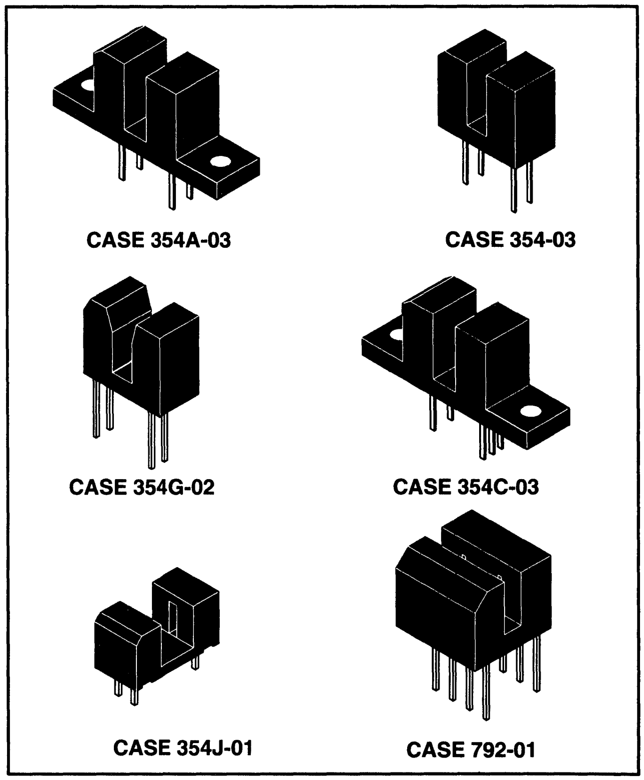
Table 29. Photo Triac Drivers

Device	H_{FT} mW/cm^2 Max	$I_{T(RMS)}$ mA Max	V_{DRM} Volts Peak Min	I_{DRM} nA Typ	Case/ Style
MRD3010	5	100	250	10	82-05/3

Table 30. Photo Schmitt Triggers

Device	Threshold Current mA ON Max	Threshold Current mA OFF Min	$\frac{I_{F(off)}}{I_{F(on)}}$ Typ	V_{CC} Volts	t_r/t_f µs Typ	Case/ Style
MRD950	20	1	0.75	3–15	0.1	422-01/3
MRD5009	20	1	0.75	3–15	0.1	82-05/1

Devices listed in bold, italic are Motorola preferred devices.



Optointerrupters

An Optointerrupter consists of an infrared emitting diode facing a photodetector in a molded plastic housing. A slot in the housing between the emitter and detector provides a means for interrupting the signal transmission.

Motorola Optointerrupters are available in a wide selection of detector functions and housings to meet the designer's system requirements.

Motorola also offers custom designed packaging in a broad range of output functions, including those shown below, and more. Contact your nearest Motorola Sales Office or call us at 602-BIG-OPTO.

Table 31. Transistor

Device	Current Transfer Ratio % Min	@ I_F mA	V_{CE} Volts	$V_{CE(sat)}$ Volts Max	@ I_F mA	I_C mA	V_F Volts Max	@ I_F mA	Output Voltage Range Volts Max	Package Case/Style
H21A1	5	20	5	0.4	30	1.8	1.7	60	30	354A-03/1
H21A2	10	20	5	0.4	20	1.8	1.7	60	30	354A-03/1
H21A3	20	20	5	0.4	20	1.8	1.7	60	30	354A-03/1
H22A1	5	20	5	0.4	30	1.8	1.7	60	30	354-03/1
H22A2	10	20	5	0.4	20	1.8	1.7	60	30	354-03/1
H22A3	20	20	5	0.4	20	1.8	1.7	60	30	354-03/1
MOC70T1	5	20	10	0.4	30	1.8	1.8	50	30	354A-03/1
MOC70T2	10	20	10	0.4	20	1.8	1.8	50	30	354A-03/1
MOC70P1	5	20	10	0.4	30	1.8	1.8	50	30	354J-01/1
MOC70P2	10	20	10	0.4	20	1.8	1.8	50	30	354J-01/1
MOC70V1	5	20	10	0.4	30	1.8	1.8	50	30	354G-02/1

Table 32. Dual Channel — Transistor

MOC70W1	0.5	20	10	0.4	20	0.1	1.8	50	30	792-01/2

Table 33. Darlington

H21B1	75	10	1.5	1	10	1.8	1.7	60	30	354A-023/1
H22B1	75	10	1.5	1	10	1.8	1.7	60	30	354-03/1

Table 34. Logic

Device	LED Trigger Current mA	Hysteresis Ratio $I_{F(off)}/I_{F(on)}$	$t_{(on)}/t_{(off)}$ µs	V_F Volts Max	@ I_F mA	Output Voltage Range Volts	Package Case/Style
MOC75T1	30	0.75	1.2	1.6	20	3–15	354C-03/1

Devices listed in bold, italic are Motorola preferred devices.

Fiber Optic Components

Emitters

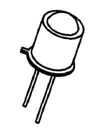
Motorola offers two families of emitters for fiber optic systems.

- **"High Performance"** family in hermetic Case 210 for systems requiring greater than 100 MHz analog bandwidth over several kilometers. An additional family in Case 210 provides electrical performance (120 MHz) over moderate distances (500 meters) and is specified for use with hard clad silica fiber (Ensign-Bickford HCP — MO200T-06)
- **"POF"** family in unique Plastic Optic Fiber package is designed for applications requiring low cost, speeds up to 10 MHz and distances under 200 meters. (The POF package serves as its own connector.) It is used with inexpensive 1000 micron plastic core fiber (Eska SH4001).

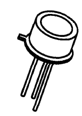
Detectors

Detectors are available with a variety of output configurations that greatly affect bandwidth and responsivity.

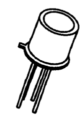
All Motorola fiber optic components, except the POF family, are designed for use with 100 micron (or larger) core glass fiber and fit directly into the following industry standard connector systems. AMP #228756-1, AMPHENOL #905-138-5001, OFTI #PCR001.



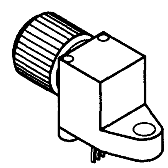
CASE 209-02/1



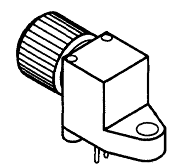
CASE 210A-01/1
TO-206AC
(TO-52)



CASE 210D-01/1
(TO-52 Type)



POF
CASE 363C-01/1
(3-lead)



POF
CASE 363B-01/1
(2-lead)

Table 35. Emitters

Device	Total Power Output mW Typ	@ I_F mA	Response Time t_r ns Typ	t_f ns Typ	λ nm Typ	Case/Style
MFOE71	3.5	100	25	25	820	363B-01/1
MFOE76	3.5	100	200	150	660	
MFOE200	3	100	250	250	940	209-02/1
MFOE1100	2.6	100	15	16	850	210A-01/1
MFOE1101	4	100	15	16	850	
MFOE1102	5	100	15	16	850	
MFOE1200	0.9	100	5	5	850	210A-01/1
MFOE1201	1.5	100	2.8	3.5	850	
MFOE1202	2.4	100	2.8	3.5	850	
MFOE1203	2.8	100	2.8	3.5	850	
MFOE1300	5	100	15	16	850	210A-01/1
MFOE1400	2.5	100	2.8	3.5	850	

Devices listed in bold, italic are Motorola preferred devices.

Fiber Optic Components: Detectors (continued)

Table 36. Detectors

Device	BWE MHz	Responsivity μA/μW Typ	Response Time μs Typ t_{on}* t_r	t_{off}* t_f	$V_{(BR)}$ Volts Min	Case/Style
Photo PIN Diodes						
MFOD1100	350	0.35	0.5 ns	0.15 ns	50	210A-01/1
MFOD71	70	0.2	1* ns	1* ns	100	363B-01/3
Phototransistors						
MFOD72	6 kHz	125	10*	60*	30	363B-01/2
Photodarlingtons						
MFOD73	2 kHz	1500	125*	150*	60	363B-01/2
		mV/μW			V_{CC} Range	
Detector Preamps						
MFOD2404	10	35	0.035	0.035	4–6	
MFOD2405	35	6	0.010	0.010	4–6	210D-01/1

ACT Align Series Receptacle Mounted

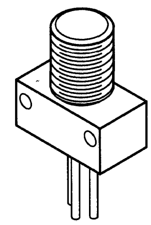
Fiber Optic Transmitter and Receiver Components

Motorola ACT Align Fiber Optic Components eliminate the time consuming and often performance robbing process of aligning fiber optic components within commercial housings. Utilizing advanced techniques Motorola can install any Motorola fiber optic component into the connector of your choice and guarantee the listed performance characteristics.

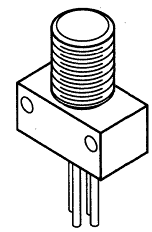
- Guaranteed performance
- Cost effective installation
- Improved coupling efficiency
- Lowers connector loss
- High launched power
- Industry standard connectors
- Designed for 100 Micron core fibers (62.5 and 50 Micron core fibers available)
- MFOE1300/1400 designed for use with 200 Micron core hard clad silica fiber (Ensign-Bickford HCP-MO200T-06)
- Connectors designed for board or panel mounting
- If you desire another connector type, or are using a fiber core diameter other than stated, please contact us at 602-BIG-OPTO

Ordering Information

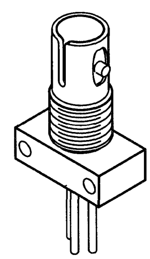
To order Fiber Optic components simply add the connector suffix to the Motorola base device designation. For example: to order an MFOE1201 fiber optic emitter in an SMA low profile connector order part number MFOE1201SMA.



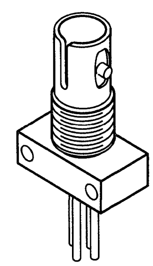
CASE 364-01
Low Profile SMA



CASE 364A-01
Low Profile SMA



CASE 364B-01
Low Profile ST®



CASE 364C-01
Low Profile ST®

Table 37. Emitters

Device	Power Launched			Response Time		
	µW Min	Max	I_F mA	t_r ns Typ	t_f ns Typ	λ nm Typ
MFOE200			100			940
MFOE1100	60	—	100	15	16	850
MFOE1101	120	240	100	15	16	850
MFOE1102	180	360	100	15	16	850
MFOE1200	60	—	100	5	5	850
MFOE1201	40	80	100	2.8	3.5	850
MFOE1202	75	150	100	2.8	3.5	850
MFOE1203	135	270	100	2.8	3.5	850
MFOE1300	1000	—	100	15	16	850
MFOE1400	800	—	100	2.8	3.5	850

Table 38. Detectors

Device	BWE MHz	Responsivity µA/µW Typ	Response Time µs Typ		$V_{(BR)}$ Volts Min
			t_{on} t_r	t_{off} t_f	
Photo Pin Diodes					
MFOD1100	350	0.35	0.5 ns	0.5 ns	50
Detector Preamps					
		mV/µW			V_{CC} Range
MFOD2404	10	35	0.035	0.035	4–6
MFOD2405	35	6	0.01	0.01	4–6

Optoelectronic Chips

Motorola offers Optoelectronic chips for use in hybrid assembly and other customer applications. These chips are the same high quality, high performance Light Emitting Diodes and Detectors utilized in Motorola Optoisolators and Discrete components.

Electrical Specifications and Ordering Information

- All dice have aluminum front metallization (minimum 10000 Å) and Gold back metal (minimum 15000 Å).
- All wafers are .008 to .010 inch thick
- All wafers are unsawed and shipped in anti-static protective containers
- Minimum order quantity is one whole wafer, see "Good Die Per Wafer" column for estimated die quantity
- All shipments in whole wafer increments

Table 39. LED

Chip Part Number	Die Geometry Reference #	Parameter	Symbol	Min	Typ	Max	Units	Estimated Good Chip Per Wafer
MLEDC1000WP	1	Peak Wavelength (I_F = 50 mA)	λ_p	—	940	—	nm	10450
		Total Power Out (I_F = 50 mA)	P_o	2	—	—	mW	
		Forward Voltage (I_F = 50 mA)	V_F	—	—	1.5	V	
MFOEC1200WP Fiber Optic	2	Peak Wavelength (I_F = 100 mAdc)	λ_p	—	850	—	nm	1470
		Total Power Out (I_F = 100 mA)	P_o	1.5	—	—	mW	
		Forward Voltage (I_F = 100 mA)	V_F	1	—	2.5	V	

Table 40. Pin Diode

MRDC100WP	3	Responsivity (V_R = 20 V, λ = 850 nm)	R	0.3	0.4	—	μA/μW	9860
		Dark Current (V_R = 20 V, H = 0)	I_D	—	—	10	nA	
MFODC1100WP Fiber Optic	4	Responsivity (V_R = 5 V, λ = 850 nm, P = 10 μW)	R	0.3	0.4	—	μA/μW	9860
		Dark Current (V_R = 5 V, H = 0, R_L = 1 Mohm)	I_D	—	—	1	nA	

Table 41. Transistor

MRDC200WP	5	Light Current (V_{CE} = 5 V, H = 5 mW/cm^2)	I_L	0.8	—	22	mA	11600
		Collector-Emitter Breakdown Voltage (I_{CE} = 100 μA)	$V_{(BR)CEO}$	40	—	—	V	

Table 42. Darlington

MRDC400WP	6	Light Current (V_{CE} = 5 V, H = 1 mW/cm^2)	I_L	0.8	—	20	mA	14600
		Collector-Emitter Breakdown Voltage (I_{CE} = 1 mA)	$V_{(BR)CEO}$	45	—	—	V	

Devices listed in bold, italic are Motorola preferred devices.

Optoelectronic Chips (continued)

Table 43. Triac Driver

Chip Part Number	Die Geometry Reference #	Parameter	Symbol	Min	Typ	Max	Units	Estimated Good Chip Per Wafer
MRDC800WP Random Phase	7	Trigger Current (λ = 940 nm, V_{TM} = 3 V, R_L = 150 ohm)	H_{FT}	—	5	10	mW/cm^2	5444
		On-State RMS Current (Full Cycle 50–60 Hz)	$I_{T(RMS)}$	—	—	100	mA	
		Off-State Output Terminal Voltage	V_{DRM}	—	—	400	V	
		Peak Blocking Current (V_{DRM} = 400 V)	I_{DRM}	—	10	100	nA	
MRDC600WP Zero Crossing	8	Trigger Current (λ = 940 nm, V_{TM} = 3 V, R_L = 150 ohm)	H_{FT}	0	5	10	mW/cm^2	4180
		Peak Repetitive Current (PW = 100 μs, 120 pps)	I_T	—	—	300	mA	
		Off-State Output Terminal Voltage	V_{DRM}	—	—	600	V	
		Peak Blocking Current (V_{DRM} = 400 V)	I_{DRM}	—	60	500	nA	
		Inhibit Voltage (H = 20 mW/cm^2, MT1-MT2; voltage above which device will not trigger	V_{IH}	—	10	20	V	

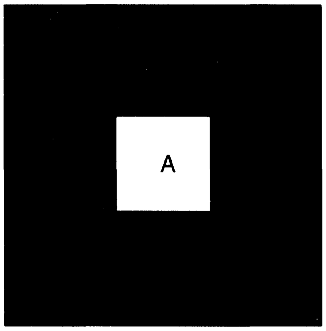
Devices are available in sawed wafer format by substituting the WP suffix with a CP suffix; e.g. use MRDC600CP to order MRDC600 in sawed wafer format.

Devices listed in bold, italic are Motorola preferred devices.

Optoelectronic Chips (continued)

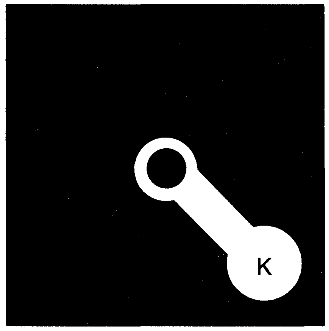
Geometries, Chip Size, Bond Pad Size

1



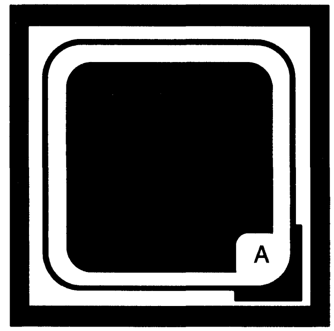
Chip Size: 15 x 15 mils/0.4 x 0.4 mm
Bond Pad Size:
Anode — 4 x 4 mils/0.1 x 0.1 mm
Cathode — =15 x 15 mils/0.4 x 0.4 mm

2



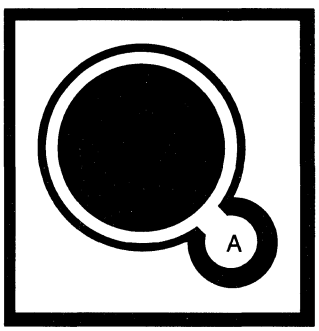
Chip Size: 24 x 24 mils/0.6 x 0.6 mm
Bond Pad Size:
Anode — 24 x 24 mils/0.6 x 0.6 mm
Cathode — 3.5 mils dia./0.09 mm dia.

3



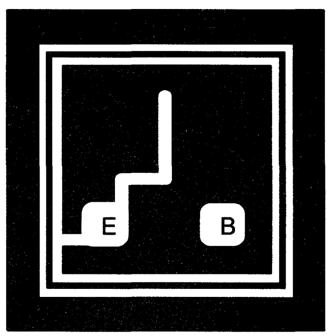
Chip Size: 30 x 30 mils/0.76 x 0.76 mm
Bond Pad Size:
Anode — 4.5 x 4.5 mils/0.11 x 0.11 mm
Cathode — 30 x 30 mils/0.76 x 0.76 mm

4



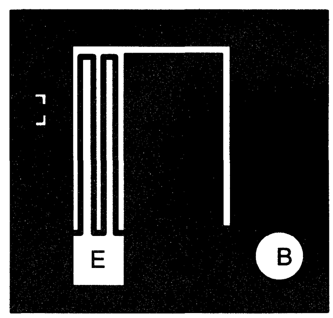
Chip Size: 30 x 30 mils/0.76 x 0.76 mm
Bond Pad Size:
Anode — 4.0 mils dia./0.1 mm dia.
Cathode — 30 x 30 mils/0.76 x 0.76 mm

5



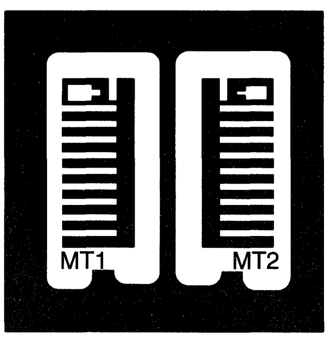
Chip Size: 25 x 25 mils/0.64 x 0.64 mm
Bond Pad Size:
Emitter — .3.5 x 3.5 mils/0.09 x 0.09 mm
Base — .3.5 x 3.5 mils/0.09 x 0.09 mm

6



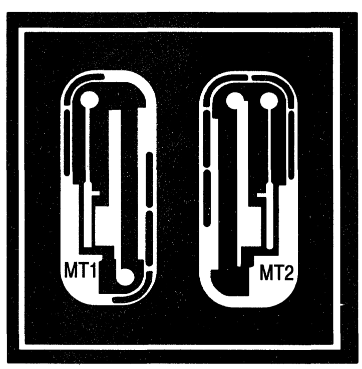
Chip Size: 27 x 27 mils/0.69 x 0.69 mm
Bond Pad Size:
Emitter — .4.0 x 4.0 mils/0.1 x 0.1 mm
Base — .4.0 mils dia./0.1 mm dia.

7



Chip Size: 40 x 40 mils/1.0 x 1.0 mm
Bond Pad Size:
MT — .14.0 x 5.0 mils/0.1 x 0.13 mm
MT — .24.0 x 5.0 mils/0.1 x 0.13 mm

8



Chip Size: 45 x 45 mils/1.14 x 1.14 mm
Bond Pad Size:
MT — .14.6 mils dia./0.12 mm dia.
MT — .24.6 mils dia./0.12 mm dia.

A = Anode
B = Base
C = Collector
E = Emitter
G = Gate
K = Cathode

Front Metallization Thickness — a minimum of 10000 Å
Back Metallization Thickness — a minimum of 15000 Å

Sensors

In Brief . . .

Pressure Sensors

The marriage of integrated circuit technology with the most advanced pressure sensor architecture now offers an unrivaled combination of performance, reliability and design adaptability in a single monolithic pressure sensing element — the Motorola MPX series of pressure transducers. Available in three versions:

- *Fully signal conditioned for high-level output (single chip device designed to compete with modules);*
- *Temperature compensated and calibrated, for simplified circuit design;*
- *Uncompensated for unlimited adaptability*

This series of sensors provides both electrical and mechanical design-in options that uniquely fit the varying requirements of the system designer.

Temperature Sensors

The sensitivity of a semiconductor junction to variation in temperature is utilized in a series of temperature-calibrated transistors that provide high temperature accuracy (± 2% over a temperature range from – 40 ° to +150 ° C at low cost).

Page

Pressure Sensors

Introduction

Motorola pressure sensors combine advanced piezoresistive sensor architecture with integrated circuit technology to offer a wide range of pressure sensing devices for automotive, biomedical, consumer and industrial applications. Selection versatility includes choice of:

Pressure Ranges in PSI
0 to 1.5, 0 to 7.3, 0 to 14.5, 0 to 29, 0 to 100

Sensing Options
Uncompensated, Temperature Compensated/Calibrated, Signal Conditioned (with on-chip amplifiers)

Application Measurements
Absolute, Differential, Gauge

Package Options
Basic Element, Ported Elements for specific measurements

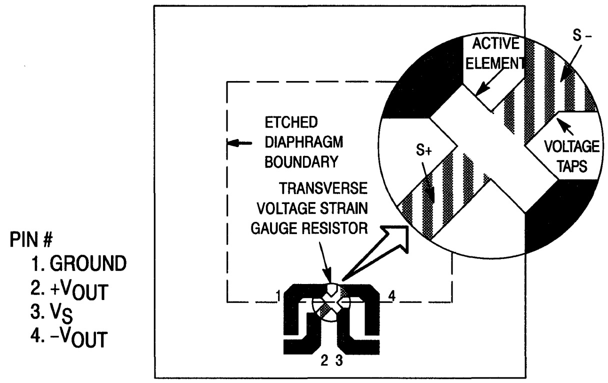


Figure 1. Basic Uncompensated Sensor Element — Top View

The Basic Structure

The Motorola pressure sensor is designed utilizing a monolithic silicon piezoresistor, which generates a changing output voltage with variations in applied pressure. The resistive element, which constitutes a strain gauge, is ion implanted on a thin silicon diaphragm.

Applying pressure to the diaphragm results in a resistance change in the strain gauge, which in turn causes a change in the output voltage in direct proportion to the applied pressure. The strain gauge is an integral part of the silicon diaphragm, hence there are no temperature effects due to differences in thermal expansion of the strain gauge and the diaphragm. The output parameters of the strain gauge itself are temperature dependent, however, requiring that the device be compensated if used over an extensive temperature range. Simple resistor networks can be used for narrow temperature ranges, i.e., 0°C to 85°C. For temperature ranges from –40°C to +125°C, more extensive compensation networks are necessary.

Motorola's Patented X-ducer™

Excitation current is passed longitudinally through the resistor (taps 1 and 3), and the pressure that stresses the diaphragm is applied at a right angle to the current flow. The stress establishes a transverse electric field in the resistor that is sensed as voltage at taps 2 and 4, which are located at the midpoint of the resistor. The single-element transverse voltage strain gauge can be viewed as the mechanical analog of a Hall effect device.

Using a single element eliminates the need to closely match the four stress and temperature sensitive resistors that form a Wheatstone bridge design. At the same time, it greatly simplifies the additional circuitry necessary to accomplish calibration and temperature compensation. The offset does not depend on matched resistors but instead on how well the transverse voltage taps are aligned. This alignment is accomplished in a single photolithographic step, making it easy to control, and is only a positive voltage, simplifying schemes to zero the offset.

Linearity

Linearity refers to how well a transducer's output follows the equation: $V_{out} = V_{off}$ + sensitivity x P over the operating pressure range. There are two basic methods for calculating nonlinearity: (1) end point straight line fit (see Figure 2) or (2) a least squares best line fit. While a least squares fit gives the "best case" linearity error (lower numerical value), the calculations required are burdensome.

Conversely, an end point fit will give the "worst case" error (often more desirable in error budget calculations) and the calculations are more straightforward for the user. Motorola's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

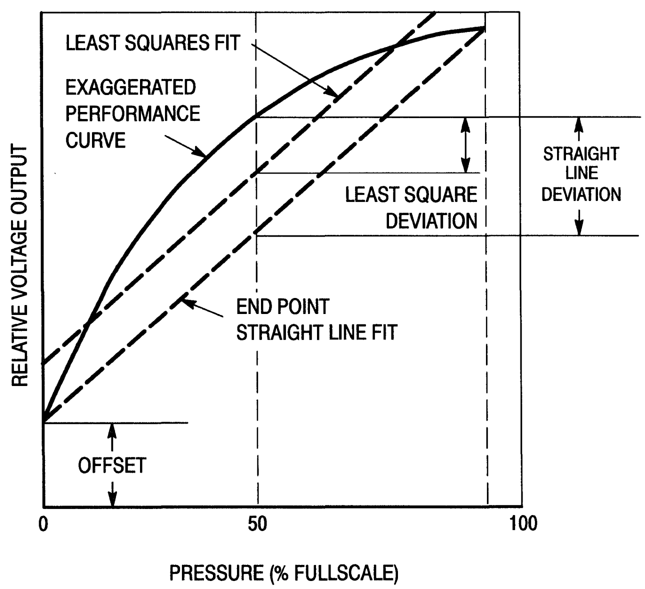


Figure 2. Linearity Specification Comparison

Pressure Sensors (continued)

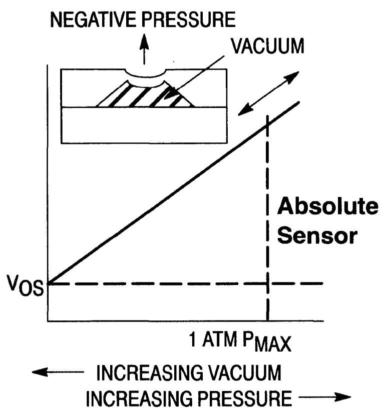
Operation

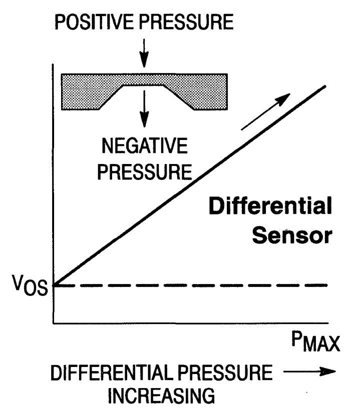
Motorola pressure sensors support three types of pressure measurements: Absolute Pressure, Differential Pressure and Gauge Pressure.

Absolute Pressure Sensors measure an external pressure relative to a zero-pressure reference (vacuum) sealed inside the reference chamber of the die during manufacture. This corresponds to a deflection of the diaphragm equal to approximately 15 PSI (one atmosphere), generating a quiescent full-scale output for the MPX100A (15 PSI) sensor, and a half-scale output for the MPX200A (30 PSI) device. Measurement of external pressure is accomplished by applying a relative negative pressure to the "Pressure" side of the sensor.

Differential Pressure Sensors measure the difference between pressures applied simultaneously to opposite sides of the diaphragm. A positive pressure applied to the "Pressure" side generates the same (positive) output as an equal negative pressure applied to the "Vacuum" side.

Gauge Pressure readings are a special case of differential measurements in which the pressure applied to the Pressure side is measured against the ambient atmospheric pressure applied to the Vacuum side through the vent hole in the chip of the differential pressure sensor elements.





Motorola sensing elements can withstand pressure inputs as high as four times their rated capacity, although accuracy at pressures exceeding the rated pressure will be reduced. When excessive pressure is reduced, the previous linearity will immediately be restored.

Figure 3. Pressure Measurements

Electrical Characteristics

Table 1. Uncompensated (V_S = 3 Vdc, T_A = 25°C)

Device Series	Pressure Range kPa/psi	Over Pressure (kPa)	Offset mV (Typ)	Full Scale Span mV (Typ)	Sensitivity (mV/kPa) (Typ)	Linearity % of FSS(1) (Min)	(Max)	Temperature Coefficient of Span %/°C (Typ)	Input Impedance Ohms (Typ)
MPX10D	10/1.5	100	20	35	3.5	–1	1	–0.19	475
MPX11D	10/1.5	100	20	50	5	–0.5	3	–0.19	475
MPX12D	10/1.5	100	20	55	5.5	0	5	–0.19	475
MPX50D	50/7.3	200	20	60	1.2	–0.1	0.1	–0.19	475
MPX51D	50/7.3	200	20	45	0.9	–0.1	0.1	–0.19	475
MPX52D	50/7.3	200	20	60	1.2	–0.5	0.5	–0.19	475
MPX100D,A	100/15	200	20	60	0.6	–0.1	0.1	–0.19	475
MPX200D,A	200/30	400	20	60	0.3	–0.25	0.25	–0.19	475
MPX201D,A	200/30	400	20	60	0.3	–0.35	0.35	–0.19	475
MPX700D	700/100	2100	20	60	0.086	–0.50	0.50	–0.18	475

Table 2. Compensated and Calibrated (On-Chip) (V_S = 10 Vdc, T_A = 25°C)

								% FSS	
MPX2010D	10/1.5	75	±0.05	25	2.5	–1.0	1.0	±0.5	1800
MPX2050D	50/7.3	200	±0.05	40	0.8	–0.25	0.25	±0.5	1800
MPX2051D	50/7.3	200	±0.1	40	0.8	–0.50	0.50	±0.5	1800
MPX2052D	50/7.3	200	±0.1	40	0.8	–0.55	0.25	±0.5	1800
MPX2100D,A	100/15	400	±0.05	40	0.4	–0.25	0.25	±0.5	1800
MPX2101D,A	100/15	400	±0.1	40	0.4	–0.50	0.50	±0.5	1800
MPX2200D,A	200/30	400	±0.05	40	0.2	–0.25	0.25	±0.5	1800
MPX2201D,A	200/30	400	±0.1	40	0.2	–0.50	0.50	±0.5	1800

Table 3. High Impedance (On-Chip) (V_S = 10 Vdc, T_A = 25°C)

****MPX7050D***	50/7.3	400	±0.1	40	0.8	–0.25	0.25	±0.5	10K
****MPX7100D,A***	100/15	400	±0.1	40	0.2	–0.25	0.25	±0.5	10K
****MPX7200D,A***	200/30	400	±0.1	40	0.2	–0.25	0.25	±0.5	10K

Table 4. Signal Conditioned (On-Chip) (V_S = 5 Vdc, T_A = 25°C)

Device Series	Pressure Range kPa/psi	Over Pressure (kPa)	Offset mV (Typ)	Full Scale Span mV (Typ)	Sensitivity (mV/kPa)(Typ)	Linearity % of FSS(1) (Min)	(Max)	Temperature Coefficient of Span %/°C (Typ)	Input Impedance Ohms (Typ)
MPX5050D	50/7.3	700	0.5 V	4 V	80	–0.25	0.25	±1	—
MPX5100D,A	100/15	700	0.5 V	4 V	40	–0.25	0.25	±1	—

Table 5. Temperature Sensor

Device Series	$V_{(BR)EBO}$ Min Vdc	V_{BE} mV (Typ)	ΔV_{BE} mV	ΔT °C	T_C mV/°C (Typ)
MTS102	4	595	3	2	–2.265
MTS103	4	595	4	3	–2.265
MTS105	4	595	7	5	–2.265

(1)Based on end point straight line fit method. Best fit straight line linearity error is approximately 1/2 of listed value.

* New Product for 1993

Devices listed in bold, italic are Motorola preferred devices.

Typical Electrical Characteristic Curves

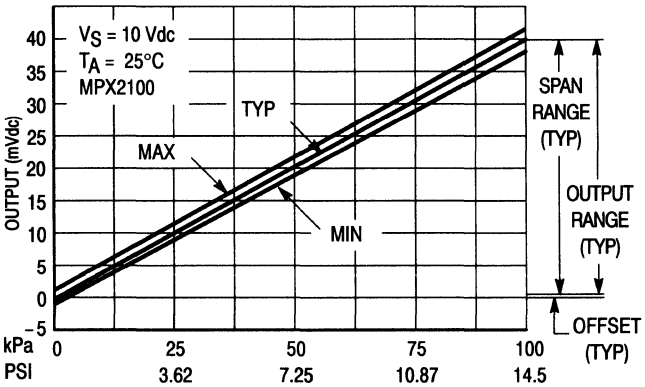


Figure 4. Output versus Pressure Differential

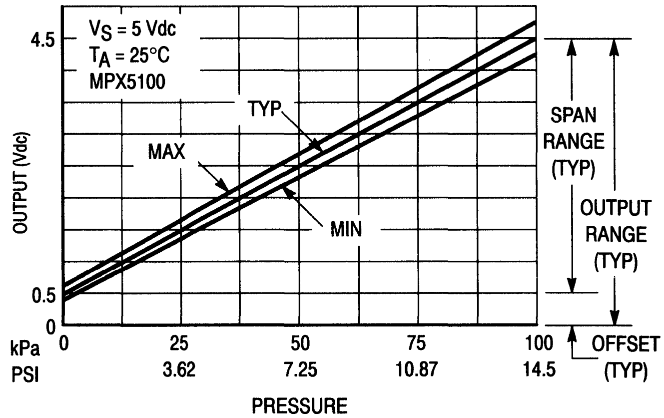


Figure 5. Signal Conditioned MPX5100

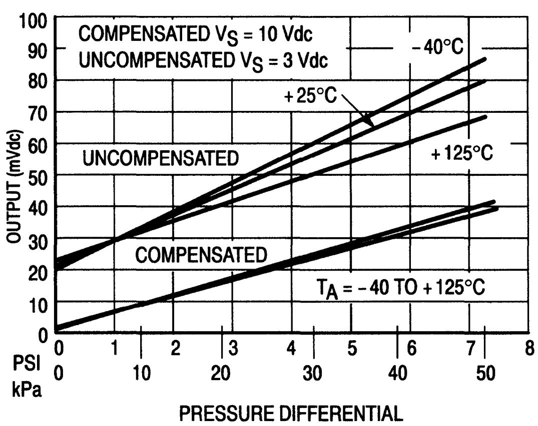


Figure 6. Typical-Output Voltage versus Pressure and Temperature for Compensated and Uncompensated Devices

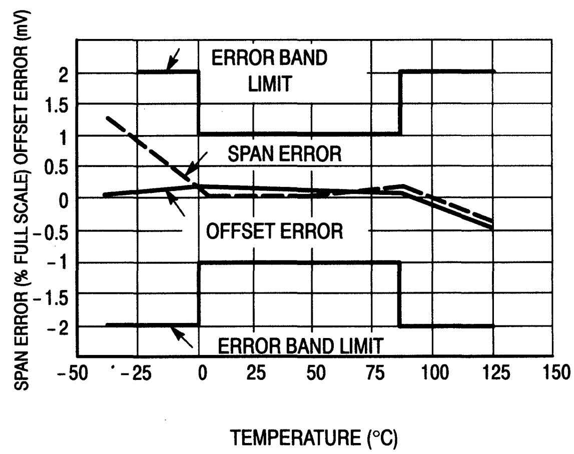


Figure 7. Temperature Error Band Limit and Typical Span and Offset Errors — Compensated Devices

Pressure Sensors (continued)

Unibody Cross-sectional Drawings

Figure 8 illustrates the absolute sensing configuration (right) and the differential or gauge configuration in the basic chip carrier (Case 344-08). A silicone gel isolates the die surface and wire bonds from harsh environments, while allowing the pressure signal to be transmitted to the silicon diaphragm.

The MPX series pressure sensor operating characteristics and internal reliability and qualification tests are based on use of dry air as the pressure media. Media other than dry air may have adverse effects on sensor performance and long term stability. Contact the factory for information regarding media compatibility in your application.

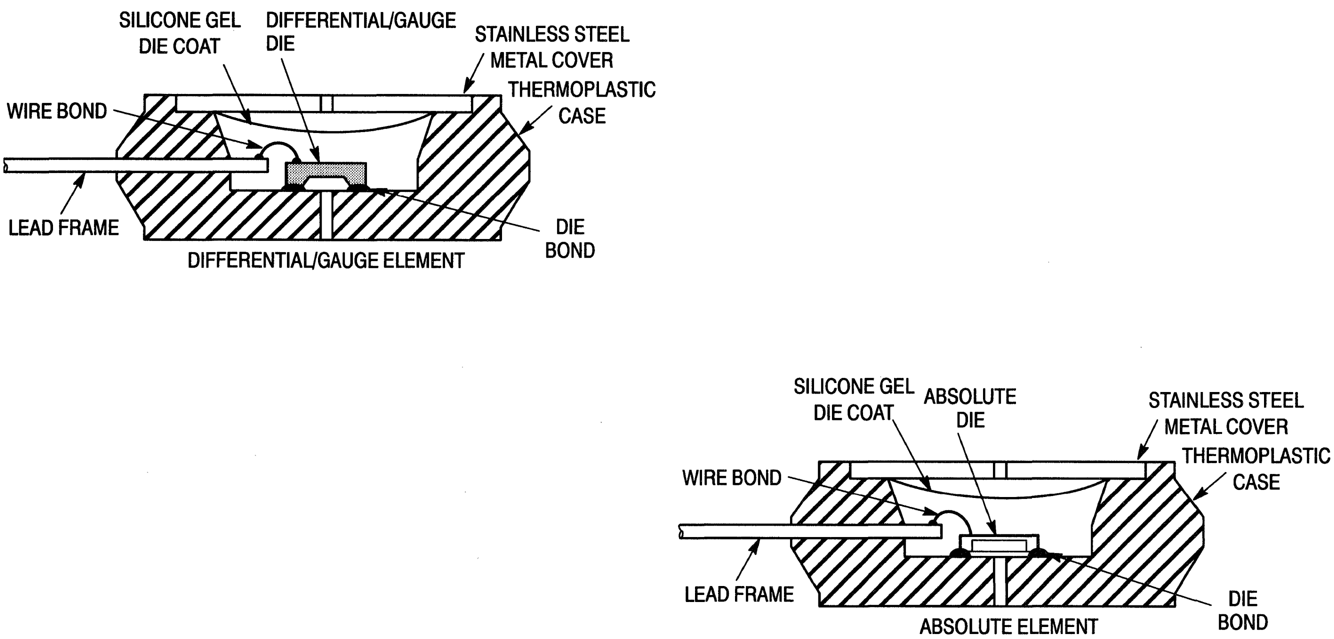


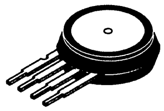
Figure 8. Cross-Sectional Diagrams (not to scale)

Stainless steel cap is not installed on devices with a port attached on the pressure (gel) side.

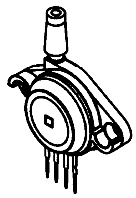
Pressure Sensors (continued)

Packaging Options

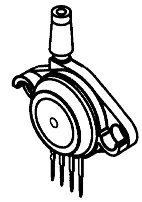
4 PIN



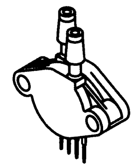
BASIC ELEMENT
CASE 344-08/STYLE 1
SUFFIX A/D



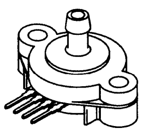
GAUGE PORT
CASE 350-03
SUFFIX AP/GP



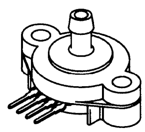
GAUGE VACUUM PORT
CASE 350-04
SUFFIX GVP



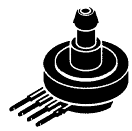
DUAL PORT
CASE 352-02
SUFFIX DP



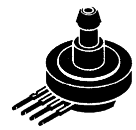
AXIAL PORT
CASE 371C-02
SUFFIX ASX/GSX



AXIAL VACUUM PORT
CASE 371D-02
SUFFIX GVSX

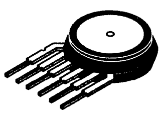


STOVEPIPE PORT
CASE 371-05
SUFFIX AS/GS

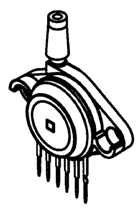


STOVEPIPE VACUUM PORT
CASE 371-06
SUFFIX GVS

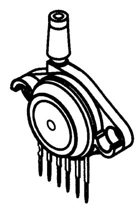
6 PIN



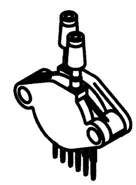
BASIC ELEMENT
CASE 867-04
SUFFIX A/D



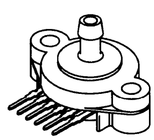
GAUGE PORT
CASE 867B-03
SUFFIX AP/GP



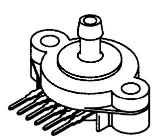
GAUGE VACUUM PORT
CASE 867D-03
SUFFIX GVP



DUAL PORT
CASE 867C-03
SUFFIX DP



AXIAL PORT
CASE 867F-02
SUFFIX ASX/GSX



AXIAL VACUUM PORT
CASE 867G-02
SUFFIX GVSX

STOVEPIPE PORT
CASE 867E-02
SUFFIX AS/GS

STOVEPIPE VACUUM PORT
CASE 867A-03
SUFFIX GVS

Pressure Sensors (continued)

Pressure Side Identification

Motorola designates the two sides of the pressure sensor as the Pressure (top) side and the Vacuum Pressure (back) side. The Pressure side is the side containing silicone gel which protects the die from harsh media. The Motorola MPX pressure sensor is designed to operate with positive differential pressure applied (i.e., top side pressure is greater than or equal to back side pressure). The Pressure side may be identified by using the example tables below.

Table 6. Pressure/Vacuum Side Identification

Part Number	Case Type 4 PIN	Positive Pressure Side Identifier
MPXxxxxA,D	344-08	Stainless Steel Cap
MPXxxxxDP	352-02	Side with Part Marking
MPXxxxxAP,GP	350-02	Side with Port Attached
MPXxxxxGVP	350-04	Stainless Steel Cap
MPXxxxxAS,GS	371-06	Side with Port Attached
MPXxxxxGVS	371-05	Stainless Steel Cap
MPXxxxxASX,GSX	371C-02	Side with Port Attached
MPXxxxxGVSX	371D-02	Stainless Steel Cap

Part Number	Case Type 6 PIN	Positive Pressure Side Identifier
MPXxxxxA,D	867-04	Stainless Steel Cap
MPXxxxxDP	867C-03	Side with Part Marking
MPXxxxxAP,GP	867B-03	Side with Port Attached
MPXxxxxGVP	867D-03	Stainless Steel Cap
MPXxxxxAS,GS	867E-02	Side with Port Attached
MPXxxxxGVS	867A-03	Stainless Steel Cap
MPXxxxxASX,GSX	867F-02	Side with Port Attached
MPXxxxxGVSX	867G-02	Stainless Steel Cap

Stainless steel cap is not installed on devices with a port attached to the pressure (gel) side.

Ordering Information

MPX series pressure sensors are available in absolute, differential and gauge configurations. Devices are available in the Basic Element package or with pressure port fittings which provide printed circuit board mounting ease and barbed hose pressure connections.

Table 7. MPX10/50/100/200/700 Series (Uncompensated)

Device Type	Measurement Options	Package Options	Pressure Range				
			0 – 1.5 PSI	0 – 7.3 PSI	0 – 7.3 PSI	0 – 7.3 PSI	0 – 14.5 PSI
4-Pin Basic Elements	Absolute	Case 344-08	—	—	—	—	MPX100A
	Differential	Case 344-08	MPX10D	MPX50D	MPX51D	MPX52D	MPX100D
Ported Elements	Absolute Port	Case 350-03	—	—	—	—	MPX100AP
	Absolute Stovepipe	Case 371-05	—	—	—	—	MPX100AS
	Absolute Axial	Case 371C-02	—	—	—	—	MPX100ASX
	Differential Port	Case 352-02	MPX10DP	MPX50DP	MPX51DP	MPX52DP	MPX100DP
	Gauge	Case 350-03	MPX10GP	MPX50GP	MPX51GP	MPX52GP	MPX100GP
	Gauge Vacuum	Case 350-04	MPX10GVP	MPX50GVP	MPX51GVP	MPX52GVP	MPX100GVP
	Gauge Stovepipe	Case 371-05	MPX10GS	MPX50GS	MPX51GS	MPX52GS	MPX100GS
	Gauge Vacuum Stovepipe	Case 371-06	MPX10GVS	MPX50GVS	MPX51GVS	MPX52GVS	MPX100GVS
	Gauge Axial	Case 371C-02	MPX10GSX	MPX50GSX	MPX51GSX	MPX52GSX	MPX100GSX
	Gauge Vacuum Axial	Case 371D-02	MPX10GVSX	MPX50GVSX	MPX51GVSX	MPX52GVSX	MPX100GVSX

Table 7. MPX10/50/100/200/700 Series (Uncompensated) (continued)

Device Type	Measurement Options	Package Options	Pressure Range		
			0 – 29 PSI	0 – 29 PSI	0 – 100 PSI
4-Pin Basic Elements	Absolute	Case 344-08	MPX200A	MPX201A	—
	Differential	Case 344-08	MPX200D	MPX201D	***MPX700D***
Ported Elements	Absolute Port	Case 350-03	MPX200AP	MPX201AP	—
	Absolute Stovepipe	Case 371-05	MPX200AS	MPX201AS	—
	Absolute Axial	Case 371C-02	MPX200ASX	MPX201ASX	—
	Differential Port	Case 352-02	MPX200DP	MPX201DP	***MPX700DP***
	Gauge	Case 350-03	MPX200GP	MPX201GP	***MPX700GP***
	Gauge Vacuum	Case 350-04	MPX200GVP	MPX201GVP	***MPX700GVP***
	Gauge Stovepipe	Case 371-05	MPX200GS	MPX201GS	***MPX700GS***
	Gauge Vacuum Stovepipe	Case 371-06	MPX200GVS	MPX201GVS	***MPX700GVS***
	Gauge Axial	Case 371C-02	MPX200GSX	MPX201GSX	***MPX700GSX***
	Gauge Vacuum Axial	Case 371D-02	MPX200GVSX	MPX201GVSX	***MPX700GVSX***

Devices listed in bold, italic are Motorola preferred devices.

Pressure Sensors: Ordering Information (continued)

Table 8. MPX2000 Series (Temperature Compensated and Calibrated On-Chip)

Device Type	Measurement Options	Package Options	Pressure Range			
			0 – 1.5 PSI	0 – 7.3 PSI	0 – 7.3 PSI	0 – 7.3 PSI
4-Pin Basic Elements	Absolute	Case 344-08	—	—	—	—
	Differential	Case 344-08	***MPX2010D***	***MPX2050D***	***MPX2051D***	***MPX2052D***
Ported Elements	Absolute Port	Case 350-03	—	—	—	—
	Absolute Stovepipe	Case 371-05	—	—	—	—
	Absolute Axial	Case 371C-02	—	—	—	—
	Differential Port	Case 352-02	***MPX2010DP***	***MPX2050DP***	***MPX2051DP***	***MPX2052DP***
	Gauge	Case 350-03	***MPX2010GP***	***MPX2050GP***	***MPX2051GP***	***MPX2052GP***
	Gauge Vacuum	Case 350-04	***MPX2010GVP***	***MPX2050GVP***	***MPX2051GVP***	***MPX2052GVP***
	Gauge Stovepipe	Case 371-05	***MPX2010GS***	***MPX2050GS***	***MPX2051GS***	***MPX2052GS***
	Gauge Vacuum Stovepipe	Case 371-06	***MPX2010GVS***	***MPX2050GVS***	***MPX2051GVS***	***MPX2052GVS***
	Gauge Axial	Case 371C-02	***MPX2010GSX***	***MPX2050GSX***	***MPX2051GSX***	***MPX2052GSX***
	Gauge Vacuum Axial	Case 371D-02	***MPX2010GVSX***	***MPX2050GVSX***	***MPX2051GVSX***	***MPX2052GVSX***

Table 9. MPX2100 Series (Temperature Compensated and Calibrated On-Chip)

Device Type	Measurement Options	Package Options	Pressure Range			
			0 – 1.5 PSI	0 – 7.3 PSI	0 – 7.3 PSI	0 – 7.3 PSI
4-Pin	Absolute	Case 344-08	***MPX2100A***	***MPX2101A***	***MPX2200A***	***MPX2201A***
Basic Elements	Differential	Case 344-08	***MPX2100D***	***MPX2101D***	***MPX2200D***	***MPX2201D***
	Absolute Stovepipe	Case 371-05	***MPX2100AS***	***MPX2101AS***	***MPX2200AS***	***MPX2201AS***
	Absolute Axial	Case 371C-02	***MPX2100ASX***	***MPX2101ASX***	***MPX2200ASX***	***MPX2201ASX***
	Differential Port	Case 352-02	***MPX2100DP***	***MPX2101DP***	***MPX2200DP***	***MPX2201DP***
	Gauge	Case 350-03	***MPX2100GP***	***MPX2101GP***	***MPX2200GP***	***MPX2201GP***
	Gauge Vacuum	Case 350-04	***MPX2100GVP***	***MPX2101GVP***	***MPX2200GVP***	***MPX2201GVP***
	Gauge Stovepipe	Case 371-05	***MPX2100GS***	***MPX2101GS***	***MPX2200GS***	***MPX2201GS***
	Gauge Vacuum Stovepipe	Case 371-06	***MPX2100GVS***	***MPX2101GVS***	***MPX2200GVS***	***MPX2201GVS***
	Gauge Axial	Case 371C-02	***MPX2100GSX***	***MPX2101GSX***	***MPX2200GSX***	***MPX2201GSX***
	Gauge Vacuum Axial	Case 371D-02	***MPX2100GVSX***	***MPX2101GVSX***	***MPX2200GVSX***	***MPX2201GVSX***

Devices listed in bold, italic are Motorola preferred devices.

Pressure Sensors: Ordering Information (continued)

Table 10. MPX5000 Series (Signal Conditioned On-Chip)

Device Type	Measurement Options	Package Options	Pressure Range	
			0 – 7.3 PSI	0 –14.5 PSI
6-Pin Basic Element	Absolute	Case 867-04	—	***MPX5100A***
	Differential	Case 867-04	***MPX5050D***	***MPX5100D***
Ported Element	Absolute Port	Case 867B-03	—	***MPX5100AP***
	Absolute Stovepipe	Case 867E-02	—	***MPX5100AS***
	Absolute Axial	Case 867F-02	—	***MPX5100ASX***
	Differential Port	Case 867C-03	***MPX5050DP***	***MPX5100DP***
	Gauge	Case 867B-03	***MPX5050GP***	***MPX5100GP***
	Gauge Vacuum	Case 867D-03	***MPX5050GVP***	***MPX5100GVP***
	Gauge Stovepipe	Case 867E-02	***MPX5050GS***	***MPX5100GS***
	Gauge Vacuum Stovepipe	Case 867A-03	***MPX5050GVS***	***MPX5100GVS***
	Gauge Axial	Case 867F-02	***MPX5050GSX***	***MPX5100GSX***
	Gauge Vacuum Axial	Case 867G-02	***MPX5050GVSX***	***MPX5100GVSX***

Table 11. MPX7000 Series (High Impedance On-Chip)

Device Type	Measurement Options	Package Options	Pressure Range	Pressure Range	Pressure Range
			0 – 7.3 PSI	0 – 14.5 PSI	0 – 29 PSI
4-Pin Basic Elements	Absolute	Case 344-08	—	****MPX7100A***	****MPX7200A***
	Differential	Case 344-08	****MPX7050D***	****MPX7100D***	****MPX7200D***
Ported Elements	Absolute Port	Case 350-03	—	****MPX7100AP***	****MPX7200AP***
	Absolute Stovepipe	Case 371-05	—	****MPX7100AS***	****MPX7200AS***
	Absolute Axial	Case 371C-02	—	****MPX7100ASX***	****MPX7200ASX***
	Differential Port	Case 352-02	****MPX7050DP***	****MPX7100DP***	****MPX7200DP***
	Gauge	Case 350-03	****MPX7050GP***	****MPX7100GP***	****MPX7200GP***
	Gauge Vacuum	Case 350-04	****MPX7050GVP***	****MPX7100GVP***	****MPX7200GVP***
	Gauge Stovepipe	Case 371-05	****MPX7050GS***	****MPX7101GS***	****MPX7200GS***
	Gauge Vacuum Stovepipe	Case 371-06	****MPX7050GVS***	****MPX7101GVS***	****MPX7200GVS***
	Gauge Axial	Case 371C-02	****MPX7050GSX***	****MPX7101GSX***	****MPX7200GSX***
	Gauge Vacuum Axial	Case 371D-02	****MPX7050GVSX***	****MPX7101GVSX***	****MPX7200GVSX***

* New Product for 1993

Devices listed in bold, italic are Motorola preferred devices.

Pressure Sensors: Ordering Information (continued)

Table 12. Sample Kits

Device	Pressure Range kPa/psi	Available	Description	Order Information	Cost
MPX2010DP	10/1.5	NOW	Device w/Literature	KITNOK29/D	—
MPX700DP	700/100	NOW	Device w/Literature	KITNOK32/D	—
MPX5100DP	100/15	NOW	Device w/Literature	KITMPX5100D/D	25.00
MPX5100AP	100/15	NOW	Device w/Literature	KITMPX5100A/D	25.00
MPX7100DP	100/15	NOW	Device w/Literature	KITMPX7100D/D	—
MPX7200DP	200/30	NOW	Device w/Literature	KITMPX7200D/D	—

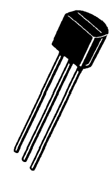
Table 13. Evaluation Kits*

SEK-1	100/15	NOW	Evaluation Board for MPX2000 Series	SEK1KIT/D	10.00
DEVB-114	100/15	NOW	Pressure Sensor w/Microprocessor	KITDEVB114/D	95.00
DEVB-126	100/15	NOW	4–20 mA Pressure Transducer	KITDEVB126/D	75.00
DEVB-129	100/15	NOW	Bar Graph Pressure Gauge	KITDEVB129/D	50.00
DEVB-147	100/15	NOW	Temperature Compensated Sensor Evaluation Board that Demonstrates a User-Friendly Circuit	KITDEVB147/D	75.00
DEVB-160	100/15	NOW	Frequency Output Sensor	KITDEVB160/D	95.00

Sample/Evaluation kits are available through Literature Distribution.
*Note that Evaluation Boards are available in limited quantities. Call 602-994-6561 to order.

Silicon Temperature Sensors

Available in a standard (TO-92) plastic package, these temperature sensing transistor elements are suitable for applications in automotive, consumer and industrial products requiring low cost and high accuracy.



CASE 29-04
(TO-92)

Table 14. Silicon Temperature Sensors

Device	V_{BE} @ I_C = 0.1 mA, T_A = 25°C (Typ)	Temperature Over – 40°C to 150°C	Thermal Time Constant Liquid-to-Liquid (Typ)	Thermal Time Constant Flowing Air (Typ)	Case
MTS102	595 mV	±2°C	3 s	8 s	29-04
MTS103	595 mV	±3°C	3 s	8 s	29-04
MTS105	595 mV	±5°C	3 s	8 s	29-04

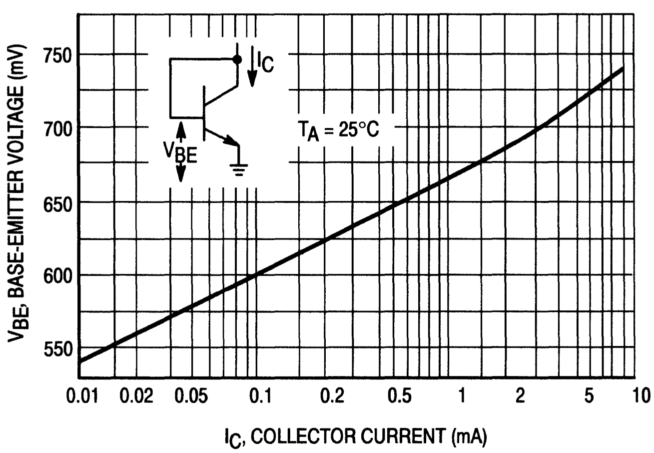


Figure 9. Base-Emitter Voltage versus Collector-Emitter Current

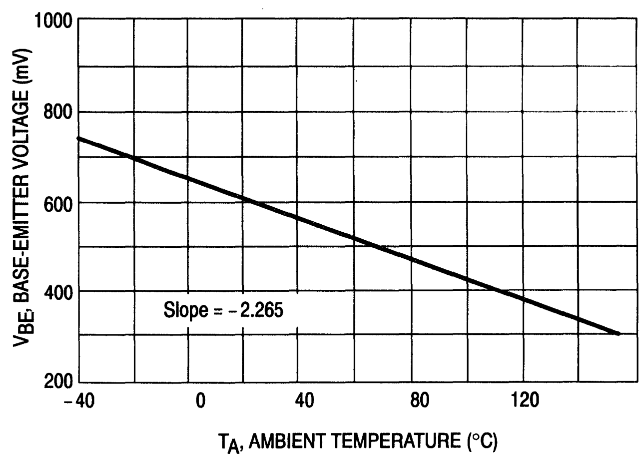


Figure 10. Base-Emitter Voltage versus Ambient Temperature

RF Products

In Brief . . .

While Motorola is considered to be the supermarket for semiconductor products, there is not a category in which the selection is more diverse, or more complete, than in products designed for RF system applications. From MOS and bipolar power and signal transistors to tuning and switching diodes, Motorola's RF components cover the entire spectrum from HF to microwave. Yet, product expansion continues — not only to keep pace with the progressive needs of the industry, but to better serve the needs of designers for a reliable and comprehensive source of supply.

Motorola has taken three major steps to continue leading the industry in supplying RF products. The first step taken was the acquisition of the RF Devices Division of TRW which occurred in 1988; the second step was the creation of an RF Integrated Circuits group within the RF Products Division which occurred in late 1990; and the third step was the recent investment of a major GaAs fabrication facility which was announced in 1991.

Acquiring the RF products of TRW has expanded Motorola's portfolio particularly in the area of high power linear transistors and microwave devices. These products can be found in the current listing of Motorola RF devices. The acqusition, which included a major design and manufacturing facility in France, has positioned Motorola for increased participation in the European market and particularly for significant participation in the greater European common market that is being established in 1992.

The creation of an integrated circuits group dedicated exclusively to RFICs emphasizes the importance that Motorola places on these devices for future needs in RF, particularly the trends to higher frequency, lower power RF commercial applications. And GaAs products — both discrete and IC — will play an increasing role in this market place of the future. The current list of RF products does not reflect the RFIC and GaAs products that are in various stages of development. For a detailed description of these products, consult your Motorola sales representative or distributor.

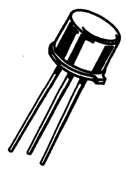
Page

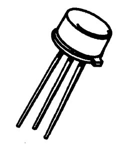
RF Discrete Transistors

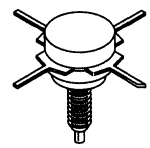
In the following pages, the reader will find the most extensive group of RF Discrete Transistors offered by any semiconductor manufacturer anywhere in the world today.

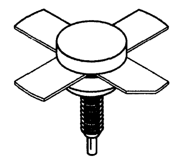
From Bipolar to FET, from Low Power to High Power, the user can choose from a variety of packages. They include plastic, metal can and ceramic that are microstrip circuit compatible or surface mountable. Many are designed for automated assembly equipment.

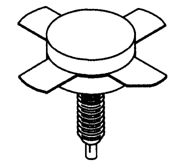
Major sub-headings are MOSFETs, Power Bipolar and Small Signal Bipolar.

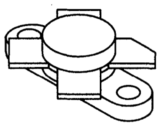

CASE 79-04
STYLES 1
(TO-205AD)

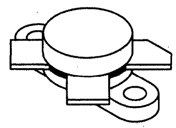

CASE 79-05
STYLES 5, 7
(TO-39 CE)

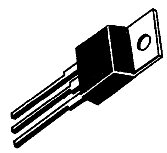

CASE 144B-05
STYLE 1
(.380″ STUD)

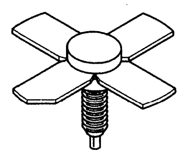

CASE 145A-09
STYLE 1
(.380″ STUD)

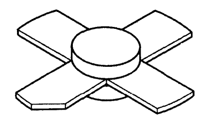

CASE 145A-10
STYLE 1
(.500″ STUD)

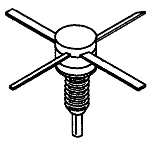

CASE 211-07
STYLES 1, 2
(.380″ FLANGE)

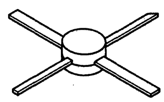

CASE 211-11
STYLES 1, 2
(.500″ FLANGE)

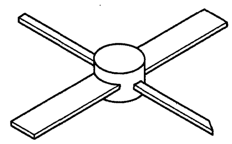

CASE 221A-04
STYLES 1, 2
(TO-220AB)

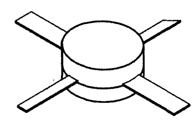

CASE 244-04
STYLES 1, 3, 4
(.280″ STUD)

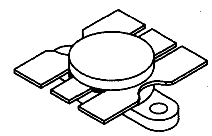

CASE 249-05
STYLE 1
(.280″ PILL)

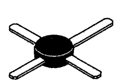

CASE 305-01
STYLE 1
(.204″ STUD)

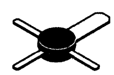

CASE 305A-01
STYLE 1,2
(.204″ PILL)

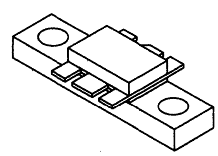

CASE 305C-01
STYLE 1

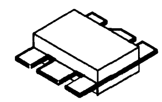

CASE 305D-01
STYLE 1

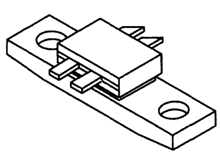

CASE 316-01
STYLE 1
(.500″ CQ)

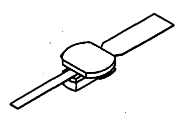

CASE 317-01
STYLE 2
(MACRO-X)

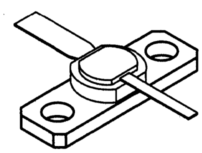

CASE 317D-02
STYLE 2

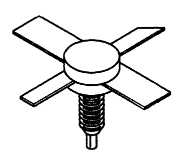

CASE 319-06
STYLES 1, 2, 3
(CS-12)

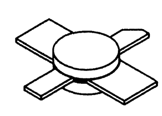

CASE 319A-02
STYLES 2

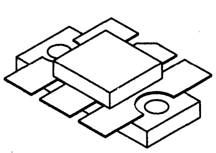

CASE 319B-01
STYLE 1

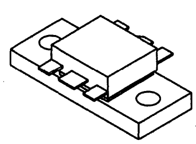

CASE 328-02
STYLE 2

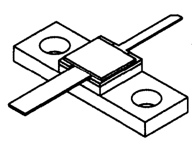

CASE 328A-03
STYLE 1, 5

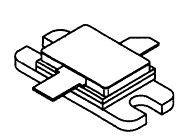

CASE 332-04
STYLES 1, 2
(.280″ STUD)

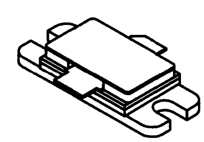

CASE 332A-03
STYLES 1, 2
(.280″ PILL)


CASE 333-04
STYLE 1

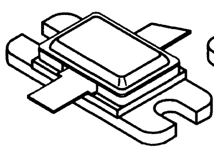

CASE 333A-02
STYLE 1,2
(MAAC PAC)

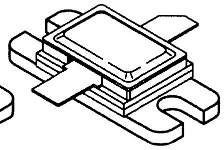

CASE 336E-02
STYLE 1

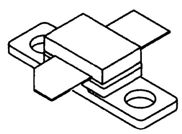

CASE 355C-02
STYLE 1

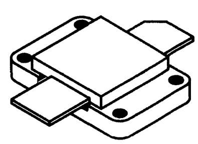

CASE 355D-02
STYLE 1

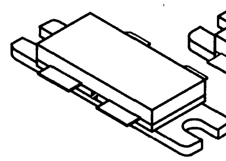
RF Products

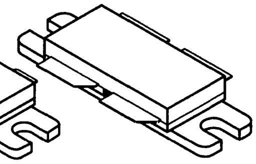

CASE 355E-01 STYLE 1

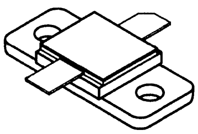

CASE 355G-01 STYLE 1

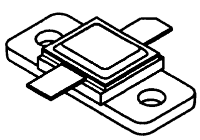

CASE 360A-01 STYLE 1

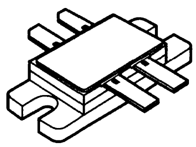

CASE 368-02 STYLES 1, 2 (HOG PAC)

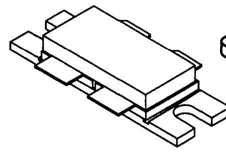

CASE 375-03 STYLE 1,2

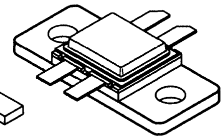

CASE 375A-01 STYLE 1

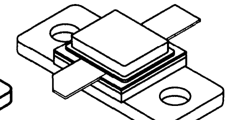

CASE 376B-02 STYLE 1

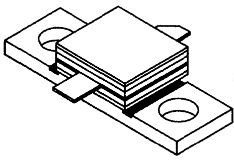

CASE 376C-01 STYLE 1

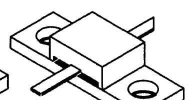

CASE 382-01 STYLE 1

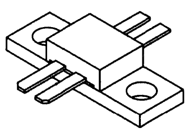

CASE 390A-02 STYLE 1

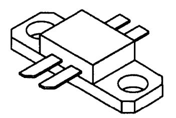

CASE 391-03 STYLE 1

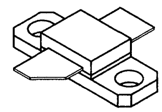

CASE 392-03 STYLE 1

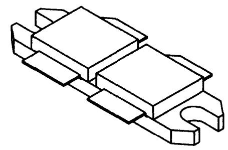

CASE 393-03 STYLE 1

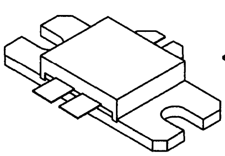

CASE 394-02 STYLE 1

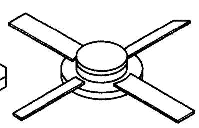

CASE 395-02 STYLE 1,2

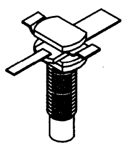

CASE 395B-01 STYLE 1

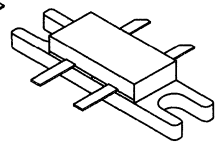

CASE 395C-01 STYLE 1

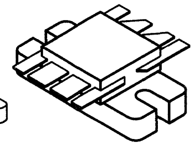

CASE 397-01 STYLE 1

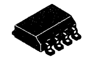

CASE 398-02 STYLE1

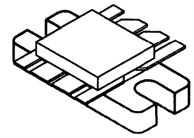

CASE 400-01 STYLE 1


CASE 401-02 STYLE 1


CASE 412-01 STYLE 1


CASE 744A-01 STYLE 1,2


CASE 751-04 STYLE 1 (SO-8)


CASE 827-01 STYLE 1

RF Power MOSFETs

Motorola RF Power MOSFETs are constructed using a planar process to enhance manufacturing repeatability. *They are N-channel field effect transistors* with an oxide insulated gate which controls vertical current flow.

Compared with bipolar transistors, RF Power FETs exhibit higher gain, higher input impedance, enhanced thermal stability and lower noise. The FETs listed in this section are specified for operation in RF Power Amplifiers and are grouped by frequency range of operation and type of application. Arrangement within each group is first by order of voltage then by increasing output power.

Table 1. To 150 MHz HF/SSB

For military and commercial HF/SSB fixed, mobile, and marine transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} Typical Gain dB @ 30 MHz	Typical IMD d_3 dB	Typical IMD d_{11} dB	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts							
MRF138	30	0.6	17	−30	−60	1.5	211-07/2
MRF140	150	4.7	15	−30	−60	0.6	211-11/2
V_{DD} = 50 Volts							
MRF148	30	0.5	18	−35	−60	1.5	211-07/2
MRF150	150	2.9	17	−32	−60	0.6	211-11/2
MRF154	600	12	17	−25	—	0.13	368-02/2
MRF157★	600	6	20	−25	—	0.13	368-02/2

★New Product

Table 2. To 225 MHz VHF AM/FM

For VHF military and commercial aircraft radio transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} (Typ)/Freq. dB/MHz	η Eff., Typ %	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts						
MRF134	5	0.2	14/150	55	10	211-07/2
MRF136	15	0.38	16/150	60	3.2	211-07/2
MRF166★	20	0.5	16/150	60	3.2	211-07/2
MRF136Y	30	1.2	14/150	54	1.8	319B-01/1
MRF137	30	0.75	16/150	60	1.8	211-07/2
MRF171	45	1.4	15/150	60	1.5	211-07/2
MRF173★	80	4	13/150	65	0.8	211-11/2
MRF173CQ★	80	4	13/150	65	0.8	316-01/2
MRF175LV	100	4	14/225	65	0.65	333-04/1
MRF174	125	8.3	11.8/150	60	0.65	211-11/2
MRF141	150	10	10/175	55	0.6	211-11/2
MRF175GV	200	8	14/225	65	0.44	375-03/2
MRF141G	300	13	10/175	55	0.35	375-03/2
V_{DD} = 50 Volts						
MRF151	150	7.5	13/175	45	0.6	211-11/2
MRF176GV	200	4	17/225	55	0.44	375-03/2
MRF151G	300	7.5	16/175	55	0.35	375-03/2

Devices listed in bold, italic are Motorola preferred devices.

Table 3. To 500 MHz UHF AM/FM

For VHF/UHF military and commercial aircraft radio transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} (Typ)/Freq. dB/MHz	η Eff., Typ %	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts						
MRF158★	2	0.02	20/400	55	13.2	305A-01/2
MRF158R★	2	0.02	20/400	55	22	79-05/7
MRF160(1)	4	0.08	17/400	45	15	249-05/1
MRF161	5	0.4	13.5/400	45	10	244-04/3
MRF162	15	0.65	13.6/400	50	3.5	244-04/3
MRF166C★	20	0.4	17/400	55	2.5	319-06/3
MRF164W★	20	0.4	17/400	50	1.5	412-01/1
MRF163	25	1.6	12/400	50	2	244-04/3
MRF166W(1)	40	4	10/400	50	1.5	412-01/1
MRF175LU	100	10	10/400	55	0.65	333-04/1
MRF175GU	150	9.5	12/400	55	0.44	375-03/2
MRF177★	100	6.4	12/400	60	0.65	744A-01/2
MRF177M★	100	6.4	12/400	60	0.65	390A-02/1
V_{DD} = 50 Volts						
MRF176GU	150	6	14/400	50	0.44	375-03/2

(1)To be Introduced
★New Product

Devices listed in bold, italic are Motorola preferred devices.

RF Power Bipolar Transistors

Motorola's broad line of bipolar RF power transistors are characterized for operation in RF power amplifiers. Typical applications are in military and commercial landmobile, avionics and marine radio transmitters. Groupings are by frequency band and type of application. Within each group, the arrangement of devices is by major supply voltage rating, then in the order of increasing output power. All devices are NPN polarity except where otherwise noted.

HF Transistors

Table 4. 1.5 – 30 MHz, HF/SSB

Designed for broadband operation, these devices feature specified Intermodulation Distortion at rated power output. Applications include mobile, marine, fixed station, and amateur HF/SSB equipment, operating from 12.5, 13.6, 28, or 50 volt supplies.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 30 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 or 13.6 Volts					
MRF476	3 PEP/CW	0.1	15	17.5	221A-04/1
MRF475	12 PEP/CW	1.2	10	10	221A-04/1
MRF433	12.5 PEP/CW	0.125	20	8.8	211-07/1
MRF406	20 PEP/CW	1.25	12	2.2	211-07/1
MRF477	40 PEP/CW	1.25	15	2	221A-04/2
MRF421	100 PEP/CW	10	10	0.6	211-11/1
V_{CC} = 28 Volts					
MRF485	15 PEP/CW	1.5	10	3.4	221A-04/1
MRF426	25 PEP/CW	0.16	22	2.5	211-07/1
MRF466	40 PEP/CW	1.25	15	1	211-07/1
MRF486	40 PEP/CW	1.25	15	2	221A-04/2
MRF464	80 PEP/CW	2.53	15	0.7	211-11/1
MRF464A	80 PEP/CW	2.53	15	0.7	145A-10/1
MRF422	150 PEP/CW	15	10	0.6	211-11/1
V_{CC} = 50 Volts					
MRF427	25 PEP/CW	0.4	18	2.2	211-11/1
MRF428	150 PEP/CW	7.5	13	0.5	211-11/1
MRF429	150 PEP/CW	7.5	13	0.8	211-11/1
PT9790	150 PEP/CW	4.8	15(3)	0.5	211-11/1
MRF448	250 PEP/CW	15.7	12	0.6	211-11/1
MRF430	600 PEP/CW	60	10	0.2	368-02/1

Table 5. 14 – 30 MHz, CB/Amateur Band

These HF transistors are designed for economical, high-volume use in CW, AM and SSB applications.

V_{CC} = 12.5 or 13.6 Volts

MRF476	3	0.1	15	17.5	221A-04/1
MRF475	4	0.4	10	10	221A-04/1
MRF450	50	4	11	1.5	211-07/1
MRF450A	50	4	11	1.5	145A-09/1
MRF455	60	3	13	1	211-07/1
MRF455A	60	3	13	1	145A-09/1
MRF454	80	5	12	0.7	211-11/1

(3)Gain specified at 28 MHz

Devices listed in bold, italic are Motorola preferred devices.

HF Transistors (continued)

Table 6. 27 – 50 MHz, Low-Band FM Band

For use in the FM "Low-Band," for Mobile communications.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 50 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 or 13.6 Volts					
MRF475	4	0.4	10	10	221A-04/1
MRF497	40	4	10	2	221A-04/2
MRF492	70	5.6	11	0.7	211-11/1

VHF Transistors

Table 7. 30 – 200 MHz Band

Designed for Military Radio and Commercial Aircraft VHF bands, these 28-volt devices include the all-gold metallized MRF314/15/16/17 high-reliability series.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
2N3553	2.5	0.25	10/175	25	79-04/1
2N5641	7	1	8.4/175	11.6	144B-05/1
MRF340	8	0.4	13/136	11.6	221A-04/2
2N5642	20	3	8.2/175	5.9	145A-09/1
MRF342	24	1.9	11/136	3.2	221A-04/2
MRF314	30	3	10/150	2.2	211-07/1
MRF314A	30	3	10/150	2.2	145A-09/1
2N5643	40	6.9	7.6/175	2.9	145A-09/1
MRF315	45	5.7	9/150	1.6	211-07/1
MRF315A	45	5.7	9/150	1.6	145A-09/1
PT9733	50	10	7/175	2.1	145A-09/1
MRF344	60	15	6/136	2	221A-04/2
MRF316(4)	80	8	10/150	0.8	316-01/1
MRF317(4)	100	12.5	9/150	0.65	316-01/1
TP9386	150	15	10/175	0.7	316-01/1

(4)Internal Impedance Matched

Devices listed in bold, italic are Motorola preferred devices.

VHF Transistors (continued)

Table 8. 88 – 108 MHz, FM Broadcast Band

These parts are designed for solid state transmitter applications in the FM broadcast band. They feature diffused ballast resistors and gold metallization that enhance long term reliability.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts Bipolar					
TP9380	75	7	10.3/108	1.5	211-11/1
TP9383	150	18	9.2/108	0.75	211-11/1
V_{CC} = 50 Volts MOSFET					
TP1940	300	3	20/108	0.35	375-03/2

Table 9. 136 – 174 MHz High Band

The "workhorse" VHF FM High-Band is served by Motorola with the broadest range of devices and package combinations in the industry.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 175 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts					
2N4427	1	0.1	10	50	79-04/1
MRF4427	1	0.016	18(16)	125(47)	751-04/1
MRF553	1.5	0.11	11.5	25	317D-02/2
MRF607	1.75	0.12	11.5	36	79-04/1
MRF220	4	0.25	12	14.6	211-07/1
MRF237	4	0.25	12	22	79-05/5
MRF260	5	0.5	10	14.6	221A-04/2
MRF221	15	3.5	6.3	5.7	211-07/1
MRF262	15	3.5	6.3	4.7	221A-04/2
MRF2628	15	0.95	12	4	244-04/1
MRF264	30	9.1	5.2	2.4	221A-04/2
MRF1946	30	3	10	1.6	211-07/1
MRF1946A	30	3	10	1.8	145A-09/1
MRF224	40	14.3	4.5	2.2	211-07/1
MRF240	40	5	9	2.2	145A-09/1
MRF240A	40	5	9	2.2	211-07/1
MRF247(4)	75	15	7	0.7	316-01/1

Table 10. 225 MHz, Ultra High Band

Specifically designed and characterized for the 225 MHz band, these devices eliminate the guesswork required when adapting 175 MHz characterized devices to this application.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 225 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts					
MRF207	1	0.15	8.2	50	79-04/1
MRF227	3	0.13	13.5	21.8	79-05/5
MRF208	10	1	10	4.7	145A-09/1
MRF226	13	1.6	9	3.9	145A-09/1

(4) Internal Impedance Matched
(16) Typical
(47) $R_{\theta JA}$, Thermal Resistance, Junction-to-Ambient

Devices listed in bold, italic are Motorola preferred devices.

UHF Transistors

Table 11. 100 – 400 MHz Band

Stringent requirements of the UHF Military band are met by MRF325, 326, 327, 329, 2N6439 and 2N6985 types, with all-gold metal systems, specified ruggedness and programmed wirebond construction, to assure consistent input impedances for internally matched parts.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 400 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
2N3866	1	0.1	10	35	79-04/1
2N5160(5)	1	0.16	8	35	79-04/1
MRF5174	2	0.125	12	36	244-04/1
MRF5175	5	0.4	11	12	244-04/1
PT9701B	5	0.63	9	17.5	244-04/1
TPM405	5	0.13	16	9.5	244-04/1
PT9703B	10	1.52	8.2	8.8	244-04/1
PT9702B	20	4	7	4.4	244-04/1
TPM425	25	4	8	5	244-04/1
PT9704B	30	6	7	2.5	244-04/1
MRF325(4)	30	4.3	8.5	2.2	316-01/1
MRF326(4)	40	8	9	1.6	316-01/1
TPM4040(6)	40	4	10	2	827-01/1
2N6439(4)	60	10	7.8	1.2	316-01/1
MRF390(6)	60	6.8	7.5	1.3	744A-01/1
MRF327(4)	80	14.9	7.3	0.7	316-01/1
MRF329(4)	100	20	7	0.7	333-04/1
MRF392(6)	125	19.8	8	0.7	744A-01/1
2N6985(6)	125	19.8	8	0.7	382-01/1
TPM4130(6)	130	24.8	7.2	0.85	827-01/1

Table 12. 100 – 500 MHz Band

Similar to the 100–400 MHz transistors, these devices have bandwidth capabilities allowing their use to 500 MHz. All have nitride passivated die, gold metal systems, specified ruggedness and controlled wirebond construction to meet the stringent requirements of military space applications.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
MRF313	1	0.03	15/400	28.5	305A-01/1
MRF321	10	0.62	12/400	6.4	244-04/1
MRF323	20	2	10/400	3.2	244-04/1
MRF393(6)	100	18	7.5/500	0.7	744A-01/1
2N6986(6)	100	18	7.5/500	0.7	382-01/1

(4)Internal Impedance Matched
(5)PNP
(6)Internal Impedance Matched Push-Pull Transistors

Devices listed in bold, italic are Motorola preferred devices.

UHF Transistors (continued)

Table 13. 500 – 1000 MHz Band

Capable of operation in either class AB or C, the following devices are designed for operation to 1 GHz. Gold metallized die, diffused emitter ballast resistors and a hermetic package make both the MRA0510-15H and the MRA0510-50H suitable for industrial or military applications.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min) Gain @ 1 GHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
MRA0510-15H (1)(6)	15	3	7	3.5	391-03/1
MRA0510-50H (6)	50	10	7	1.4	391-03/1

Table 14. 400 – 512 MHz Band

Higher power output devices in this UHF power transistor series feature internally input-matched construction, are designed for broadband operation, and have guaranteed ruggedness under output mismatch and RF overdrive conditions. Devices are specified for handheld, mobile and base station operation.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 7.5 Volts					
MRF750	0.5	0.05	10/470	29	305A-01/1
MRF752	2.5	0.4	8/470	12	249-05/1
MRF754	8	2	6/470	5	249-05/1
V_{CC} = 12.5 Volts					
MRF627	0.5	0.05	10/470	28.5	305A-01/1
MRF581 (7)	0.6	0.03	13/500	40	317-01/2
MRF555	1.5	0.15	10/470	25	317D-02/2
MRF630	3	0.33	9.5/470	20	79-05/5
MRF652	5	0.5	10/512	7	244-04/1
MRF652S	5	0.5	10/512	7	249-05/1
MRF660	7	2	4.9/470	7	221A-04/2
MRF653	10	2	7/512	4	244-04/1
MRF653S	10	2	7/512	4	249-05/1
MRF641(4)	15	2.5	7.8/470	4	316-01/1
MRF654 (4)	15	2.5	7.8/512	4	244-04/1
MRF644(4)	25	5.9	6.2/470	1.7	316-01/1
MRF646(4)	45	15.0	4.8/470	1.5	316-01/1
MRF650 (4)	50	15.8	5.0/512	1.3	316-01/1
MRF658 (4)	65	25	4.15/512	1	316-01/1
V_{CC} = 24 Volts					
TP5002	1.5	0.075	13/470	21	244-04/1
TP5002S	1.5	0.075	13/470	21	249-05/1
TP5015	15	1.34	11/470	7	319-06/2
TP5040	40	5	9/470	2	395-02/1
TP5051	50	6	9/470	1.2	333A-02/2
TP5060	50	11.2	6.5/470	0.7	827-01/1

(1) To be Introduced
(4) Internal Impedance Matched
(6) Internal Impedance Matched Push-Pull Transistors
(7) Small signal gain. P_o is Typ.

Devices listed in bold, italic are Motorola preferred devices.

UHF Transistors (continued)

Table 14. 400 – 512 MHz Band (continued)

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
TP5060	60	13.4	6.5/470	0.7	827-01/1
MRF338(4)	80	15	7.3/470	0.7	333-04/1

900 MHz Transistors

Table 15. 806 – 960 MHz Band

Designed specifically for the 900 MHz mobile radio band, types MRF840 through 847 offer superior gain and ruggedness, using the unique CS-12 package, which minimizes common-element impedance, and thus maximizes gain and stability. Devices are listed for mobile and base station applications.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts — Class C — Si Bipolar					
MRF559(8)	0.5	0.08	8/870	50	317-01/2
MRF581(8)	0.6	0.06	10/870	40	317-01/2
MRF837(8)	0.75	0.11	8/870	40	317-01/1
MRF8372(8)	0.75	0.11	8/870	45	751-04/1
MRF838A(8)	1	0.22	6.5/870	70	305-01/1
MRF557(8)	1.5	0.23	8/870	25	317D-02/2
MRF839(8)	3	0.46	8/870	9	305A-01/1
MRF839F(8)	3	0.46	8/870	9	319-06/2
MRF840(4)(15)	10	2.5	6/870	3.1	319-06/1
MRF873(4)(8)	15	3	7/870	4	319-06/2
MRF873S(8)	15	3	7/870	4	319A-02/2
MRF842(4)(15)	20	5	6/870	1.5	319-06/1
MRF844(4)(15)	30	9	5.2/870	1.5	319-06/1
MRF846(4)(15)	40	15	4.3/870	1.2	319-06/1
MRF847(4)(15)	45	16	4.5/870	1	319-06/1

(4)Internal Impedance Matched
(8)Common Emitter Configuration
(15)Common Base Configuration

Devices listed in bold, italic are Motorola preferred devices.

900 MHz Transistors (continued)

Table 15. 806 – 960 MHz Band (continued)

Device	P_{out} Output Power Watts	Class	P_{in}(Max) Input Power Watts	Gp (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 24 Volts — Si Bipolar						
MRF890	2	C	0.25	9/900	25	305-01/1
MRF890S	2	C	0.25	9/900	25	305A-01/1
TP3019	2	AB or A	0.25	9/960	14	305-01/1
TP3019S	2	AB or A	0.25	9/960	14	305A-01/1
TP3007★	2	AB	0.25	9/960	21	305C-01/1
TP3007S★	2	AB	0.25	9/960	21	305C-01/1
MRF896	3	AB or A	0.3	10/900	7	305-01/1
MRF896S	3	AB or A	0.3	10/900	7	305D-01/1
TP3008★	4	AB	0.28	11.5/960	5	319-06/2
MRF891	5	AB	0.63	9/900	7	319-06/2
MRF891S	5	C	0.63	9/900	7	319A-02/2
TP3021	10	AB or A	1	10/960	5	319-06/2
MRF892(4)	14	C	2	8.5/900	3.5	319-06/1
MRF894(4)	30	C	6	7/900	1.5	319-06/1
MRF897 (6)	30	AB	3	10/900	1.7	395B-01/1
TP3034★	35	AB	7	7/960	2.3	319-06/2
MRF898 (4)	60	C	12	7/900	1	333A-02/1
V_{CC} = 26 Volts — Si Bipolar						
MRF880 (6)	90	AB	12.7	8.5/900	1.3	375A-01/1
MRF899 (6)	150	AB	24	8/900	0.8	375A-01/1
TP3020A	2.2	A	0.28	9/960	20	244-04/1
TP3005	4	AB or A	0.57	8.5/960	7	319-06/2
TP3006	5	AB	0.63	9/960	7	319-06/2
TP3073(1)	12	A	1.5	9/960	2.5	395-02/1
TP3022B	15	AB	2.12	8.5/960	6	319-06/2
TP3032	21	AB	4	7.5/960	3.3	319-06/2
TP3033(1)	30	AB	5.3	7.5/900	2.5	319-06/2
TP3074(1)	35	A	4.4	9/960	1.1	375A-01/1
TP3024B(6)	35.5	AB	6.35	7.5/960	3	395-02/1
TP3061 (4)	45	AB	7.13	8/960	1.2	333A-02/2
TP3064	50	AB	8.9	7.5/960	1.2	333A-02/2
TP3060(4)	60	AB	10.67	7.5/900	1.2	333A-02/2
TP3062(6)	60	AB	12	7/960	1.2	398-02/1
TP3069(1)	100	AB	18	7.5/960	0.7	375A-01/1

(1)To be Introduced
(4)Internal Impedance Matched
(6)Internal Impedance Matched Push-Pull Transistors
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Microwave Transistors

Table 16. L-Band Pulse Power

These products are designed to operate in short pulse width, 10 μs, low duty cycle, 1%, power amplifiers operating in the 960 to 1215 MHz band. All devices have internal impedance matching. The prime application is avionics equipment for distance measuring (DME), area navigation (TACAN) and interrogation (IFF).

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_P (Min) Gain @ 1090 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 18 Volts — Class A & AB Common Emitter					
MRF1000MA	0.2	0.02	10	25	332-04/2
MRF1000MB	0.2	0.02	10	25	332A-03/2
V_{CC} = 35 Volts — Class B & C Common Base					
MRF1002MA	2	0.2	10	25	332-04/1
MRF1002MB	2	0.2	10	25	332A-03/1
MRF1004MA	4	0.4	10	25	332-04/1
MRF1004MB	4	0.4	10	25	332A-03/1
V_{CC} = 50 Volts — Class C Common Base					
MRF1015MA	15	1.5	10	10	332-04/1
MRF1015MB	15	1.5	10	10	332A-03/1
MRF1035MA	35	3.5	10	5	332-04/1
MRF1035MB	35	3.5	10	5	332A-03/1
MRF1090MA	90	9	10	0.6	332-04/1
MRF1090MB	90	9	10	0.6	332A-03/1
MRF1150MA	150	25	7.8	0.3	332-04/1
MRF1150MB	150	25	7.8	0.3	332A-03/1

Table 17. L-Band Long Pulse Power

These products are designed for pulse power amplifier applications in the 960 to 1215 MHz frequency range. They are capable of handling up to 10 μs pulses in long pulse trains resulting in up to a 50% duty cycle over a 3.5 millisecond interval. Overall duty cycle is limited to 25% maximum. The primary applications for devices of this type are military systems, specifically JTIDS and commercial systems, specifically Mode S. Package types are hermetic.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PB} (Min) Gain @ 1215 MHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts — Class C Common Base					
MRF10005(32)	5	0.71	8.5	8	336E-02/1
V_{CC} = 36 Volts — Class C Common Base					
MRF10031(32)★	30	3	10	3	376B-02/1
MRF10120(32)	120	19	8	0.6	355C-02/1
V_{CC} = 50 Volts					
MRF10070(32)	70	7	10(9)	0.4	376C-01/1
MRF10150(32)	150	15	10(9)	0.25	376B-02/1
MRF10350(32)	350	45	9(9)	0.11	355E-01/1
MRF10500(32)	500	56	9(9)	0.12	355D-02/1
MRF1375★	375	80	6.7	0.12	355G-01/1
MRF1500★	500	151	5.2	0.1	355G-01/1

(9)Typical @ 1090 MHz
(32)Available in Hi-Rel (MIL-S-19500) Processed versions by Adding Suffixes "HX" and "HXV" after Device Number
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Microwave Transistors (continued)

Table 18. 2 GHz Narrowband CW

The MRW2000 Series of NPN Silicon microwave power transistors are designed for common base service in amplifier or oscillator applications in the 1 to 2.3 GHz frequency range.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PB} (Min) Gain @ 2 GHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts — Class B & C Common Base					
MRW2001(10)	1	0.13	9	35	328A-03/1
MRW2003	3	0.48	8	15	328A-03/1
MRW2005	5	0.8	8	8.5	328A-03/1
MRW2010	10	2	7	6	328A-03/1
MRW2015	15	3.8	6	3.5	393-03/1
MRW2020	20	6	5.2	3	393-03/1

Table 19. 2.3 GHz Narrowband CW

The MRW2300 Series are common-base configured transistors in hermetic packages with guaranteed performance characteristics at 2.3 GHz. They feature diffused ballast resistors and gold metallization for extreme ruggedness and reliability.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PB} (Min) Gain @ 2.3 GHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 20 Volts					
MRW2301(10)	1.5	0.24	8	35	328A-03/1
MRW2304(10)	4	0.64	8	17	328A-03/1
MRW2307(10)	7	1	8.5	8.5	328A-03/1

Table 20. 3 GHz Narrowband CW

The MRW3000 Series are the industry's first 100% VSWR tolerant 3 GHz devices. They are common-base configured in hermetic packages and rated for 28 volt operation.

Device	P_{out} Output Power Watts	P_{in}(Max) Input Power Watts	G_{PB} (Min) Gain @ 3.0 GHz dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
MRW3001	1	0.2	7	35	328A-03/1
MRW3003	3	0.75	6	17	328A-03/1
MRW3005	5	1.6	5	8.5	328A-03/1

(10)Available in flangeless package (Case 328-02/1) by adding suffix "F" after device number

Devices listed in bold, italic are Motorola preferred devices.

Microwave Transistors (continued)

Table 21. 0.6 – 2.7 GHz Broadband Common Base

The MicRoAmp transistor employs MOS capacitors and other matching elements to transform the input, and in some devices, the output impedance, to a more manageable level prior to the point where package parasitics can reduce the bandwidth capabillity (U.S. Patent 3,713,006). These devices are assembled in common-base configuration and include an all-gold metal system and diffused ballast resistors for long life.

Device	Instantaneous Frequency Range F_L-F_H (MHz)	Output Power Min Watts	Gain Min dB	θ_{JF} °C/W	Package/Style
V_{CC} = 22 Volts					
MRAL1417-2	1400–1700	2	8	15	394-02/1
MRAL1417-6	1400–1700	6	7.4	8	394-02/1
MRAL1417-11	1400–1700	11	7.4	4.5	394-02/1
MRAL1720-2	1700–2000	2	7.5	15	394-02/1
MRAL1720-5	1700–2000	5	6.5	8	394-02/1
MRAL1720-9	1700–2000	9	6.5	4.5	394-02/1
MRAL1720-20	1700–2000	20	6	2.5	394-02/1
MRAL2023-1.5	2000–2300	1.5	8	30	394-02/1
MRAL2023-3	2000–2300	3	8	16	394-02/1
MRAL2023-6	2000–2300	6	6.8	8	394-02/1
MRAL2023-12	2000–2300	12	6.8	4.5	394-02/1
MRAL2023-18	2000–2300	18	6.5	2.5	394-02/1
MRAL2327-3	2300 - 2700	3	6.6	16	394-02/1
MRAL2327-6	2300–2700	6	7	8	394-02/1
MRAL2327-12	2300–2700	12	7	4.5	394-02/1
V_{CC} = 28 Volts					
MRA1300-10L	500–1500	10	7	2.1	360A-01/1
MRA0610-3	600–1000	3	7.8	15	394-02/1
MRA0610-9	600–1000	9	7.8	6	394-02/1
MRA0610-18A	600–1000	18	7.8	6	394-02/1
MRA1014-12	1000–1400	12	7.8	4.5	394-02/1
MRA1417-2	1400–1700	2	8	15	394-02/1
MRA1417-6	1400–1700	6	7.4	8	394-02/1
MRA1417-11	1400–1700	11	7.4	4.5	394-02/1
MRA1417-25A	1400–1700	25	7	2.5	394-02/1
MRA1618-35H	1600–1800	35	7	1.3	392-02/1
MRA1720-2	1700–2000	2	7.5	15	394-02/1
MRA1720-5	1700–2000	5	6.5	8	394-02/1
MRA1720-9	1700–2000	9	6.5	4.5	394-02/1
MRA1720-20	1700–2000	20	6	2.5	394-02/1

Devices listed in bold, italic are Motorola preferred devices.

Microwave Transistors (continued)

Table 22. L-Band CW, Narrowband, Common Base

The MRA1600 Series microwave power transistors are primarily intended for large-signal output and driver amplifier stages for satellite up/down links. Each is designed for **Class C**, common base amplifier applications.

Device	Instantaneous Frequency Range F_L-F_H (MHz)	Output Power Min Watts	Gain Min dB	θ_{JF} °C/W	Package/Style
V_{CC} = 28 Volts					
MRA1600-2	1600–1660	2	8.4	15	394-02/1
MRA1600-6	1600–1660	6	7.4	4.5	394-02/1
MRA1600-13	1600–1660	13	7.6	4.5	394-02/1
MRA1600-30	1600–1660	30	7	2.5	394-02/1
MRA1600-50H	1600–1660	50	6.5	1.5	392-03/1

Table 23. L-Band for Satellite Uplinks

The MRF6800 Series microwave transistors are primarily intended for large signal output and driver amplifier stages operating in a **Class AB** linear mode for maritime and mobile satellite uplinks.

Device	P_{out} Watts	f Frequency MHz	Bias Point Vdc/mA	Gp(Typ) Power Gain dB	θ_{JC} °C/W	Package/Style
V_{CC} = 26 Volts						
MRF6800(1)	5	1600-1660	26/40	10	5	319-06/2
MRF6801(1)	12	1600-1660	26/100	7.5	4.5	319-06/2
MRF6802(1)	25	1600-1660	26/200	7	2.5	395-02/1
MRF6803(1)	30	1600-1660	26/150	9	1.4	395C-01/1

Table 24. Power Oscillator

These oscillator devices are **common collector** configuration with diffused ballast resistors, gold metallization and hermetic packages to provide high reliability in severe environmental conditions. Each is fully characterized for power oscillator applications.

Device	Operating Conditions V_{CE}/I_C V/mA	Output Power (Typ) — Watts/@ Freq. — GHz				Package/Style
		Minimum	P_o @ Low f	P_o @ Mid f	P_o @ High f	
TP62601	20/220	1.25/2	1.85/2	1.35/2.5	0.85/3	328A-03/5
TP63601	20/120	0.6/2.3	0.75/2.3	0.5/2.8	0.28/3.3	328A-03/5

(1)To be Introduced

Devices listed in bold, italic are Motorola preferred devices.

Linear Transistors

The following sections describe a wide variety of devices specifically characterized for linear amplification. Included are medium power and high power parts covering frequencies from 100 MHz to 4 GHz.

Table 25. To 1 GHz, Class A

These devices offer a selection of performance and price for linear amplification to 1 GHz. The "MRA" prefix parts are input matched and feature high overdrive and extreme ruggedness capability.

Device	P_o @ 1 dB Comp. Point Watts	G_{SS} (Min)/Freq. Small Signal Gain dB/MHz	Bias Point (Vdc/A)	θ_{JC} °C/W	Package/Style
V_{CC} = 19 Volts					
MRA1000-3.5L	3.5	10/1000	19/0.6	8	145A-09/1
MRA1000-7L	7	9/1000	19/1.2	4	145A-09/1
MRA1000-14L	14	8/1000	19/2.4	2.1	145A-09/1
V_{CC} = 25 Volts					
MRF1029(42)	1.5	8/1000	25/0.2	12	244-04/1
MRF1030(42)	3	7.5/1000	25/0.4	6	244-04/1
MRF1031(42)	4.5	7/1000	25/0.6	3.5	244-04/1
MRF1032(42)	6	6.5/1000	25/0.85	3.5	244-04/1

Table 26. To 2 GHz, Class A

These parts offer low cost alternatives to matched devices used primarily as pre-drivers to 2 GHz.

Device	P_o @ 1 dB Comp. Point Watts	G_{SS} (Min)/Freq. Small Signal Gain dB/MHz	Bias Point (Vdc/A)	θ_{JC} °C/W	Package/Style
V_{CC} = 20 Volts					
MRF3094(42)	0.5	10.5/2000	20/0.12	40	328A-03/1
MRF3104(42)	0.5	10.5/2000	20/0.12	40	305A-01/1
MRF3095(42)	0.8	9/2000	20/0.12	35	328A-03/1
MRF3105(42)	0.8	9/2000	20/0.12	35	305A-01/1
MRF3096(42)	1.6	9/2000	20/0.24	22	328A-03/1
MRF3106(42)	1.6	9/2000	20/0.24	22	305A-01/1
MRF2000-5L(26)	5	7/2000	19/0.6	10	360A-01/1

Table 27. VHF Ultra Linear For TV Applications

The following devices have been characterized for ultra-linear applications such as low-power TV transmitters in Band III. Each features diffused ballast resistors and an all-gold metal system to provide enhanced reliability and ruggedness.

Device	P_{ref} Watts	Gp (Min)/Freq. Small Signal Gain dB/MHz	3 Tone IMD(12) dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
TPV385	14	14/225	–53	1.5	316-01/1
TPV375	20	8/225	–51	1.5	145A-10/1
TPV387	24	13/225	–50	1	316-01/1
TPV376	30	7.5/225	–53	1	316-01/1
TPV3100	28	14/225	–51	0.8	827-01/1
TPV387	90(13)	10/225	—	1	316-01/1
TPV3100	100(13)	13/225	—	0.8	827-01/1

(12)Vision Carrier: – 8 dB; Sound Carrier: – 7 dB; Sideband Carrier: – 16 dB
(13)Output power at 1 dB compression in Class AB
(26)Former prefix was "MRA."
(42)Former Prefix was "RF"

Devices listed in bold, italic are Motorola preferred devices.

Linear Transistors (continued)

Table 28. UHF Ultra Linear For TV Applications

The following devices have been characterized for ultra-linear applications such as low-power TV transmitters in Band IV and V. Each features diffused ballast resistors and an all-gold metal system to provide enhanced reliability and ruggedness.

Device	P_{ref}(Min) Watts	Gp (Min)/Freq. Small Signal Gain dB/MHz	3 Tone IMD(12) dB	θ_{JC} °C/W	Package/Style
V_{CC} = 20 Volts					
TPV590	0.25	14/860	−58	30	305A-01/1
TPV591	0.5	13/860	−58	16	305A-01/1
TPV596A	0.5	11.5/860	−58	20	244-04/1
TPV597	1	10.5/860	−58	9	244-04/1
TPV598	4	7/860	−60	5	244-04/1
V_{CC} = 25 Volts					
TPV593	2	8.5/860	−60	11	244-04/1
TPV595A	14	8.5/860	−47	2.5	395-02/1
TPV695A	14	9.5/860	−47	2.5	395-02/1
TPV7025	25	8.5/860	−45	1.5	398-02/1
TPV6030	20/35(13)	9.5/860	−51/–	1.1	375A-01/1
V_{CC} = 28 Volts					
TPV5051	50(13)	6.5/860	—	1.8	395-02/1
TPV5055B	50(13)	7/860	—	1.5	398-02/1
TPV8100B	100(13)	8.5/860	—	0.7	398-02/1
TPV8200B★	150(13)	8/860	—	0.7	375A-01/1

Table 29. Microwave Linear For PCN Applications

The following devices have been developed for linear amplifiers in the 1.5 to 2 GHz region and have characteristics particularly suitable for PCN base station applications.

Device	P_{out} Watts	Class	Bias Point Vdc/mA	Gain (Typ)/Freq dB/MHz	θ_{JC} °C/W	Package/Style
MRF6401(1)(45)	0.5	A	20/80	10/1880	30	305C-01/1
MRF6402(1)(43)	4	AB	26/40	10/1880	5	319-06/2
TP4012(1)	12	AB	26/100	7.5/1880	4.5	319-06/2
MRF6403(1)(44)	25	AB	26/250	6.5/1880	2.5	395-02/1
MRF6404(1)(46)	30	AB	26/150	9/1880	1.4	395C-01/1

(1)To be Introduced
(12)Vision Carrier: – 8 dB; Sound Carrier: – 7 dB; Sideband Carrier: – 16 dB
(13)Output power at 1 dB compression in Class AB
(43)Formerly known as "TP4004"
(44)Formerly known as "TP4025"
(45)Formerly known as "TP4001S"
(46)Formerly known as "TP4035"
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Linear Transistors (continued)

Table 30. Microwave Linear Power

Common emitter microwave devices are offered for a wide variety of uses in small and medium signal, Class A, AB and C applications up to 4 GHz. The use of all-gold metal systems, diffused ballast resistors and hermetic packaging results in devices that display excellent reliability even in a military environment.

Device	G_{SS} (Min) @ Freq. Small Signal Gain dB/GHz	1 dB Comp. Watts	P_{sat} Watts	−30 dB IMD Watts	Emitter Current mA	Package/Style
V_{DD} = 20 Volts						
MRW52001	6/2	1.8	2.5	1.5	220	400-01/1
MRW52501	5/2	1.8	2.5	1.5	220	401-02/1
MRW52504	5/2	7.2	10	6	880	401-02/1
MRW52601	6/2	1.8	2.5	1.5	220	328A-03/1
MRW52602	6/2	3.6	5	3	440	328A-03/1
MRW52604	5/2	7.2	10	6	880	328A-03/1
MRW53001	6/3	0.8	1	0.8	120	400-01/1
MRW53102	6/3	1.6	2	1.5	230	328-02/2
MRW53501	5/3	0.8	1	0.8	120	401-02/1
MRW53502	5/3	1.6	2	1.5	230	401-02/1
MRW53505	5/3	4	5	4	600	401-02/1
MRW53601	6/3	0.8	1	0.8	120	328A-03/1
MRW53602	5/3	1.6	2	1.5	230	328A-03/1
MRW53605	6/3	4	5	4	600	328A-03/1
MRW54001	5/4	0.5	0.8	0.5	120	400-01/1
MRW54101	6/4	0.5	0.8	0.5	120	328-02/2
MRW54501	5/4	0.5	0.8	0.5	120	401-02/1
MRW54601	6/4	0.5	0.8	0.5	120	328A-03/1
MRW54602	9/2	1	2	1	240	328A-03/1

Table 31. Bias Devices

The BT500F bias device is used to provide the proper bias point for Class AB linear amplifiers. It features excellent thermal tracking and simple external circuitry.

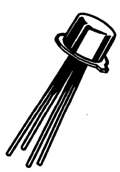
Device	I_F Typ mA	h_{FE} Min-Max	$V_{(BR)EBO}$ Min Volts	Package/Style
Bias Devices for Class AB 28–50 Volt Transistors				
BT500F	500	20–100	4	211-07/1

Devices listed in bold, italic are Motorola preferred devices.

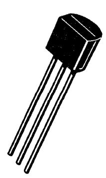
RF Small Signal Bipolar Transistors

Motorola's broad line of RF Small Signal Transistors includes NPN and PNP Silicon Bipolar Transistors characterized for low noise amplifiers, mixers, oscillators, multipliers, non-saturated switches and low-power drivers.

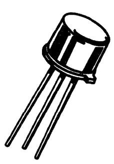
These devices are available in a wide variety of package types: metal can, plastic Macro-X and Macro-T, ceramic and surface mounted. Most of these transistors are fully characterized with s-parameters.



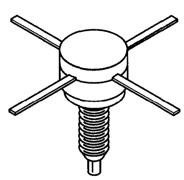
CASE 20-03
STYLE 10
(TO-206AF)
(TO-72)



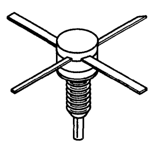
CASE 29-04
STYLE 2
(TO-226AA)



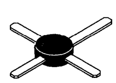
CASE 79-04
STYLE 1
(TO-205AD)
(TO-39)



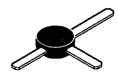
CASE 244A-01
STYLES 1, 3



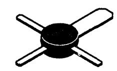
CASE 305-01
STYLE 1



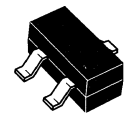
CASE 317-01
STYLES 2, 3
(MACRO-X)



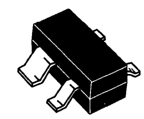
CASE 317A-01
STYLE 2
(MACRO-T)



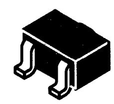
CASE 317D-02
STYLES 2,3
(POWER MACRO)



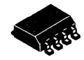
CASE 318-07
STYLE 6
(SOT-23)



CASE 318A-05
STYLES 1, 4
LOW PROFILE
(SOT-143)



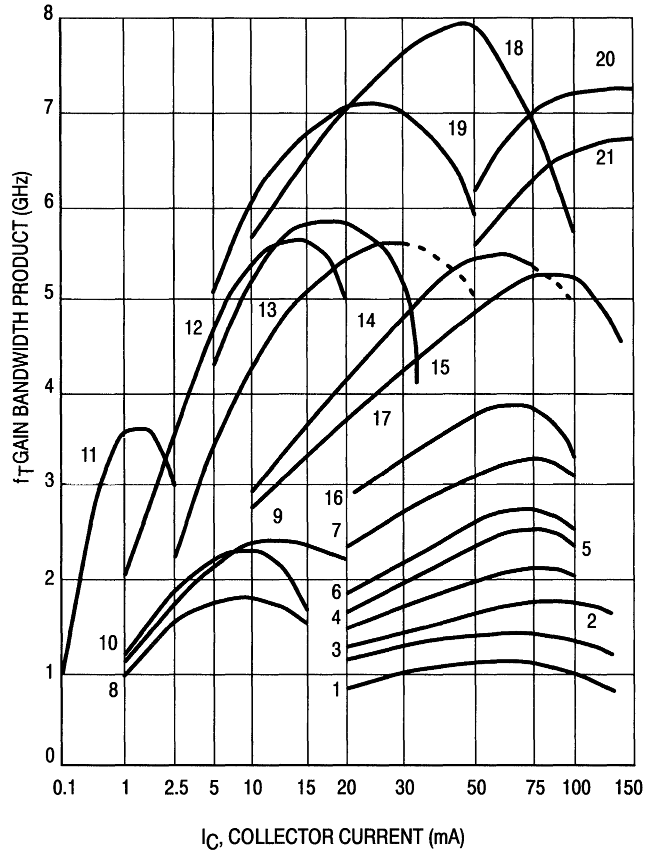
CASE 419-02
STYLE 3
(SC-70)



CASE 751-04
STYLE 1
(SO-8)

RF Small Signal Transistor Gain Characteristics

Curve numbers apply to transistors listed in the subsequent tables.

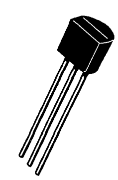
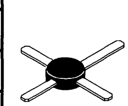


Selection by Package

In small-signal RF applications, the package style is often determined by the end application or circuit construction technique. To aid the circuit designer in device selection, the Motorola broad range of RF small-signal amplifier transistors is organized by package. Devices for other applications such as oscillators or switches are shown in the appropriate preceding tables. **These devices are NPN polarity unless otherwise designated.**

Plastic SOE Case

Table 32. Plastic SOE Case

Device	Gain-Bandwidth f_T Typ GHz	@ I_C mA	Curve No. Page 5.8-20	NF @ f Typ dB	MHz	Gain @ f Typ dB	MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 29-04/2, TO-226AA											
MPS536(5)	5	−20	19	4.5	500	14	500	−10	−30	625	
MPS571	6	50	18	2	500	14	500	10	80	625	
MPS901	4.5	15	12	2.4	900	12	900	15	30	300	
MPS911	7	30	13	1.7	500	16.5	500	12	40	625	
MPS3866	0.8	50	1	—	—	10	400	30	400	625	
Case 317-01/2 — MACRO-X											
MRF521(5)	4.2	−50	—	2.8	1000	11	1000	−10	−70	750	
MRF536(5)	6	−20	19	4.5	1000	10	1000	−10	−30	300	
MRF559	3	100	16	—	—	13	512	18	150	2000	
MRF571	8	50	18	1.5	1000	12	1000	10	70	1000	
MRF581	5	75	17	2	500	15.5	500	18	200	2500	

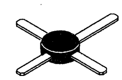
(5)PNP

Devices listed in bold, italic are Motorola preferred devices.

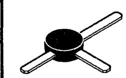
Table 32. Plastic SOE Case (continued)

Device	Gain-Bandwidth		Curve No. Page 5.8-20	NF @ f		Gain @ f		Maximum Ratings			Package
	f_T Typ GHz	@ I_C mA		Typ dB	MHz	Typ dB	MHz	$V_{(BR)CEO}$ Volts	I_C mA	P_T mW	

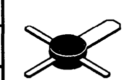
Case 317-01/2 — MACRO-X (continued)

Device	f_T Typ GHz	@ I_C mA	Curve No. Page 5.8-20	NF Typ dB	NF f MHz	Gain Typ dB	Gain f MHz	$V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
MRF581A	5	75	17	1.8	500	15.5	500	15	200	2500	
MRF837	5	75	17	—	—	10	870	16	200	2500	
MRF901	4.5	15	12	2	1000	12	1000	15	30	375	
MRF941	8	15	—	2.1	2000	12.5	2000	10	50	400	
MRF951	7.5	30	—	2.1	2000	12.5	2000	10	100	1000	
MRF2369	6	40	18	1.5	1000	12	1000	15	70	750	

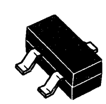
Case 317A-01/2 — MACRO-T

Device	f_T Typ GHz	@ I_C mA	Curve No. Page 5.8-20	NF Typ dB	NF f MHz	Gain Typ dB	Gain f MHz	$V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
BFR90	5	14	12	2.4	500	18	500	15	30	180	
BFR91	5	30	13	1.9	500	16	500	12	35	180	
BFR96	4.5	50	14	2	500	14.5	500	15	100	500	
BFW92A	4.5	10	15	2.7	500	16	500	15	35	180	
MRF580	5	75	17	2	500	14	500	18	200	2500	
MRF580A	5	75	17	1.8	500	14	500	15	200	2500	

Case 317D-02/2,3

Device	f_T Typ GHz	@ I_C mA	Curve No. Page 5.8-20	NF Typ dB	NF f MHz	Gain Typ dB	Gain f MHz	$V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
MRF553	—	—	—	—	—	13	175	16	500	3000	
MRF555	—	—	—	—	—	12.5	470	16	400	3000	
MRF557	—	—	—	—	—	9	870	16	400	3000	

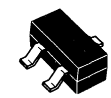
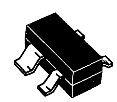
Case 318-07/6 — SOT–23

Device	f_T Typ GHz	@ I_C mA	Curve No. Page 5.8-20	NF Typ dB	NF f MHz	Gain Typ dB	Gain f MHz	$V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
BFR92L	3.4	14	—	3.0	500	15	—	15	25	350	
BFR93L	3.4	30	—	2.5	30	—	—	12	35	350	
BFS17L	1.3	25	—	5	30	—	—	15	—	350	
MMBR521L★(5)	3.4	–35	—	1.5	500	15	500	–10	–70	312	

(5)PNP

Devices listed in bold, italic are Motorola preferred devices.

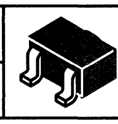
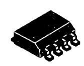
Table 32. Plastic SOE Case (continued)

Device	Gain-Bandwidth f_T Typ GHz	@ I_C mA	Curve No. Page 5.8-20	NF Typ dB	@ f MHz	Gain Typ dB	@ f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 318-07/6 — SOT-23 (continued)											
MMBR536L (5)	5.5	−20	19	4.5	500	14	500	−10	−30	350	
MMBR571L	8	50	18	2	500	16.5	500	10	80	350	
MMBR901L	4	15	12	1.9	1000	12	1000	15	30	350	
MMBR911L	6	30	13	2	500	17	500	12	40	350	
MMBR920L	4.5	14	—	2.4	500	15	500	15	35	350	
MMBR941L	8	15	—	2.1	2000	8.5	2000	10	50	400	
MMBR951L	8	30	—	2.1	2000	7.5	2000	10	100	500	
MMBR931L	3	1	11	4.3	1000	10	1000	5	5	350	
MMBR4957L(5)	1.2	−2	10	3	450	17	450	−30	−30	350	
MMBR5031L	1	5	—	2.5	450	17	450	10	20	350	
MMBR5179L	1.4	5	8	4.5	200	15	200	12	50	350	
Case 318A-05/1 — SOT-143											
MRF0211L	5.5	40	18	1.8	1000	9.5	1000	15	70	580	
MRF5211L (5)	4.2	−50	—	2.8	1000	11	1000	−10	−70	580	
MRF5711L	8	50	18	1.6	1000	13.5	1000	10	70	580	
MRF9011L	3.8	15	12	2.3	1000	10.2	1000	15	30	300	
MRF9331L	5	1	—	2.5	1000	12.5	1000	8	1	50	
MRF9411L	8	15	—	2.1	2000	9.5	2000	10	50	400	
MRF9511L	8	30	—	2.1	2000	9	2000	10	100	500	

(5)PNP

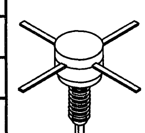
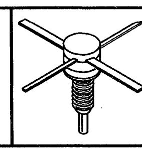
Devices listed in bold, italic are Motorola preferred devices.

Table 32. Plastic SOE Case (continued)

Device	Gain-Bandwidth f_T Typ GHz	@ I_C mA	Curve No. Page 5.8-20	NF Typ dB	@ f MHz	Gain Typ dB	@ f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 419-02/3 — SC-70											
MRF947	8	15	—	2.1	1500	10.5	1500	10	50	175	
MRF957	8	30	—	2.0	1500	9	1500	10	100	175	
Case 751-04/1 — SO-8											
MRF3866	0.8	50	1	—	—	10.5	400	30	400	1000	
MRF4427	1.6	50	1	—	—	18	175	20	400	1000	
MRF5160(5)	0.8	−50	1	—	—	10	400	−40	−400	1000	
MRF5583(5)	2.1	−35	5	—	—	1.5	250	−30	−500	1000	
MRF5812	5.5	75	17	2	500	15.5	500	15	200	1500	
MRF5943	1.5	35	4	3.4	200	12	250	30	400	1000	
MRF8372	5	75	17	—	—	10	870	16	200	1500	
MRFQ17	2.25	50	5	—	—	12	500	25	300	1000	
MRFQ19	5.3	50	14	3.5	500	14.6	500	15	150	1000	

Ceramic SOE Case

Table 33. Ceramic SOE Case

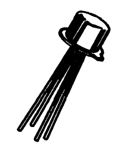
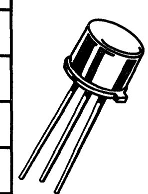
Device	Gain-Bandwidth f_T Typ GHz	@ I_C mA	Curve No. Page 5.8-20	N Typ dB	@ f MHz	Gain Typ dB	@ f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 244A-01/1,3											
LT2001	3	90	7	2.5	300	11.5	300	20	200	5000	
MRF546(15)	—	—	—	2	500	5.5	250	70	600	900	
MRF547(5)	—	—	—	2	500	5.5	250	−70	600	9000	
MRF548(15)	—	—	2	—	—	5.5	250	70	400	5000	
MRF549(5)	—	—	2	—	—	5.5	250	−70	−400	5000	
MRF587	5.5	90	17	3	500	13	500	15	200	5000	
MRF4217A★(11)	5.5	90	17	2.5	500	15	500	12	400	5000	
Case 305-01/1											
MRF6900(1)	—	—	—	—	—	15	800	19	250	5800	

(5)PNP
(11)Former Prefix was "LT"
(15)Common Base Configuration
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Metal Can

Table 34. Metal Can

Device	Gain-Bandwidth fT Typ GHz	@ IC mA	Curve No. Page 5.8-20	N @ f Max dB	MHz	Gain @ f Min dB	MHz	Maximum Ratings V(BR)CEO Volts	IC mA	PT mW	Package
Case 20-03/10, TO-206AF											
2N2857	1.6	8	8	4.5	450	12.5	450	15	40	200	
2N4957[5]	1.6	−2	10	3	450	17	450	−30	−30	200	
2N5031	1.6	5	8	2.5	450	14	450	10	20	200	
2N5179	1.4	10	8	4.5	200	15	200	12	50	200	
2N6304	1.8	10	9	4.5	450	15	450	15	50	200	
BFY90	1.7	25	9	5	500	21[16]	200	15	50	200	
MM4049[5]	5	−20	19	3[16]	500	11.5	500	−10	−30	200	
MRF904	4	15	12	1.5[16]	450	16[16]	450	15	30	200	
Case 79-04/1, TO-205AD											
2N3866	0.7	50	—	—	—	10	400	30	400	5000	
2N3866A	1	50	—	—	—	10	400	30	400	5000	
2N4427	1	50	1	—	—	10	175	20	400	3500	
2N5108	1.2	50	2	—	—	5	1000	30	400	3500	
2N5109	1.5	50	4	3[16]	200	11	216	20	400	2500	
2N5160[5]	0.9	−50	—	—	—	8.0	400	−40	−400	5000	
2N5583[5]	1.5	−100	5	—	—	—	—	−30	−500	5000	
2N5943	1.5	50	4	3.4[16]	200	11.4[16]	200	30	400	3500	
MRF1001A[11]	3	90	7	2.5	300	13.5	300	20	200	3000	
MRF4239A[11]★	5	90	21	2.5	500	14	500	12	400	3000	
MRF517	2.7	60	7	7.5	300	10[16]	300	20	150	2500	
MRF531	0.8	50	—	—	—	—	—	100	100	2500	
MRF544	1.4	50	2	—	—	16.5[16]	250	70	400	3500	
MRF545[5]	1.2	−50	2	—	—	15.5[16]	250	−70	−400	3500	
MRF586	4.5	90	17	4	500	9	500	17	200	2500	

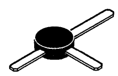
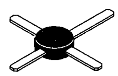
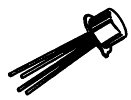
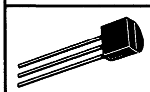
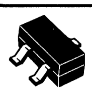
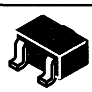
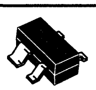
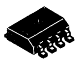
[1] To be Introduced
[5] PNP
[11] Former Prefix was "LT"
[16] Typical
★ New Product

Devices listed in bold, italic are Motorola preferred devices.

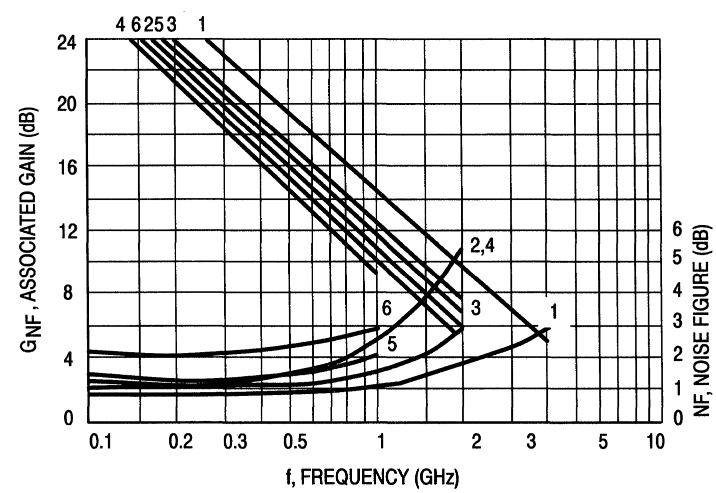
Selection by Application

Table 35. Low Noise

The Small-Signal devices listed are designed for low noise and high gain amplifier mixer, and multiplier applications. Each transistor type is available in various packages. **Polarity is NPN unless otherwise noted.**

Package	Name	Case Number	Curve Number (See figure below)					
			1	2(5)	3	4	5	6
	MACRO-T	317A-01/2	—	—	—	MRF580	—	BFR91
	MACRO-X	317-01/2	MRF941 MRF951(18)	MRF521	MRF571 MRF2369(17)	MRF581	MRF901	—
	TO-206AF	20-03/10	—	—	—	—	MRF904	—
	TO-226AA	29-04/2	—	—	MPS571	—	MPS901	MPS911
	SOT-23	318-07/6	MMBR941L MMBR951L(18)	MMBR521L	MMBR571L	—	MMBR901L	MMBR911L
	SC-70	419-02/3	MRF947 MRF957(18)	—	—	—	—	—
	SOT-143	318A-05/1	MRF9411L MRF9511L(18)	MRF5211L	MRF5711L MRF0211L(17)	—	MRF9011L	—
	SO-8	751-04/1	—	—	—	MRF5812	—	—

(5)PNP
(17)Higher Voltage Version
(18)Higher Current Version



Gain and Noise Figure versus Frequency

Devices listed in bold, italic are Motorola preferred devices.

Selection by Application (continued)

Table 36. CATV, MATV and Class A Linear

For Class A linear CATV/MATV applications. Listed according to increasing gain bandwidth (f_T).

Device	Nominal Test Conditions V_{CE}/I_C Volts/mA	f_T Typ MHz	Noise Figure	Distortion Specifications				$V_{(BR)CEO}$ V	Package/ Style
			Typ/Freq. dB/MHz	2nd Order IMD dBc	3rd Order IMD dBc	12 Ch. Cross-Mod. dBc	Output Level dBmV		
2N5179	6/10	1400	3.2/200					12	20-03/10
MMBR5179L	6/5	1500	4/450					12	318-07/6
2N5109	15/50	1500	3/200					20	79-04/1
2N5943	15/50	1500	3.4/200	−50		−4	+50	30	79-04/1
MRF5943	15/50	1500	3.4/200					30	751-04/1
MRF5583[5]	10/−100	1500						−30	751-04/1
BFY90	5/25	1700	2.5/500					15	20-03/10
2N6304	5/10	1800	3.2/450					15	20-03/10
MMBR4957L[5]	10/−2	2000	3/450					−30	318-07/6
MMBR5031L	6/5	2000	1.9/450					10	318-07/6
MRFQ17	12.5/50	2200						25	751-04/1
MRF517	15/60	2700	6.5/300	−60	−72	−57	+45	20	79-04/1
MRF1001A[11]	14/90	3000	2.5/300					20	79-04/1
LT2001	14/90	3000	2.5/300					20	244A-01/1
MMBR920L	10/14	4500	2.4/500					15	318-07/6
BFW92A	10/10	4500	2.7/500					15	317A-01/2
MRF586	15/90	4500	3/500	−50	−72		+50	17	79-04/1
BFR96	10/50	4500	2/500					15	317A-01/2
BFR90	10/14	5000	2.4/500					15	317A-01/2
BFR91	5/30	5000	1.9/500					12	317A-01/2
MRF4217A[11]	8/90	5000	2/300					10	244A-01/1
MRF4239A[11]	8/90	5000	2.7/300					10	79-04/1
MRF581	10/75	5000	2.7/300		−65		+50	18	317-01/2
MRF581A	10/75	5000	1.8/500		−65		+50	15	317-01/2
MRF5812	10/75	5000	1.8/500		−65		+50	15	751-04/1
MRF587	15/90	5500	3/500	−52	−72		+50	17	244A-01/1
MRF6900(1)	18/120				− 64[20]		61.5[20]	19	305-01/1

[1]To be Introduced
[5]PNP
[11]Former Prefix was "LT"
[20]Output in volts according to DIN45004B

Devices listed in bold, italic are Motorola preferred devices.

Selection by Application (continued)

Table 37. CRT Drivers

These discrete devices are specially designed for CRT driver applications requiring high frequency response and high voltage, such as high resolution color graphics video monitors. Gold metallized die are used to insure high reliability and improved ruggedness.

Device	$V_{(BR)CEO}$ V	$V_{(BR)CBO}$ V	$I_{C(max)}$ mA	h_{FE}	$f_T/V_{CE}, I_C$ GHz/V, mA	C_{CB}/V_{CE} pF/V	Package/ Style
NPN							
MRF531	100	100	100	25–	0.8/25, 50	4/10	79-04/1
MRF544	70	120	400	15–	1.4/10, 50	1.8/10	79-04/1
MRF546	70	120	600	15–	—	3.6/10	244A-01/3
MRF548	70	120	400	15–	—	2/10	244A-01/3
PNP							
MRF545	–70	–100	–400	15–	1.2/25, – 50	2/–10	79-04/1
MRF547	–70	–100	–600	15–	—	3.6/–10	244A-01/3
MRF549	–70	–100	–400	15–	—	2/–10	244A-01/3

Table 38. High-Speed Switches

The transistors listed below are for use as high-frequency current-mode switches. They are also suitable for RF amplifier and oscillator applications. The devices are listed in ascending order of collector current. These devices are NPN polarity unless otherwise designated.

Device	Test Conditions I_C/V_{CE} mA/Volts	f_T Min MHz	$r_{b'}C_C$ Max ps	Package/Style
MM4049(5)	20/5	4000	15	20-03/10
2N5583(5)	50/10	1000	8(16)	79-04/1
2N5943	50/15	1200	5.5(16)	79-04/1

(5)PNP
(16)Typical

Table 39. UHF and Microwave Oscillators

The transistors listed below are for UHF and microwave oscillator applications as initial signal sources or as output stages of limited range transmitters. Devices are listed in order of increasing output power.

Device	Test Conditions		P_{out} Min mW	f_T Typ MHz	Package/Style
	f MHz	V_{CC} Volts			
2N5179	500	10	20	1400	20-03/10
2N2857	500	10	30	1600	20-03/10
2N5108	1680	20	300	1400	79-04/1
2N3866	400	15	1000	800	79-04/1
MPS3866	400	15	1000	800	29-04/2
MRF3866	400	15	1000	800	751-04/1

Devices listed in bold, italic are Motorola preferred devices.

Complementary Devices

The transistor complements listed are suitable for most applications requiring NPN and PNP devices of similar RF characteristics. See indicated pages for specifications.

Table 40. Complementary Devices

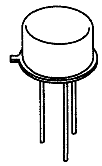
NPN	Page #	PNP	Page #
2N2857	5.8-24	2N4957	5.8-24
2N3866	5.8-25	2N5160	5.8-25
2N5943	5.8-25	2N5583	5.8-25
MRF904	5.8-24	MM4049	5.8-24
MRF571	5.8-21	MRF521	5.8-21

Devices listed in bold, italic are Motorola preferred devices.

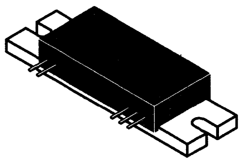
RF Amplifiers

Motorola's line of RF amplifiers designed and specified for use in land mobile radios, CATV distribution systems and general purpose wideband amplification applications. They feature small size, matched inputs and outputs, high stability and guaranteed performance specifications. For the user they offer the benefits of smaller and less complex system designs, in less time and at lower overall cost.

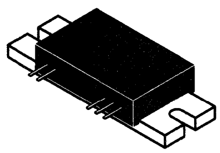
Each amplifier uses modern transistor chips which are gold metallized and have silicon nitride passivation for increased reliability and long life. Chip and wire construction features MOS capacitors and laser trimmed nichrome resistors. Circuit substrates and metallization have been selected for optimum performance cost and reliability.



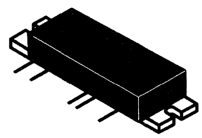
CASE 31A-03
STYLE 2
(TO-205AD)



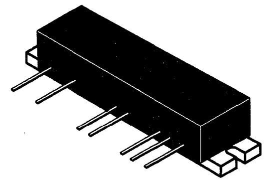
CASE 301AA-01
STYLE 1



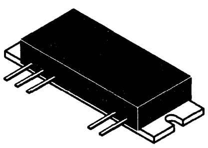
CASE 301AB-01
STYLE 1



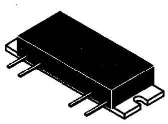
CASE 301E-04
STYLE 1



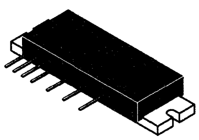
CASE 301F-03
STYLE 1



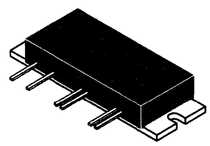
CASE 301G-03
STYLE 1



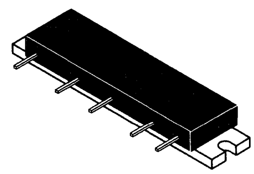
CASE 301H-03
STYLE 2



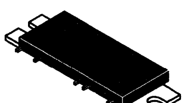
CASE 301J-02
STYLE 1



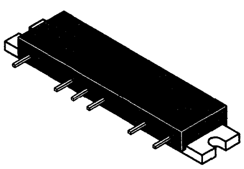
CASE 301K-02
STYLE 3



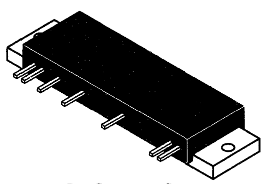
CASE 301L-02
STYLE 2



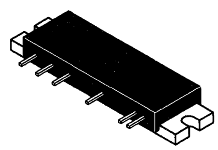
CASE 301N-01
STYLE 1



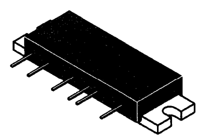
CASE 301R-01
STYLE 2



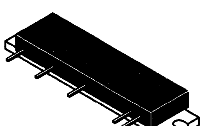
CASE 301S-02
STYLE 1



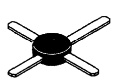
CASE 301T-02
STYLE 1



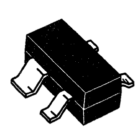
CASE 301V-02
STYLE 1



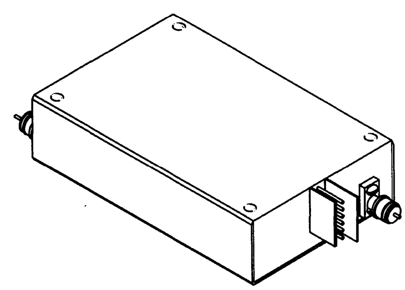
CASE 301Y-02
STYLE 1



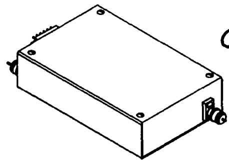
CASE 317-01
STYLE 3



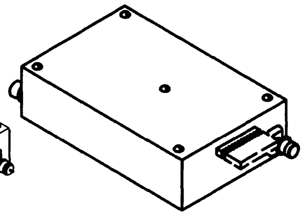
CASE 318A-05
STYLE 4



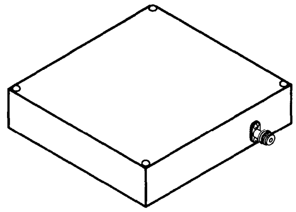
CASE 389B-02
STYLE 1



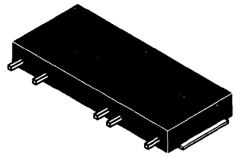
CASE 389N-01
STYLE 1



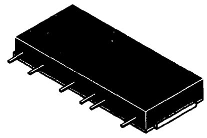
CASE 389P-01
STYLE 1



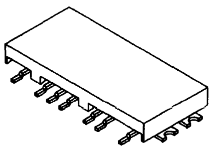
CASE 389U-01
STYLE 1



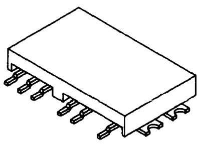
CASE 413-02
STYLE 1



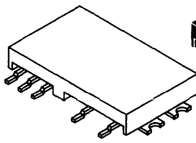
CASE 413A-01
STYLE 1



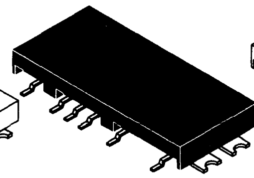
CASE 420-01
STYLES 1, 2



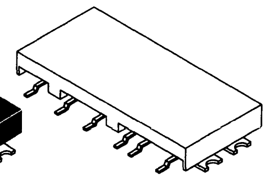
CASE 420A-01
STYLE 1



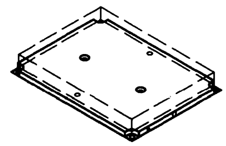
CASE 420B-03
STYLES 1, 2



CASE 420C-01
STYLE 1



CASE 420E-01
STYLE 1



CASE 429-02
STYLE 1

CASE
NOT AVAILABLE.
CONSULT FACTORY.

CASE429A-01
STYLE 1

CASE
NOT AVAILABLE.
CONSULT FACTORY.

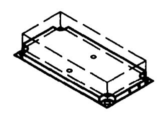
CASE 429B-01
STYLE 1

CASE
NOT AVAILABLE.
CONSULT FACTORY.

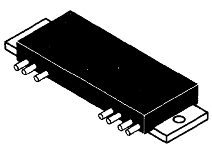
CASE 429C-01
STYLE 1

CASE
NOT AVAILABLE.
CONSULT FACTORY.

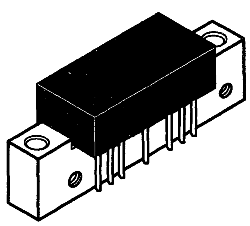
CASE 429D-01
STYLE 1



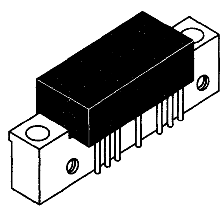
CASE 429E-01
STYLE 1



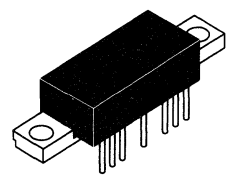
CASE 700-04
STYLE 1



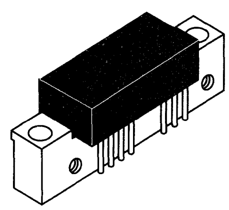
CASE 714-04
STYLE 1



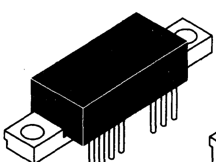
CASE 714F-01
STYLE 1



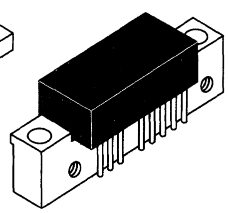
CASE 714G-01
STYLE 1



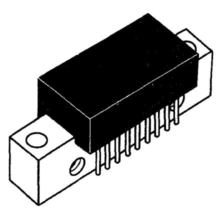
CASE 714H-01
STYLE 1



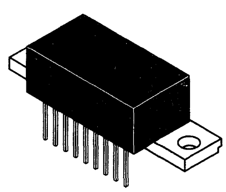
CASE 714L-01
STYLE 1



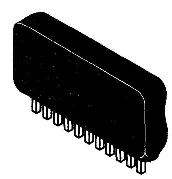
CASE 714M-01
STYLE 1, 2



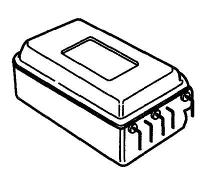
CASE 714P-01
STYLES 2, 3



CASE 714T-01
STYLES 2, 3



CASE 790-01
STYLE 1



CASE 825A-02
STYLE 1

High Power

Complete amplifiers with 50 ohm in/out impedances are available for a variety of applications including land mobile radios, base stations, TV transmitters and other uses requiring large-signal amplification, both linear and Class C. Frequencies covered range from 136 MHz to 1900 MHz with power levels extending to 270 watts.

Land Mobile/Portable

The advantages of small size, reproducibility and overall lower cost become more pronounced with increasing frequency of operation. These amplifiers offer a wide range in power levels and gain, with guaranteed performance specifications for bandwidth, stability and ruggedness.

Table 41. VHF/UHF, Class C

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	Gp Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
136–174 MHz, VHF Band — Class C (Silicon Bipolar Die)						
MHW105★	5	0.001	68–88	37	7.5	301K-02/2
MHW607-1	7	0.001	136–150	38.4	7.5	301K-02/3
MHW607-2	7	0.001	146–174	38.4	7.5	301K-02/3
MHW607-3	7	0.001	174–195	38.4	7.5	301K-02/3
MHW607-4	7	0.001	184–210	38.4	7.5	301K-02/3
400–512 MHz, UHF Band — Class C (Silicon Bipolar Die)						
MHW703	2.3	0.002	450 – 460	30.6	7.2	301J-02/1
MHW704★	3	0.001	440 – 470	34.8	7.5	301J-02/1
MHW707-1	7	0.001	403 – 440	38.4	7.5	301J-02/1
MHW707-2	7	0.001	440 – 470	38.4	7.5	301J-02/1
MHW707-3	7	0.001	470 – 500	38.4	7.5	301J-02/1
MHW707-4	7(35)	0.001	490 – 512	38.4(35)	7.5	301J-02/1
MHW709-1	7.5	0.1	400 – 440	18.8	12.5	700-04/1
MHW709-2	7.5	0.1	440 – 470	18.8	12.5	700-04/1
MHW709-3	7.5	0.1	470 – 512	18.8	12.5	700-04/1
MHW710-1	13	0.15	400 – 440	19.4	12.5	700-04/1
MHW710-2	13	0.15	440 – 470	19.4	12.5	700-04/1
MHW710-3	13	0.15	470 – 512	19.4	12.5	700-04/1
MHW720-1	20	0.15	400 – 440	21	12.5	700-04/1
MHW720-2	20	0.15	440 – 470	21	12.5	700-04/1
MHW720A1(21)	20	0.15	400 – 440	21	12.5	700-04/1
MHW720A2(21)	20	0.15	440 – 470	21	12.5	700-04/1
MHW720A3	20	0.15	450 – 458	21	12.5	700-04/1
806–960 MHz, UHF Band — Class C (Silicon Bipolar Die)						
MHW801-1	1.6	0.001	820–850	32	6	413-02/1
MHW801-2	1.6	0.001	870–905	32	6	413-02/1
MHW801-3	2	0.001	890–915	33	6	413-02/1
MHW801-4	1.6	0.001	915–925	32	6	413-02/1
MHW851-1	1.6	0.001	820–850	32	6	301N-01/1
MHW851-2	1.6	0.001	870–905	32	6	301N-01/1
MHW851-3	2	0.001	890–915	33	6	301N-01/1
MHW851-4	1.6	0.001	915–925	32	6	301N-01/1
MHW803-1	2	0.001	820–850	33	7.5	301E-04/1
MHW803-2	2	0.001	806–870	33	7.5	301E-04/1
MHW803-3	2	0.001	870–905	33	7.5	301E-04/1

(21)Designed for Wide Range P_{out} Level Control
(35)P_o @ f = 490 MHz. P_o = 6.5 W @ f = 512 MHz
H New Product

Devices listed in bold, italic are Motorola preferred devices.

High Power: Land Mobile/Portable (continued)

Table 41. VHF/UHF, Class C (continued)

806 – 960 MHz, UHF Band – Class C (Silicon Bipolar Die) (continued)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	Gp Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
MHW804-1	4	0.001	800–870	36	7.5	301F-03/1
MHW804-2	4	0.001	896–940	36	7.5	301F-03/1
MHW806A1(21)	6	0.03	820–850	23	12.5	301H-03/2
MHW806A2(21)	6	0.03	806–870	23	12.5	301H-03/2
MHW806A3(21)	6	0.04	890–915	21.7	12.5	301H-03/2
MHW806A4(21)	6	0.04	870–950	21.7	12.5	301H-03/2
MHW807-1(21)	6	0.001	820–850	38	12.5	301L-02/2
MHW807-2(21)	6	0.001	870–905	38	12.5	301L-02/2
MHW812A3(21)	12	0.1	870–950	20.8	13	301H-03/2
MHW820-3(21)	18	0.35	870–950	17.1	12.5	301G-03/1
MHW820-1(21)	20	0.25	806–870	19	12.5	301G-03/1
MHW820-2(21)	20	0.25	806–890	19	12.5	301G-03/1

806 – 960 MHz, UHF Band — Class C (GaAs FET Die)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	Gp Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
MHW9002-1(21)(1)	1.4	0.005	824–849	24.5	5.8	420A-01/1
MHW9002-2(21)(1)	1.4	0.005	870–905	24.5	5.8	420A-01/1
MHW9002-3(21)	1.6	0.005	890–915	25	5.8	420A-01/1
MHW9002-4(21)	1.4	0.005	898–925	24.5	5.8	420A-01/1

806 – 960 MHz, UHF Band — Class C (Silicon FET Die)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	Gp Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
MHW941-1(21)(1)	1.6	0.13	824–849	21	7.2	420B-02/1
MHW941-2(21)(1)	1.6	0.13	872–905	21	7.2	420B-02/1

Table 42. UHF, Linear

806–960 MHz, UHF Band — Class AB (Silicon Bipolar Die)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	Gp Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
MHW921(1)(21)	1.6(2)	0.001	824–849	32	6	420C-01/1
MHW926(21)★	6(2)	0.065	824–849	19.7	12.5	301AB-01/1
MHW927A(21)★	6(2)	0.001	824–849	37.8	12.5	301AA-01/1
MHW927B(21)★	6(2)	0.001	824–849	37.8	12.5	301AA-01/1

880–915 MHz (for GSM) — Class AB (Silicon Bipolar Die)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	Gp Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
MHW902(1)(21)	3.2	0.002	880–915	32	7.5	420E-01/1
MHW903(21)	3.5	0.001	890–915	35.4	7.2	413A-01/1
MHW953(21)	3.5	0.001	890–915	35.4	7.2	301V-02/1
MHW954(21)	3.5	0.1	890–915	15.4	7.2	301Y-02/1
MHW909(21)	9	0.1	890–915	19.5	7.2	301T-02/1
MHW912(21)	12	0.001	890–915	40.8	12.5	301R-01/1
MHW914(21)	14	0.001	890–915	41.4	12.5	301R-01/1
MHW915(21)	14	0.1	890–915	21.4	12.5	301T-02/1
MHW932(21)	32	0.1	890–915	26	12.5	301S-02/1

Table 43. Microwave, Class C

1.5 GHz, L-Band (for JSMR) — Class C (Silicon Bipolar Die)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	f Frequency MHz	Gp Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
MHW1503(1)	3	0.004	1465–1477	28.8	9.8	301E-04/1

(1)To be Introduced
(2)Average Power; Peak power is twice average power
(21)Designed for Wide Range P_{out} Level Control
★New Product

Devices listed in bold, italic are Motorola preferred devices.

High Power: Land Mobile/Portable (continued)

Table 43. Microwave, Class C (continued)

Device	P_{out} Output Power dBm	P_{in} Input Power Watts	f Frequency MHz	Gp Power Gain, Min dB	V_{CC} Supply Voltage Volts	Package/Style
1.8 GHz, L-Band (for PCN) — GaAs FET Die						
MHW9012(1)	33.5	0.001	1710–1785	33.5	6	420-01/1
1.9 GHz, L-Band (for DECT) — GaAs FET Die						
MHW9013(1)	28.0	0.001	1880–1900	28.0	3	420-01/1

TV Transmitters

Table 44. VHF Ultra Linear For TV Applications

These amplifiers are characterized for ultra-linear applications in Band IV and V TV transmitters.

Device	Frequency MHz	P_{ref} Watts	Gp (Min)/Freq. Power Gain dB/MHz	3 Tone(12) IMD 1 dB	3 Tone(24) IMD 2 dB	V_{CC} Volts	Package/Style
ATV5030	470–860	20	7.5/860	–51	–54	26	389B-02/1
ATV6031	470–860	20	10.5/860	–50	–53	26.5	389B-02/1
MRFA2600(1)(48)	470–860	20	10.5/860	–50	–53	26.5	429A-01/1
ATV7050	470–860	30	8/860	–51	–54	25	389P-01/1
MRFA2601(1)(49)	470–860	30	8/860	–51	–54	25.5	429B-01/1
ATV6060★	470–860	40	9/860	–50	–53	25.5	389U-01/1
MRFA2602(1)(47)	470–860	40	9/860	–50	–53	25.5	429C-01/1
ATV5090B	470–860	90(13)	7/860	—	—	28	389N-01/1
RFA8090B(1)	470–860	95(13)	8/860	—	—	28	429E-01/1
RFA8180B★	470–860	180(13)	8/860	—	—	28	429-02/1
MRFA2603(1)(50)	470–860	270	7.5/860	—	—	28	429D-01/1

(1)To be Introduced
(12)Vision Carrier: – 8 dB; Sound Carrier: – 7 dB; Sideband Carrier: – 16 dB
(13)Output power at 1 dB compression in Class AB
(24)Vision Carrier = – 8 dB; Sound Carrier = –10 dB; Sideband Carrier = –16dB
(47)Formerly known as "RFA6060"
(48)Formerly known as "RFA6031"
(49)Formerly known as "RFA7050"
(50)Formerly known as "RFA8270B"
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Low Power

The following categories describe a wide range of complete amplifier assemblies both hybrid and monolithic for use in CATV distribution systems, instrumentation, communications and military equipment. A variety of power levels and frequencies of operation is offered for many applications.

CATV Distribution

Motorola Hybrids are manufactured using fourth generation technology which has set new standards for CATV system performance and reliability. These hybrids have been optimized to provide premium performance in all CATV systems up to 152 channels.

Table 45. 5 to 200 MHz Hybrids

Device	Hybrid Gain (Nominal dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test(30) dB	Composite Triple Beat dB 22 CH	Composite Triple Beat dB 26 CH	Cross Modulation dB 22 CH	Cross Modulation dB 26 CH	Noise Figure @ 175 MHz dB	Package/ Style
MHW1134	13	22	+50	–72	–73	–71(16)	–65	–65(16)	7	714-04/1
MHW1184	18	22	+50	–72	–72	–70(16)	–64	–64(16)	5.5	714-04/1
MHW1224	22	22	+50	–72	–71	–68(16)	–62	–62(16)	5.5	714-04/1
MHW1244	24	22	+50	–72	–70	–68(16)	–61	–61(16)	5	714-04/1

Table 46. 40 to 450 MHz Hybrids

Device	Hybrid Gain (Nominal) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test dB	Composite Triple Beat dB 60 CH	Cross Modulation dB 60 CH	Noise Figure @ 450 MHz dB Typ	Package/ Style
Conventional Hybrids								
MHW5122A	12	60	+46	–72(28)	–58	–61	7	714-04/1
MHW5142A	14	60	+46	–74(28)	–61	–62	6	714-04/1
MHW5172A	17	60	+46	–74(28)	–60	–62	6	714-04/1
MHW5182A	18	60	+46	–72(28)	–61	–59	5.5	714-04/1
MHW5183	18	60	+46	–62(19)	–60	–58	4.5	714-04/1
MHW5222A	22	60	+46	–72(28)	–60	–59	4.5	714-04/1
MHW5272A	27	60	+46	–72(28)	–59	–60	5.5	714-04/1
MHW5342A	34	60	+46	–72(28)	–59	–59	5	714-04/1
MHW5382A	38	60	+46	–70(28)	–59	–59	4	714-04/1
CA7901	21(27)	60	+46	–61(28)	–58	–60	5.6	714F-01/1
Power Doubling Hybrids								
MHW5185	18	60	+46	–74(28)	–65	–66	5.5	714-04/1
MHW5185B(1)	18	60	+46	–67(19)	–67	–67	5.5	714-04/1
MHW5205	20	60	+46	–58(41)	–64	–64	5.5	714-04/1
MHW5225	22	60	+46	–69(28)	–62	–60	5	714-04/1
Feedforward Hybrids								
MFF124B	24	60	+46	–84(28)	–79	–75	10(48)	825A-02/1

(1) To be introduced
(16) Typical
(19) Composite 2nd order; V_{out} = +46 dBmV/ch
(27) Hi-Slope Trunk Amplifier, The specified gain is at 450 MHz
(28) Channel 2 and M13 @ M22
(30) Channel 2 and A @ 7
(41) Composite 2nd order IMD, 60 channel flat
(48) Maximum

Devices listed in bold, italic are Motorola preferred devices.

Low Power: CATV Distribution **(continued)**

Table 47. 40 to 550 MHz Hybrids

Device	Hybrid Gain (Nom.) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test dB	Composite Trible Beat dB: 77 CH	87 CH	Cross Modulation dB: 77 CH	87 CH	Noise Figure @ 550 MHz dB Typ	Package/ Style
Conventional Hybrids										
MHW6122	12	77	+44	–74[29]	–56		–62		7	714-04/1
MHW6142	14	77	+44	–72[29]	–59		–62		6.5	714-04/1
MHW6172	17	77	+44	–70[29]	–59		–62		6	714-04/1
MHW6182	18	77	+44	–72[29]	–58		–62		6	714-04/1
MHW6183	18	77	+44	–58[23]	–58		–58		5	714-04/1
MHW6222	22	77	+44	–66[29]	–57		–57		5	714-04/1
MHW6272	27	77	+44	–64[29]	–57		–57		6	714-04/1
MHW6342	34	77	+44	–64[29]	–57		–57		5.5	714-04/1
Power Doubling Hybrids										
MHW6185	18	77	+44	–71[29]	–63		–63		6	714-04/1
MHW6185B[1]	18	77	+44	–65[23]	–65		–68		6	714-04/1
MHW6185-6[1]	18	87	+44	–60[23]		–62		–66	5[48]	714-04/1
MHW6205B[1]	20	77	+44	–60[23]	–64		–67		6	714-04/1
MHW6225B[1]	22	77	+44	–56[23]	–62		–66		6	714-04/1
Feedforward Hybrids										
MFF224B	24	77	+44	–86[29]	–75		–70		11[48]	825A-02/1

Table 48. 40 to 600 MHz Hybrids

Device	Hybrid Gain (Nom.) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test dB	Composite Triple Beat dB 85 CH	Cross Modulation dB 85 CH	Noise Figure @ 600 MHz dB Max	Package/ Style
Feedforward Hybrids								
Conventional Hybrids[14]								
Power Doubling Hybrids[14]								
MFF324B★	24	85	+44	–86[46]	– 73	– 68	12.5	825A-02/1

[1] To be Introduced
[14] 600 MHz versions of the Conventional and Power Doubling Hybrids are available upon request. Please consult factory.
[23] Composite 2nd order; V_{out} = + 44 dBmV/ch
[29] Channel 2 and M30 @ M39
[46] Channel 2 and M39 @ M84
[48] Maximum
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Low Power: CATV Distribution (continued)

Table 49. 40 to 750 MHz Hybrids

Device	Hybrid Gain (Nom.) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test dB	Composite Triple Beat dB 110 CH	Cross Modulation dB 110 CH	Noise Figure @ 750 MHz dB Typ	Package/ Style
Conventional Hybrids								
MHW7182(1)	18	110	+44	–62(44)	– 62	– 64	5.5	714-04/1
MHW7222(1)	22	110	+44	–60(44)	– 61	– 63	5.5	714-04/1
Power Doubling Hybrids								
MHW7185(1)	18	110	+44	–60(44)	– 59	– 61	6	714-04/1

Table 50. 40 to 860 MHz Hybrids

Device	Gain dB	Frequency MHz	V_{CC} Volts	2nd Order IMD @ V_{out} = 50 dBMV/ch	DIN45004B @ f=860 MHz dBμV	Noise Figure @ 860 MHz dB Max	Package/ Style
Conventional Hybrids							
CA901	17	40 – 860	24	–60	120	9	714P-01/2
CA901A★	17	40 – 860	24	–64	120	9	714P-01/2
Power Doubling Hybrids							
CA902	17	40 – 860	28	–63	123	9.5	714P-01/2
CA902A★	17	40 – 860	28	–67	123	9.5	714P-01/2
CA922★	17	40 – 860	24	–63	123	9.5	714P-01/2
CA922A★	17	40 – 860	24	–67	123	9.5	714P-01/2
CA912	17	40 – 860	15	–63	123	9.5	714P-01/3

Table 51. 40 to 860/1000 MHz Hybrids

Device	Hybrid Gain (Nom.) dB	Channel Loading Capacity	Maximum Distortion Specifications: Output Level dBmV	2nd Order Test dB	Cross Modulation dB		Composite Triple Beat dB		Noise Figure @ 860 MHz dB Typ	Package/ Style
Conventional Hybrids										
MHW8182(1)	18	128	+38	–60(45)	–60	—	–60	—	6	714-04/1
MHW8222(1)	22	128	+38	–59(45)	–59	—	–59	—	6	714-04/1
MHW9182(1)	18	152	+38	–59(45)	—	–59	—	–59	6.5	714-04/1
MHW9222(1)	22	152	+38	–57(45)	—	–57	—	–57	6.5	714-04/1

(1)To be Introduced
(44) Composite 2nd order; V_{out} = + 40 dBMV/ch
(45) Composite 2nd order, V_{out} = +38 dBmV/ch
★New Product

Devices listed in bold, italic are Motorola preferred devices.

Low Power (continued)

General Purpose Wideband

A wide range of hybrid and silicon monolithic amplifiers are offered for low level signal amplification. Package type, gain, frequency of operation, output level and supply voltage combinations can be selected to fit the design engineer's specific requirements.

Table 52. 50 Ω Hybrids (Case 31A-03/2)

The MWA Series features excellent gain versus frequency flatness and temperature stability. Because of their 50 Ω input/output impulses they are easily cascadable for high gain lineups. Construction techniques include thin film gold metal circuitry and hermetic TO-205AD package.

Device	Frequency Range MHz	Gain Min/Typ dB	Supply Voltage Vdc	Output Level 1 dB Compression dBm	Noise Figure @ 250 MHz dB
MWA110(32)	0.1–400	13/14	2.9	–2.5	4
MWA120(32)	0.1–400	13/14	5	+8.2	5.5
MWA130(32)	0.1–400	13/14	5.5	+18	7
MWA131	0–400	13/14	5.5	+20	5(39)
MWA210(32)	0.1–600	9/10	1.75	+1.5	6
MWA220(32)	0.1–600	9/10	3.2	+10.5	6.5
MWA230(32)	0.1–600	9/10	4.4	+18.5	7.5
MWA310	0.1–1000	7/8	1.6	+3.5	6.5
MWA320	0.1–1000	7/8	2.9	+11.5	6.7
MWA330	0.1–1000	—/6.2	4	+15.2	+9

Table 53. 50 Ω – 75 Ω Hybrids (Case 790-01/1)

The Case 790-01 amplifiers feature high gain with low noise, low input and output VSWR and excellent gain flatness to 1 GHz. Three amplifier stages are constructed using SOT-23 packaged devices mounted on thick film circuit substrates.

Device	Frequency Range MHz	Gain Min/Typ dB	Supply Voltage Vdc	Output Level 1 dB Compression mW/@ MHz	Noise Figure @ 250 MHz dB
MHW596	30–890	22/24	10–14	+6	5
MHW597	30–890	25/27	18–22	+6	4

Table 54. 50 Ω–100 Ω Hybrids (Case 714-04/1)

The general purpose hybrid amplifiers listed are for broadband system applications requiring superior gain and current stability with temperature. The 50 to 100 ohm input and output impedances help simplify designs.

Device	Frequency Range MHz	Gain Min/Typ dB	Supply Voltage Vdc	Output Level 1 dB Compression Min/ @ MHz	Noise Figure @ 250 MHz dB
MHW591	1–250	34.5/36.5	13.6	700/100	5
MHW593	10–400	33/34.5	13.6	600/200	5
MHW590	10–400	31.5/34	24	800/200	5
MHW592	1–250	33.5/35	24	900/100	5

(32)Available in Hi-Rel (MIL-S-19500) Processed versions by Adding Suffixes "HX" and "HXV" after Device Number
(39)NF @ f = 400 MHz

Devices listed in bold, italic are Motorola preferred devices.

Low Power: General Purpose Wideband (continued)

Table 55. 50 Ω Monolithic

These monolithic amplifiers are fully cascadable and usable to frequencies over 3 GHz. External blocking capacitors are required along with an external bias resistor.

Device	Frequency Range MHz	Gain, Typ @ 1 GHz dB	Recommended Operating Current mA	Output Level, Typ 1 dB Compression dBm	Noise Figure @ 1500 MHz dB
Case 317-01/3					
MWA0204	DC-3000	11.5	25	7	6
MWA0304	DC-3000	11.5	35	12	6
Case 318A-05/4					
MWA0211L	DC-3000	11.5	25	7	6
MWA0311L	DC-3000	11.5	35	12	6

Table 56. Standard Linear Hybrids

The CA series of RF linear hybrid amplifiers consists of a family of medium power, broadband gain blocks in the CATV industry standard "CA" package. These amplifiers were designed for multi-purpose RF applications where linearity, dynamic range and wide bandwidth are of primary concern. Each amplifier is available in various package options. Eleven parts are available as indicated in a low profile package. Arrangement within the group is in order of increasing maximum frequency.

Device	BW MHz	Gain Flatness Typ ±dB	Gain/Freq. Typ dB/MHz	P_{1dB} Typ dBm	NF/Freq. Typ dB/MHz	3rd Order Intercept Point/Freq. Typ dBm/MHz	VSWR Max 50 Ω/75Ω	V_S/I_S Typ V/mA	Case/ Style
CA2850CR	40–100	0.2	17.5/100	25	4.5/70	40/70	1.3/—	–19/125	714H-01/1
CA2875CR	40–100	0.2	17.5/100	26	4.5/70	43/70	—/1.1	–19/155	714H-01/1
CA2830C	5–200	1	34.5/100	29	4.7/200	46/200	2/—	24/300	714F-01/1
CA2832C	1–200	1	35.5/100	33	6/200	47/200	2/—	28/435	714F-01/1
CA2833C	5–200	1	34.5/100	29	4.7/200	46/200	2/—	24/300	714G-01/1
CA2813C	40–300	1.25	34/50	22	5/300	40/300	2/1.3	15/160	714F-01/1
CA2842C	30–300	1	22/100	30	5/100	46/300	1.5/—	24/230	714F-01/1
CA2810C	10–350	1.5	33/50	29	8/300	43/300	2/1.3	24/300	714F-01/1
CA2818C	10–400	1	18.5/50	30	5/200	45/200	2/—	24/205	714F-01/1
CA2870C	20–400	1	34/100	27	7.5/400	45/300	2/—	24/300	714M-01/1
CA2820	1 – 520	0.8	30/100	26	8.3/500	37/500	2/—	24/330	714M-01/1
CA2851CR	40 – 1000	0.2	17.5/100	25	4.5/70	40/70	1.3/—	–19/125	714L-01/1
CA4800C(31)	10–1000	0.5	17/40	26	7.5/1000	38/752	2.6/—	24/220	714P-01/2
CA4812C(31)	10–1000	0.5	17/40	26	7.5/1000	38/752	2.6/—	12/380	714P-01/3
CA4815C(31)	10–1000	0.5	17/40	26	7.5/1000	38/752	2.6/—	15/380	714P-01/3
CA5800C(31)	10–1000	0.5	15/40	30	8.5/1000	40.5/752	2.6/—	28/400	714P-01/2
CA5801(31)	50 – 1000	0.5	17/50	30	8.5/1000	41.5/956	2/—	28/400	714P-01/2
CA5815C(31)	10–1000	0.5	15/40	30	8.5/1000	40.5/752	2.6/—	15/700	714P-01/3
CA4900(31)	10–1200	0.5	17/40	26	7.5/1200	38/752	2.6/—	24/220	714P-01/2
CA4912(31)	10–1200	0.5	17/40	26	7.5/1200	38/752	2.6/—	12/380	714P-01/3
CA4915(31)	10–1200	0.5	17/40	26	7.5/1200	38/752	2.6/—	15/380	714P-01/3
CA5900(31)	10–1200	0.5	15/40	30	8.5/1200	40.5/752	2.6/—	28/400	714P-01/2
CA5915(31)	10–1200	0.5	15/40	30	8.5/1200	40.5/752	2.6/—	15/700	714P-01/3

(31)Available in thin flange package (Case 714T-01) by adding suffix "S" after part number, i.e., CA4800CS

Devices listed in bold, italic are Motorola preferred devices.

Low Power (continued)

CRT Drivers

Table 57. Video Amplifiers

These complete hybrid amplifiers are specifically designed for CRT driver applications requiring high frequency response and high voltage, such as high resolution color graphics video monitors. Gold metallized die and substrates are used to insure high reliability and improved ruggedness.

Device	V_{CC} (nom) Volts	Gain(34) V/V	t_r/t_f (Typ)(43) nsec	3 dB BW (Typ)(43) MHz	V_{out} (Max) Volts	Load	Package/Style
CR2424A	60	12	2.0	145	50 P-P	6 to 20 pF	714G-01/1
CR2424R	−60	12	2.0	145	50 P-P	6 to 20 pF	714H-01/1
CR2425A	60	12	2.0	145	50 P-P	6 to 20 pF	714F-01/1
CR2428(1)	60	12	2.0	145	50 P-P	6 to 20 pF	—
CR3424A	80	12	2.2	130	70 P-P	6 to 20 pF	714G-01/1
CR3424R	−80	12	2.2	130	70 P-P	6 to 20 pF	714H-01/1
CR3425A	80	12	2.2	130	70 P-P	6 to 20 pF	714F-01/1
CR3428(1)	80	12	2.2	130	70 P-P	6 to 20 pF	—

(1) To be introduced
(34) Insertion gain; 50 ohm source
(43) Capacitive Load 8.5 pF, V_{out} = 40 V_{p-p}

Devices listed in bold, italic are Motorola preferred devices.

RF Die

Ordering and Shipping Information

Minimum Order Requirements

In conjunction with Motorola corporate policy the minimum order, release or line/line shipment of standard product is $200.

Packaging:

Multi-Pak — Motorola supplies all discrete semiconductors in the industry standard multi-pak. (Waffle type carrier, Figure 1.) This is a 2 x 2 or 4 x 4 waffle type carrier with a separate hole for each die. Chips are 100% visually inspected with the rejects removed. There is no suffix associated with the multi-pak carrier.

Circle Pak (CP Suffix) (See Figure 2) — The wafer is placed on a sticky film before being sawed. Each wafer is completely sawed through with the back side against the PVC film. The die stick to the PVC film and maintain exact wafer orientation and spacing. This packaging method also offers the convenience of storage with original orientation and spacing even after a portion of the wafer is used. The evacuated plastic bag is thermally sealed holding the contents securely with no die movement. Die can be removed from the sticky film by a sharp ejector-pin pushing a die up and a vacuum needle manually picking it up. This package can also be handled by an automatic die loader with some minor adjustments. To order this package, the suffix CP must appear with the part number.

Wafer Pak (WP Suffix) (See Figure 3) — The pak contains a wafer that is 100% electrically tested. With the rejects inked, the wafer is left unsawed and is packaged with protective cardboard on a vacuum sealed plastic bag. The WP suffix must appear after the chip part number.

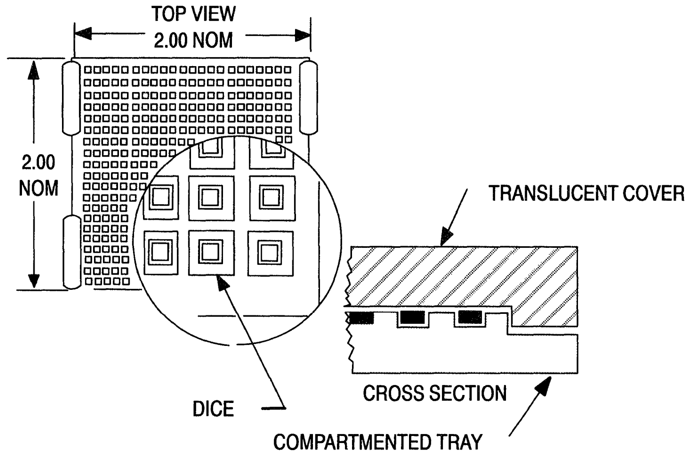


Figure 1. Multi-Pak (No Suffix)

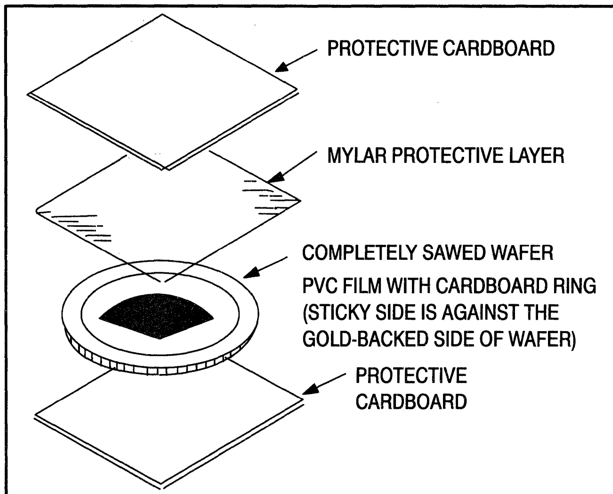


Figure 2. Circle Pak (CP Suffix)

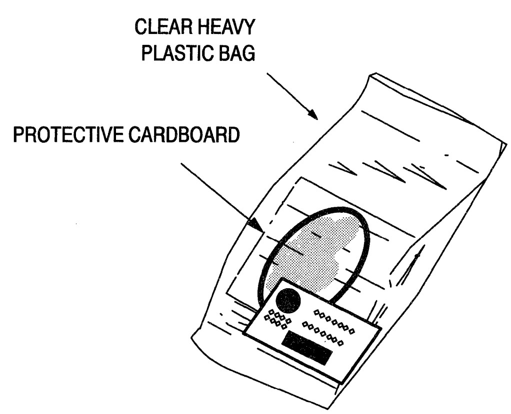
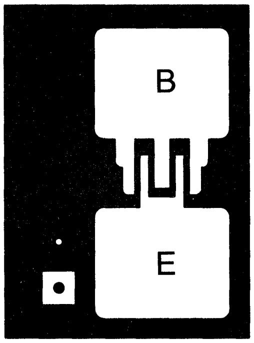


Figure 3. Wafer Pak (WP Suffix)

Die Geometries

1



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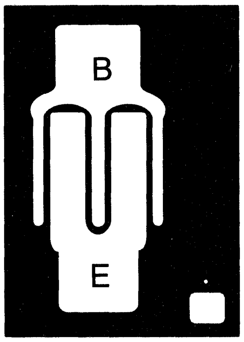

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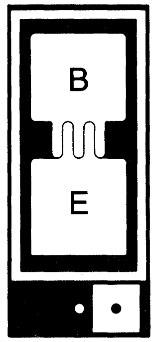

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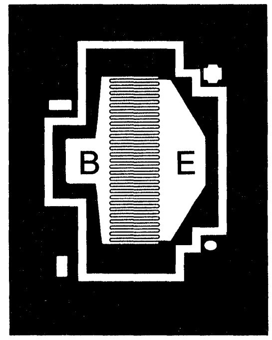

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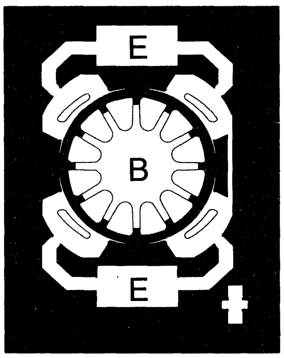

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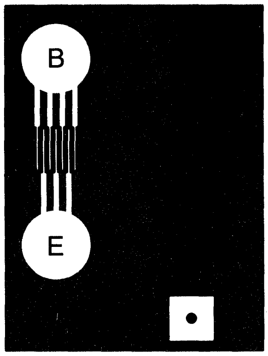

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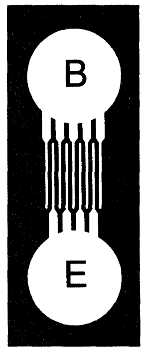

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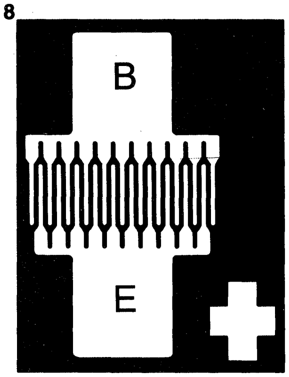

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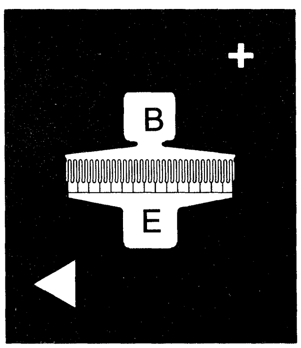

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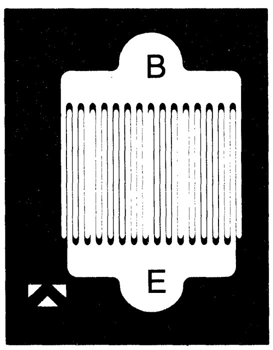

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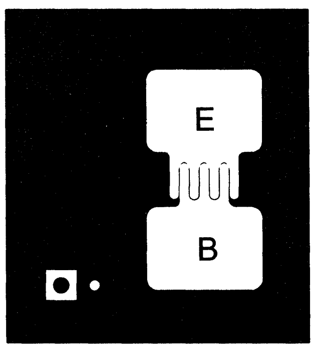
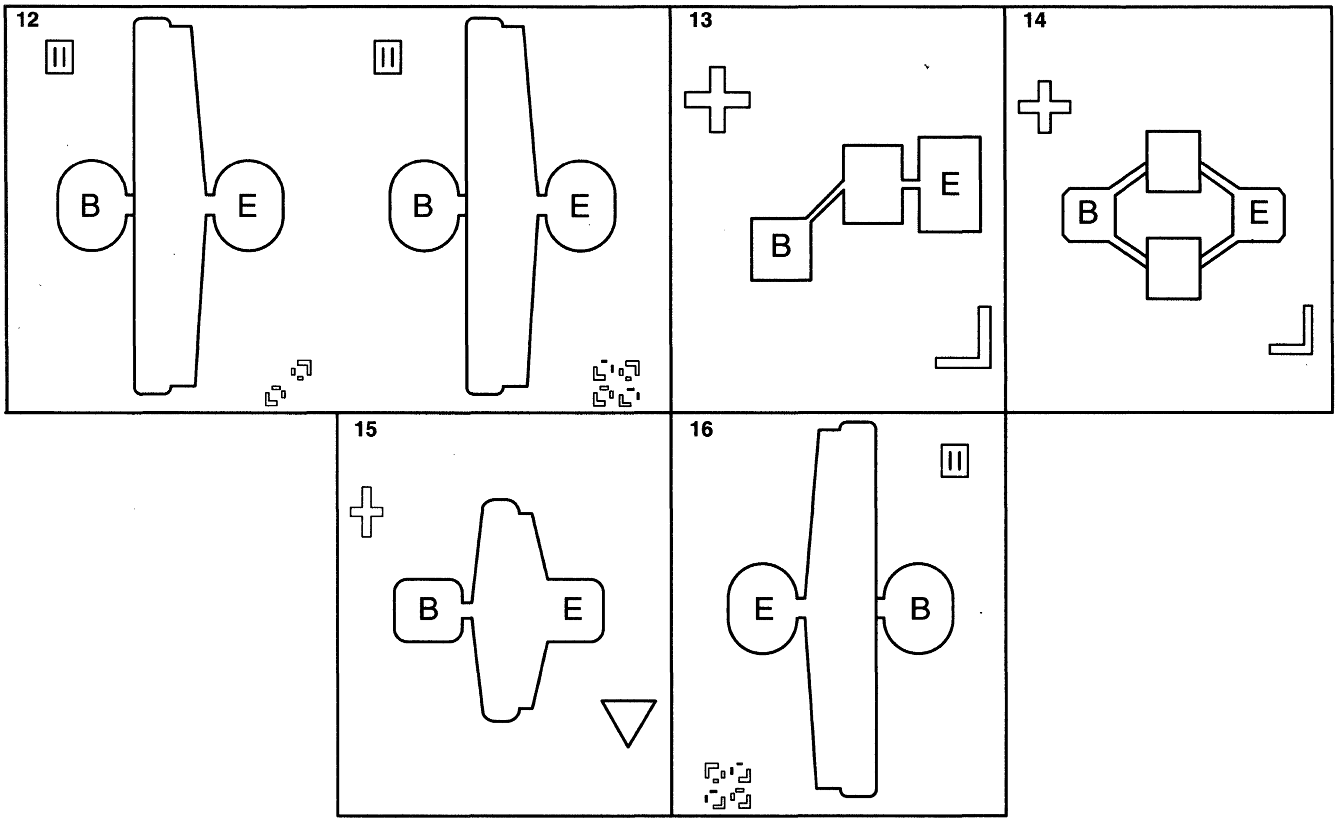


B = Base
E = Emitter

RF Die



B = Base E = Emitter

Parts List of Available Die

Table 58. Mechanical Information

Standard D.C. Parameters (at 25°C) — $V_{(BR)CBO}$, $V_{(BR)CEO}$, $V_{(BR)EBO}$, h_{FE} (d.c. current gain)

Special Request Parameters — I_{CEO}, I_{CES}, I_{CEX}, I_{EBO}, $V_{CE(sat)}$, f_T, C_{CB}, C_{EB}, h_{FE} (ac), NF (Noise Figure), G_{PE}

Front Metallization Thickness — a minimum of 10,000 Å

Back Metallization Thickness — a minimum of 3,000 Å–24,000 Å

Chip Part #	Standard Part #	Die Geometry Reference #	Die Size inches1/1 000	Die Thickness inches 1/1000	Bond Pad Size		Metallization	
					inches 1/1000 Base	inches 1/1000 Emitter	Front	Back
2C2857	2N2857	1	14x16	4–8	4.0x4.8	4.0x4.8	Al	Au
2C3866	2N3866	2	15x22	4–8	4x4	4x4	Al	Au
2C4957(5)	2N4957	3	12x22	4–8	4x4	4x4	Al	Au
2C5108	2N5108	10	12x17	4–8	2.5x2.1	2.5x2.1	Au	Au
2C5109	2N5109	2	15x22	4–8	4.0x4.0	4.0x4.0	Au	Au
2C5160(5)	2N5160	4	15x20	4–8	2.2x3.2	2.2x3.2	Al	Au
2C5583(5)	2N5583	4	15x20	4–8	2.2x3.2	2.2x3.2	Au	Au
BFRC90	BFR90	6	14x16	4–8	2.8 dia.	2.8 dia.	Au	Au
BFRC91	BFR91	7	14x16	4–8	2.8 dia.	2.8 dia.	Au	Au
BFRC96	BFR96	8	13x16	4–8	3.4x3.4	3.4x3.4	Au	Au
MMC4049(5)	MM4049	3	12x22	4–8	4x4	4x4	Al	Au
MRFC521	MMBR521L	15	15x20	4–8	2.8x2.8	2.8x28	Au	Au
MRFC544	MRF544	12	34x54	4–8	3.0x4.0	3.0x4.0	Au	Au
MRFC545(5)	MRF545	12	34x54	4–8	3.0x4.0	3.0x4.0	Au	Au
MRFC559	MRF559	5	15x24	4–8	3.5 dia.	2.16x4	Au	Au
MRFC572	MRF571	15	15x20	4–8	2.8x2.8	2.8x2.8	Au	Au
MRFC581	MRF581	16	17x27	4–8	3.0x4.0	3.0x4.0	Au	Au
MRFC901	MRF901	11	15x15	4–8	4.0x2.6	4.0x2.6	Au	Au
MRFC904	MRF904	11	15x15	4–8	4.0x2.6	4.0x2.6	Au	Au
MRFC941	MRF941	13	15x15	4–8	1.6x2	1.6x2	Au	Au
MRFC951	MRF951	14	15x15	4–8	2x2.4	2x2.4	Au	Au
MRFC2369	MRF2369	9	15x16	4–8	2.2x2.2	2.2x2.2	Au	Au

(5)PNP

Samples available upon request. Contact the Motorola Sales Office.

Storage and Handling Information

It is recommended that all Motorola die be stored at room temperature in an inert environment after removal of the seal from the original shipping package.

Special Electro-Static Discharge (ESD) precautions should be taken to avoid damaging the chips. Motorola recommends storage in the original ESD shipping package.

Surface Mount Information

In Brief . . .

Surface Mount Technology is now being utilized to offer answers to many problems that have been created in the use of insertion technology.

Limitations have been reached with insertion packages and PC board technology. Surface Mount Technology offers the opportunity to continue to advance the state-of-the-art designs that cannot be accomplished with Insertion Technology.

Surface Mount Packages allow more optimum device performance with the smaller Surface Mount configuration. Internal lead lengths, parasitic capacitance and inductance that placed limitations on chip performance have been reduced.

The lower profile of Surface Mount Packages allows more boards to be utilized in a given amount of space. They are stacked closer together and utilize less total volume than insertion populated PC boards.

Printed circuit costs are lowered with the reduction of the number of board layers required. The elimination or reduction of the number of plated through holes in the board contribute significantly to lower PC board prices.

Surface Mount assembly does not require the preparation of components that is common on insertion technology lines. Surface Mount components are sent directly to the assembly line, eliminating an intermediate step.

Automatic placement equipment is available that can place Surface Mount components at the rate of a few thousand per hour to hundreds of thousands of components per hour.

Surface Mount Technology is cost effective, allowing the manufacturer the opportunity to produce smaller units and offer increased functions with the same size product.

Page

Information For Using Surface Mount Packages

Recommended Footprints for Surface Mounted Applications

Surface mount board layout is a critical portion of the total design. The footprint for the semiconductor packages must be the correct size to insure proper solder connection interface between the board and the package. With the correct pad geometry, the packages will self align when subjected to a solder reflow process.

Power Dissipation for a Surface Mount Device

The power dissipation for a surface mount device is a function of the drain/collector pad size. These can vary from the minimum pad size for soldering to a pad size given for maximum power dissipation. Power dissipation for a surface mount device is determined by $T_{J(max)}$, the maximum rated junction temperature of the die, $R_{\theta JA}$, the thermal resistance from the device junction to ambient, and the operating temperature, T_A. Using the values provided on the data sheet, P_D can be calculated as follows:

$$P_D = \frac{T_{J(max)} - T_A}{R_{\theta JA}}$$

The values for the equation are found in the maximum ratings table on the data sheet. Substituting these values into the equation for an ambient temperature T_A of 25°C, one can calculate the power dissipation of the device. For example, for a SOT-223 device, P_D is calculated as follows.

$$P_D = \frac{150°C - 25°C}{156°C/W} = 800 \text{ milliwatts}$$

The 156°C/W for the SOT-223 package assumes the use of the recommended footprint on a glass epoxy printed circuit board to achieve a power dissipation of 800 milliwatts. There are other alternatives to achieving higher power dissipation from the surface mount packages. One is to increase the area of the drain/collector pad. By increasing the area of the drain/collector pad, the power dissipation can be increased. Although one can almost double the power dissipation with this method, one will be giving up area on the printed circuit board which can defeat the purpose of using surface mount technology. For example, a graph of $R_{\theta JA}$ versus drain pad area is shown in Figure 1.

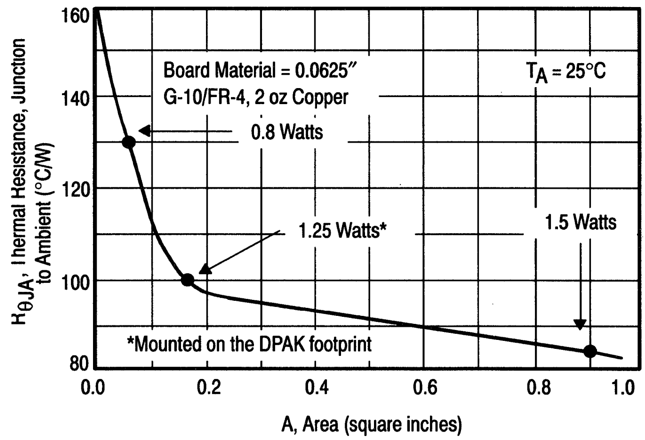


Figure 1. Thermal Resistance versus Drain Pad Area for the SOT-223 Package (Typical)

Another alternative would be to use a ceramic substrate or an aluminum core board such as Thermal Clad™. Using a board material such as Thermal Clad, an aluminum core board, the power dissipation can be doubled using the same footprint.

Solder Stencil Guidelines

Prior to placing surface mount components onto a printed circuit board, solder paste must be applied to the pads. Solder stencils are used to screen the optimum amount. These stencils are typically 0.008 inches thick and may be made of brass or stainless steel. For packages such as the SC-59, SC-70, SOD-123, SOT-23, SOT-143, SOT-223, SO-8, SO-14, SO-16, and SMB/SMC diode packages, the stencil opening should be the same as the pad size or a 1:1 registration. This is not the case with the DPAK and D²PAK packages. If one uses a 1:1 opening to screen solder onto the drain pad, misalignment and/or "tombstoning" may occur due to an excess of solder. For these two packages, the opening in the stencil for the paste should be approximately 50% of the tab area. The opening for the leads is still a 1:1 registration. Figure 2 shows a typical stencil for the DPAK and D²PAK packages. The pattern of the opening in the stencil for the drain pad is not critical as long as it allows approximately 50% of the pad to be covered with paste.

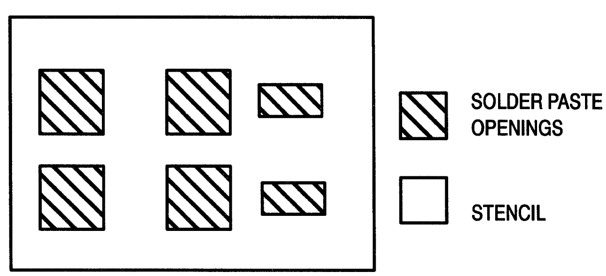


Figure 2. Typical Stencil for DPAK and D²PAK Packages

Information For Using Surface Mount Packages (continued)

Soldering Precautions

The melting temperature of solder is higher than the rated temperature of the device. When the entire device is heated to a high temperature, failure to complete soldering within a short time could result in device failure. Therefore, the following items should always be observed in order to minimize the thermal stress to which the devices are subjected.

- Always preheat the device.
- The delta temperature between the preheat and soldering should be 100°C or less.*
- When preheating and soldering, the temperature of the leads and the case must not exceed the maximum temperature ratings as shown on the data sheet. When using infrared heating with the reflow soldering method, the difference shall be a maximum of 10°C.
- The soldering temperature and time shall not exceed 260°C for more than 5 seconds.
- When shifting from preheating to soldering, the maximum temperature gradient shall be 5°C or less.
- After soldering has been completed, the device should be allowed to cool naturally for at least three minutes. Gradual cooling should be used as the use of forced cooling will increase the temperature gradient and result in latent failure due to mechanical stress.
- Mechanical stress or shock should not be applied during cooling

*Soldering a device without preheating can cause excessive thermal shock and stress which can result in damage to the device.

*Due to shadowing and the inability to set the wave height to incorporate other surface mount components, the D^2PAK is not recommended for wave soldering.

Typical Solder Heating Profile

For any given circuit board, there will be a group of control settings that will give the desired heat pattern. The operator must set temperatures for several heating zones, and a figure for belt speed. Taken together, these control settings make up a heating "profile" for that particular circuit board. On machines controlled by a computer, the computer remembers these profiles from one operating session to the next. Figure 3 shows a typical heating profile for use when soldering a surface mount device to a printed circuit board. This profile will vary among soldering systems but it is a good starting point. Factors that can affect the profile include the type of soldering system in use, density and types of components on the board, type of solder used, and the type of board or substrate material being used. This profile shows temperature versus time. The line on the graph shows the actual temperature that might be experienced on the surface of a test board at or near a central solder joint. The two profiles are based on a high density and a low density board. The Vitronics SMD310 convection/infrared reflow soldering system was used to generate this profile. The type of solder used was 62/36/2 Tin Lead Silver with a melting point between 177–189°C. When this type of furnace is used for solder reflow work, the circuit boards and solder joints tend to heat first. The components on the board are then heated by conduction. The circuit board, because it has a large surface area, absorbs the thermal energy more efficiently, then distributes this energy to the components. Because of this effect, the main body of a component may be up to 30 degrees cooler than the adjacent solder joints.

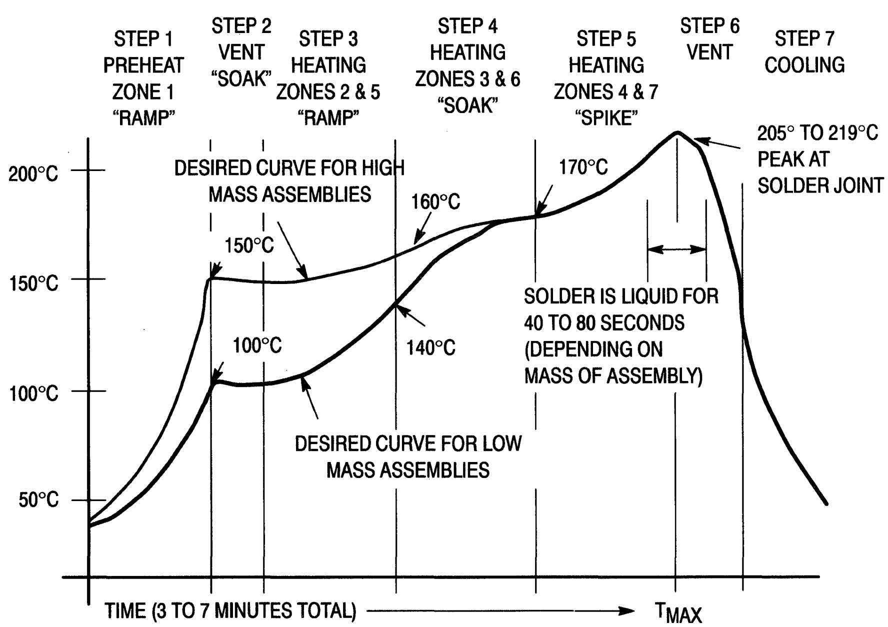
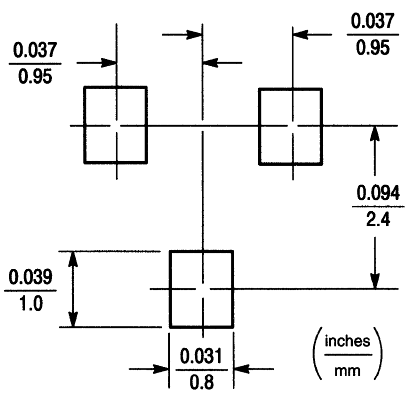
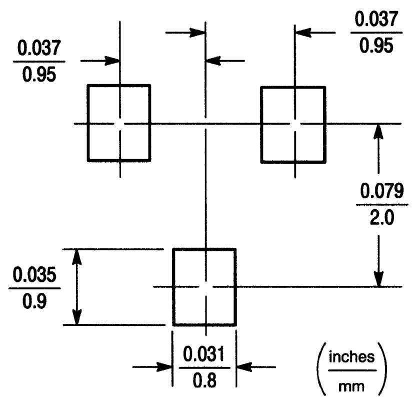


Figure 3. Typical Solder Heating Profile

Footprints for Soldering

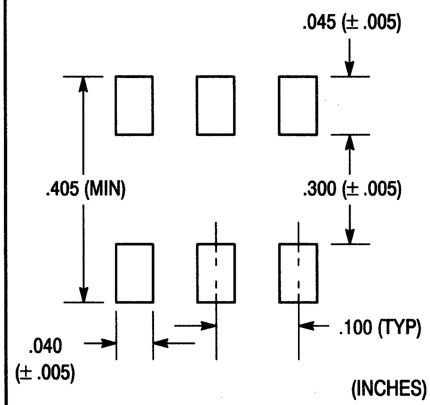


SC-59

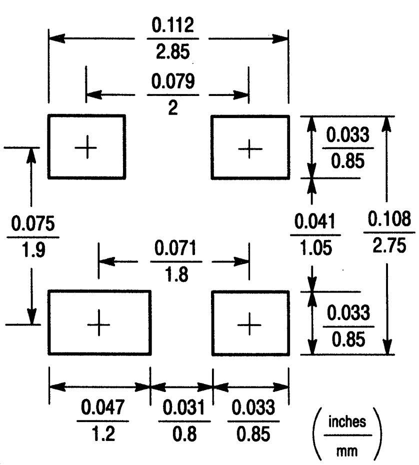


SOT-23

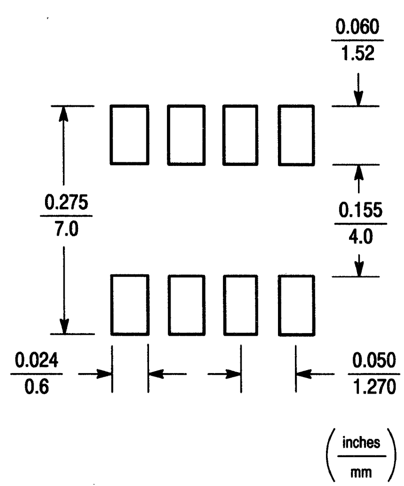
6-PIN DIP
GULL-WING



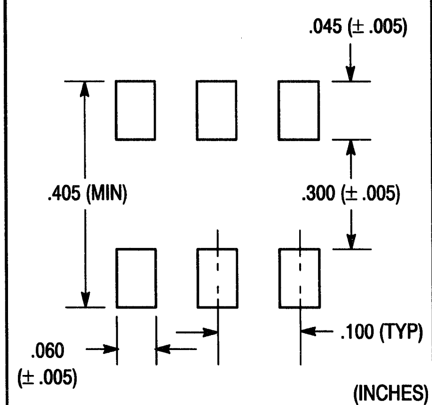
Standard "S" Option



SOT-143

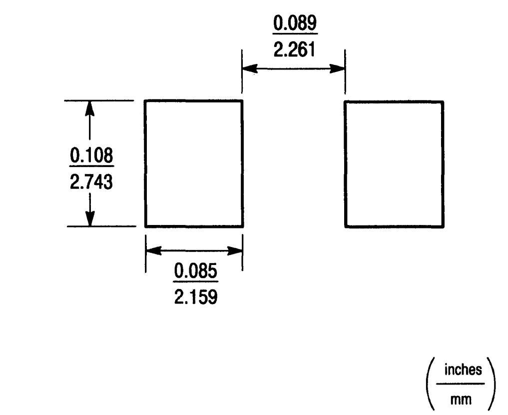


SO-8, OPTO SO-8,
SO-14, SO-16

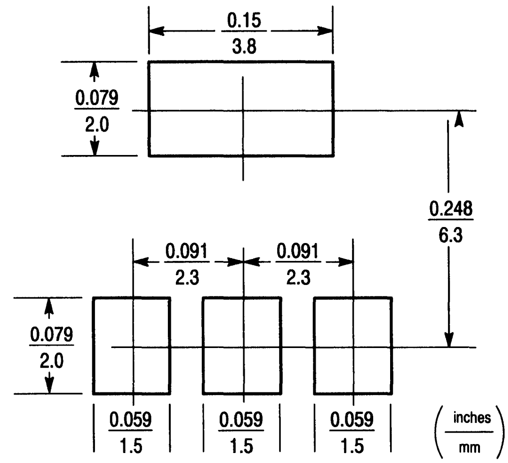


Low-Profile "F" Option

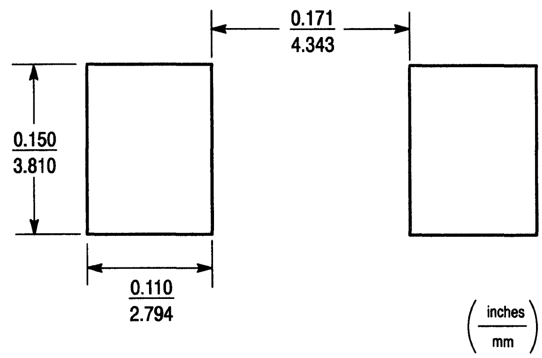
Footprints For Soldering (continued)



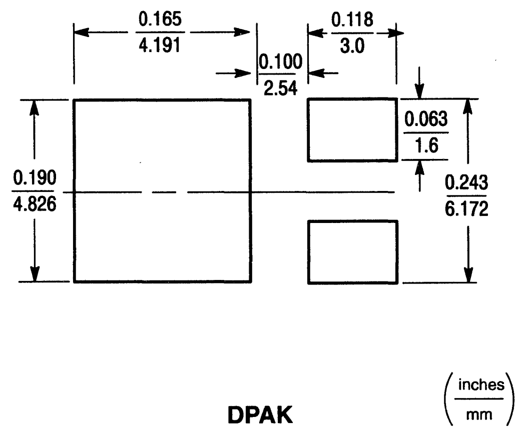
SMB



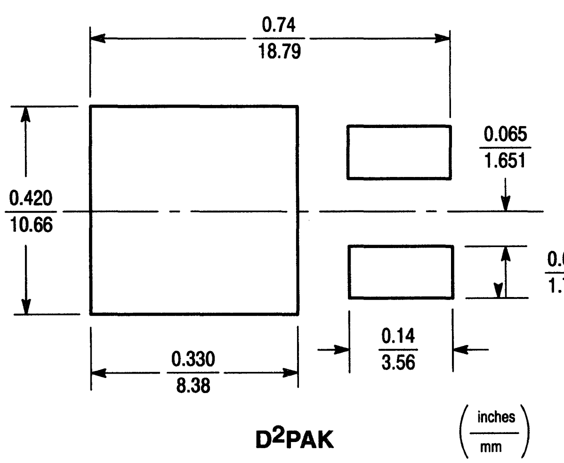
SOT-223



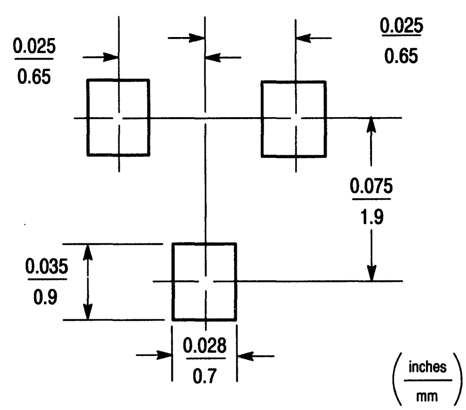
SMC



DPAK

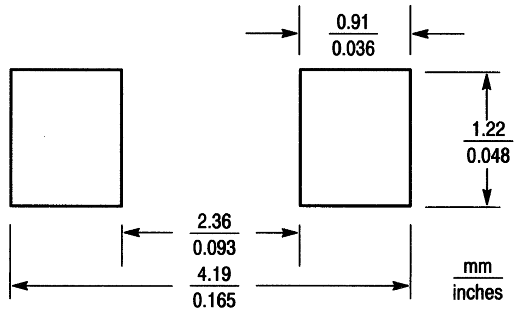


D2PAK



SC-70

Footprints For Soldering (continued)



SOD-123

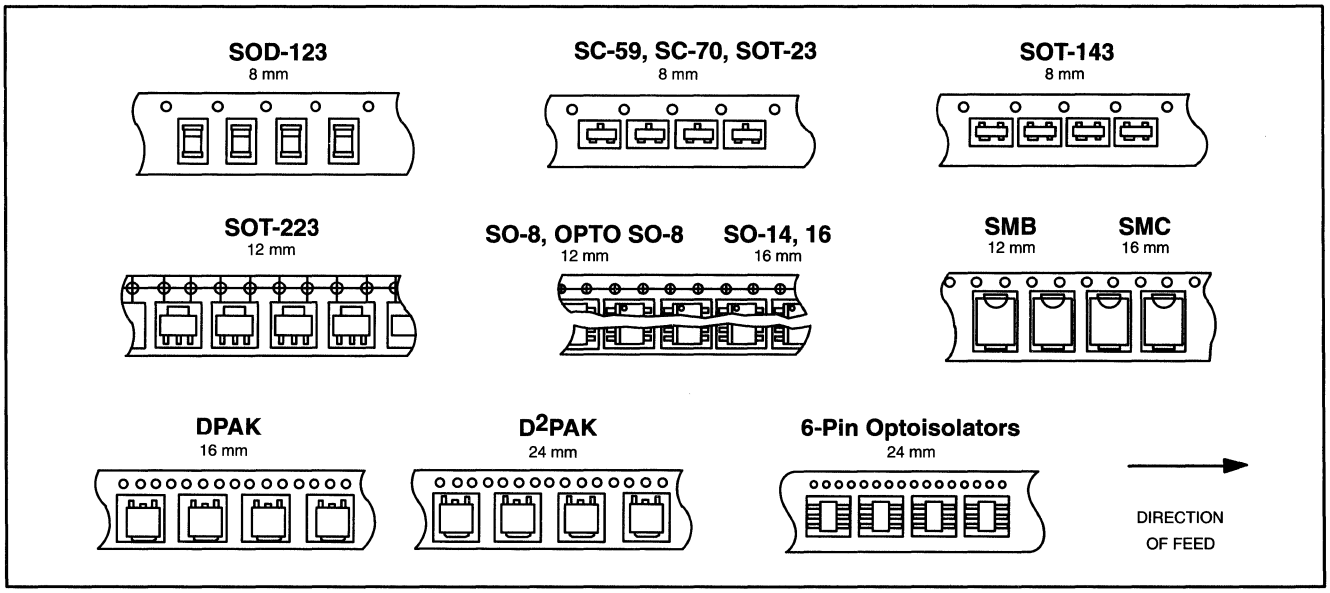
Tape and Reel Specifications and Packaging Specifications

Tape and Reel Specifications

Embossed Tape and Reel is used to facilitate automatic pick and place equipment feed requirements. The tape is used as the shipping container for various products and requires a minimum of handling. The antistatic/conductive tape provides a secure cavity for the product when sealed with the "peel-back" cover tape.

- Two reel sizes available (7″ and 13″)
- Used for automatic Pick and Place feed systems
- Minimizes product handling
- EIA 481, -1, -2
- SOD-123, SC-59, SC-70, SOT-23, SOT-143 in 8 mm tape
- SO-8, OPTO SO-8, SOT-223, SMB in 12 mm tape
- DPAK, SO-14, SO-16, SMC in 16 mm tape
- D2PAK, 6-Pin Optoisolators in 24 mm tape

Use the standard device title and add the required suffix as listed in the option table on the following page. Note that the individual reels have a finite number of devices depending on the type of product contained in the tape. Also note the minimum lot size is one full reel for each line item, and orders are required to be in increments of the single reel quantity.



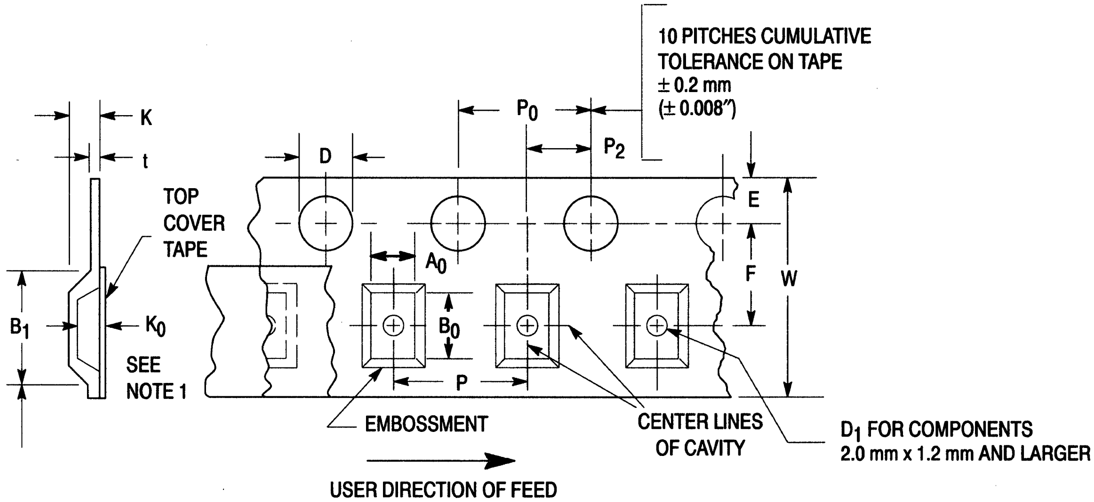
Tape and Reel Specifications (continued)

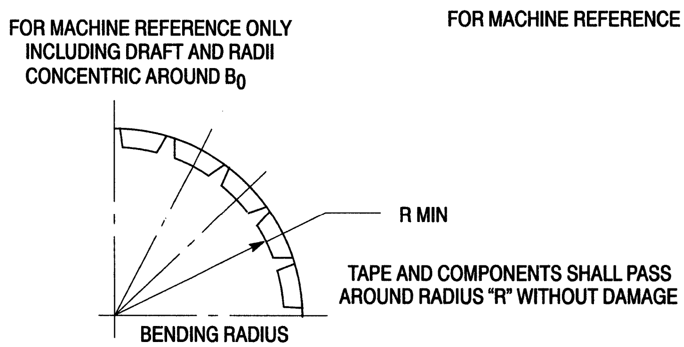
Table 1. Embossed Tape and Reel Ordering Information

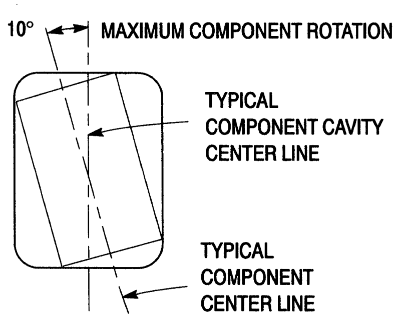
Package	Tape Width (mm)	Reel Size (inch)	Devices Per Reel and Minimum Order Quantity	Device Suffix
SC-70, SOD-123, SOT-23	8 8	7 13	3,000 10,000	T1 T3
SOT-143	8 8	7 13	3,000 10,000	T1 T3
SOT-223	12 12	7 13	1,000 4,000	T1 T3
SMB	12	13	2,500	T3
SO-8, OPTO SO-8	12 12	7 13	500 2,500	R1 R2
SO-14	16 16	7 13	500 2,500	R1 R2
SO-16	16 16	7 13	500 2,500	R1 R2
DPAK	16	13	2,500	T4
SMC	16	13	2,500	T3
SC-59	8	7	3,000	T1
D^2PAK	24	13	800	T4
6-Pin Optoisolators	24	13	1000	R2

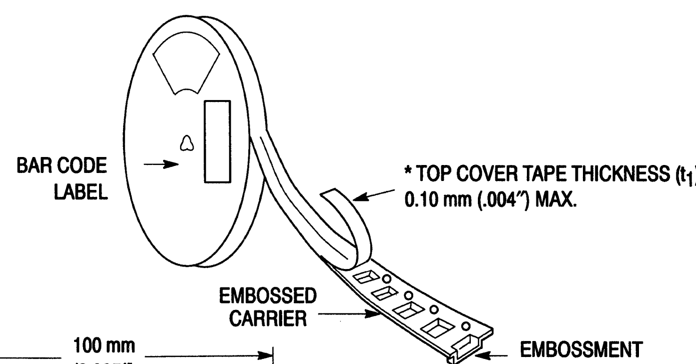
Tape and Reel Specifications (continued)

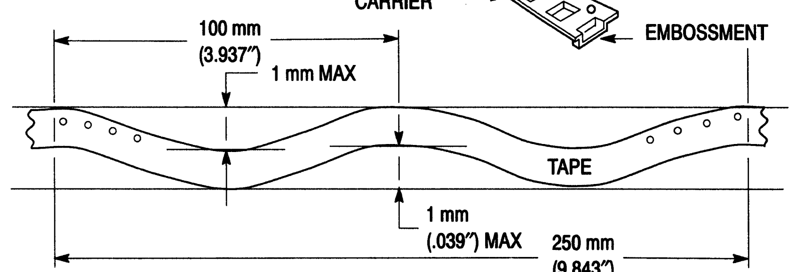
Embossed Tape and Reel Data for Discretes Carrier Tape











CAMBER (TOP VIEW)
ALLOWABLE CAMBER TO BE 1 mm/100 mm NONACCUMULATIVE OVER 250 mm

Tape and Reel Specifications (continued)

Table 2. Dimensions

Tape Size	B_1 Max	D	D_1	E	F	K	P	P_0	P_2	R Min	T Max	W Max
8 mm	4.55 mm (.179″)	1.5+0.1 mm −0.0 (.059+.004″ −0.0)	1.0 Min (.039″)	1.75±0.1 mm (.069±.004″)	3.5±0.05 mm (.138±.002″)	2.4 mm Max (.094″)	4.0±0.1 mm (.157±.004″)	4.0±0.1 mm (.157±.004″)	2.0±0.1 mm (.079±.002″)	25 mm (.98″)	0.6 mm (.024″)	8.3 mm (.327″)
12 mm	8.2 mm (.323″)		1.5 mm Min (.060″)		5.5±0.05 mm (.217±.002″)	6.4 mm Max (.252″)	4.0±0.1 mm (.157±.004″) 8.0±0.1 mm (.315±.004″)			30 mm (1.18″)		12±.30 mm (.470±.012″)
16 mm	12.1 mm (.476″)				7.5±0.10 mm (.295±.004″)	7.9 mm Max (.311″)	4.0±0.1 mm (.157±.004″) 8.0±0.1 mm (.315±.004″) 12.0±0.1 mm (.472±.004″)					16.3 mm (.642″)
24 mm	20.1 mm (.791″)				11.5±0.1 mm (.453±.004″)	11.9 mm Max (.468″)	16.0±.01 mm (.63±.004″)					24.3 mm (.957″)

Metric dimensions govern — English are in parentheses for reference only.
A_0, B_0, and K_0 are determined by component size. The clearance between the components and the cavity must be within .05 mm min. to .50 mm max., the component cannot rotate more than 10° within the determined cavity.

Embossed Tape and Reel Data For Discretes

Metric dimensions govern – English are in parentheses for reference only

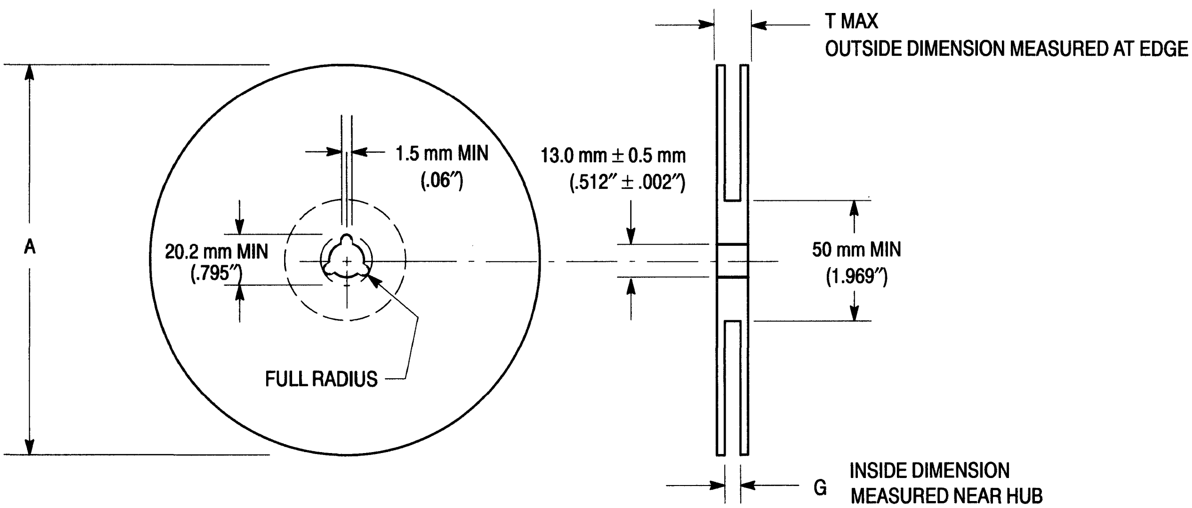


Table 3. Reel Dimensions

Size	A Max	G	T Max
8 mm	330 mm (12.992″)	8.4 mm + 1.5 mm, −0.0 (.33″ + .059″, −0.00)	14.4 mm (.56″)
12 mm	330 mm (12.992″)	12.4 mm + 2.0 mm, −0.0 (.49″ + .079″, −0.00)	18.4 mm (.72″)
16 mm	360 mm (14.173″)	16.4 mm + 2.0 mm, −0.0 (.646″ + .078″, −0.00)	22.4 mm (.882″)
24 mm	360 mm (14.173″)	24.4 mm + 2.0 mm, −0.0 (.961″ + .070″, −0.00)	30.4 mm (1.197″)

Tape and Reel Specifications (continued)

Lead Tape Packaging Standards For Axial-Lead Components

Table 4. Packaging Details (all dimensions in inches)

Case Type	Product Category	Device Title Suffix	MPQ Quantity Per Reel (Item 3.3.7)	Component Spacing A Dimension	Tape Spacing B Dimension	Reel Dimension C	Reel Dimension D (Max)	Max Off Alignment E
Case 17-02	Surmetic 40 & 600 Watt TVS	RL	4000	0.2 +/– 0.015	2.062 +/– 0.059	3	14	0.047
Case 41A-02	1500 Watt TVS	RL4	1500	0.4 +/– 0.02	2.062 +/– 0.059	3	14	0.047
Case 51-02	DO-7 Glass (For Reference only)	RL	3000	0.2 +/– 0.02	2.062 +/– 0.059	3	14	0.047
Case 59-03	DO-41 Glass & DO-41 Surmetic 30	RL	6000	0.2 +/– 0.015	2.062 +/– 0.059	3	14	0.047
	Rectifier							
Case 59-04	500 Watt TVS	RL	5000	0.2 +/– 0.02	2.062 +/– 0.059	3	14	0.047
	Rectifier							
Case 194-04	110 Amp TVS (Automotive)	RL	800	0.4 +/– 0.02	1.875 +/– 0.059	3	14	0.047
	Rectifier							
Case 267-02	Rectifier	RL	1500	0.4 +/– 0.02	2.062 +/– 0.059	3	14	0.047
Case 299-02	DO-35 Glass	RL	5000	0.2 +/– 0.02	2.062 +/– 0.059	3	14	0.047

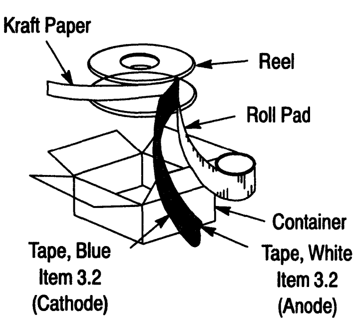


Figure 1. Reel Packing

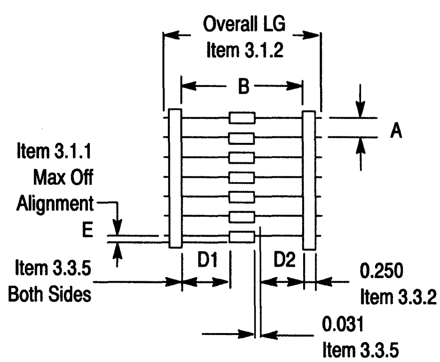


Figure 2. Component Spacing

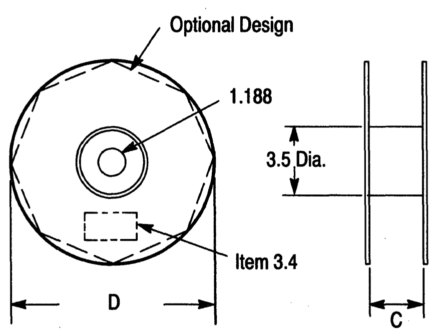
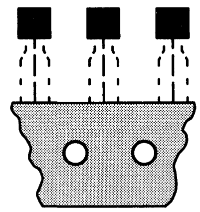


Figure 3. Reel Dimensions

Packaging Specifications

TO-92 EIA, IEC, EIAJ Radial Tape in Fan Fold Box or On Reel

TO-92
RADIAL
TAPE IN
FAN FOLD
BOX OR
ON REEL



Radial tape in fan fold box or on reel of the reliable TO-92 package are the best methods of capturing devices for automatic insertion in printed circuit boards. These methods of taping are compatible with various equipment for active and passive component insertion.

- Available in Fan Fold box
- Available on 365 mm reels
- Accommodates all standard inserters
- Allows flexible circuit board layout
- 2.5 mm pin spacing for soldering
- EIA-468, IEC 286-2, EIAJ RC1008B

Ordering Notes:

When ordering radial tape in fan fold box or on reel, specify the style per Figures 5, 6, and 12 through 15. Add the suffix "RLR" and "Style" to the device title, i.e. MPS3904RLRA. This will be a standard MPS3904 radial taped and supplied on a reel per Figure 12.

Fan Fold Box Information — Minimum order quantity 1 Box/$200LL.
Order in increments of 2000.

Reel Information — Minimum order quantity 1 Reel/$200LL.
Order in increments of 2000.

Table 5. US/European Suffix Conversions

US	EUROPE
RLRA	RL
RLRE	RL1
RLRM	ZL1

TO-92 EIA Radial Tape In Fan Fold Box Or On Reel

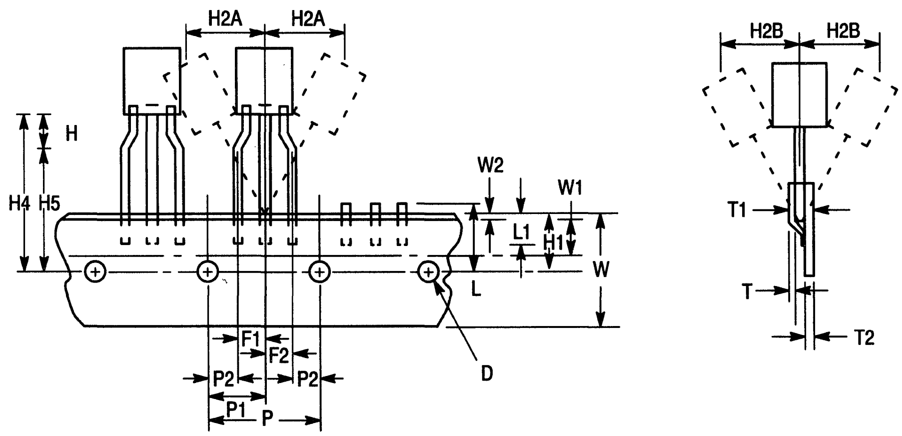


Figure 4. Device Positioning on Tape

Packaging Specifications: TO-92 EIA Radial Tape In Fan Fold Box Or On Reel (continued)

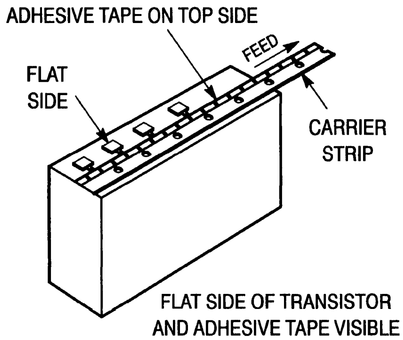
Table 6. Packaging Specifications

Symbol	Item	Specification			
		Inches		Millimeter	
		Min	Max	Min	Max
D	Tape Feedhole Diameter	0.1496	0.1653	3.8	4.2
D2	Component Lead Thickness Dimension	0.015	0.020	0.38	0.51
F1, F2	Component Lead Pitch	0.0945	0.110	2.4	2.8
H	Bottom of Component to Seating Plane	.059	.156	1.5	4.0
H1	Feedhole Location	0.3346	0.3741	8.5	9.5
H2A	Deflection Left or Right	0	0.039	0	1.0
H2B	Deflection Front or Rear	0	0.051	0	1.0
H4	Feedhole to Bottom of Component	0.7086	0.768	18	19.5
H5	Feedhole to Seating Plane	0.610	0.649	15.5	16.5
L	Defective Unit Clipped Dimension	0.3346	0.433	8.5	11
L1	Lead Wire Enclosure	0.09842	—	2.5	—
P	Feedhole Pitch	0.4921	0.5079	12.5	12.9
P1	Feedhole Center to Center Lead	0.2342	0.2658	5.95	6.75
P2	First Lead Spacing Dimension	0.1397	0.1556	3.55	3.95
T	Adhesive Tape Thickness	0.06	0.08	0.15	0.20
T1	Overall Taped Package Thickness	—	0.0567	—	1.44
T2	Carrier Strip Thickness	0.014	0.027	0.35	0.65
W	Carrier Strip Width	0.6889	0.7481	17.5	19
W1	Adhesive Tape Width	0.2165	0.2841	5.5	6.3
W2	Adhesive Tape Position	.0059	0.01968	.15	0.5

1. Maximum alignment deviation between leads not to be greater than 0.2 mm.
2. Defective components shall be clipped from the carrier tape such that the remaining protrusion (L) does not exceed a maximum of 11 mm.
3. Component lead to tape adhesion must meet the pull test requirements established in Figures 8, 9 and 10.
4. Maximum non-cumulative variation between tape feed holes shall not exceed 1 mm in 20 pitches.
5. Holddown tape not to extend beyond the edge(s) of carrier tape and there shall be no exposure of adhesive.
6. No more than 1 consecutive missing component is permitted.
7. A tape trailer and leader, having at least three feed holes is required before the first and after the last component.
8. Splices will not interfere with the sprocket feed holes.

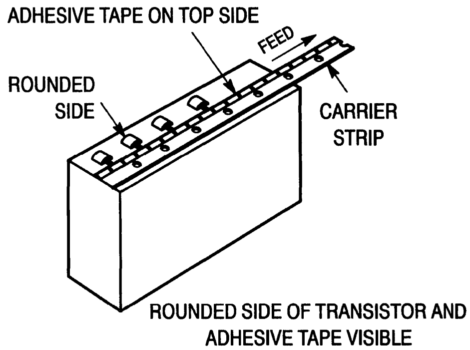
Packaging Specifications: TO-92 EIA Radial Tape In Fan Fold Box Or On Reel (continued)

Fan Fold Box Styles



Style M fan fold box is equivalent to styles E and F of reel pack dependent on feed orientation from box.

Figure 5. Style M



Style P fan fold box is equivalent to styles A and B of reel pack dependent on feed orientation from box.

Figure 6. Style P

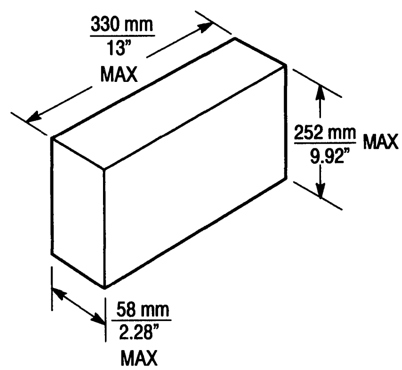
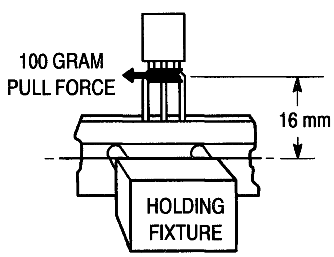


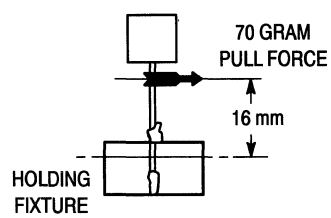
Figure 7. Fan Fold Box Dimensions

Adhesion Pull Tests



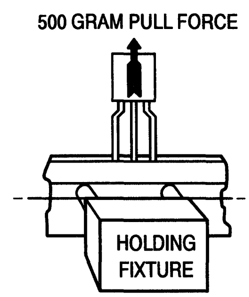
The component shall not pull free with a 300 gram load applied to the leads for 3 ± 1 second.

Figure 8. Test #1



The component shall not pull free with a 70 gram load applied to the leads for 3 ± 1 second.

Figure 9. Test #2

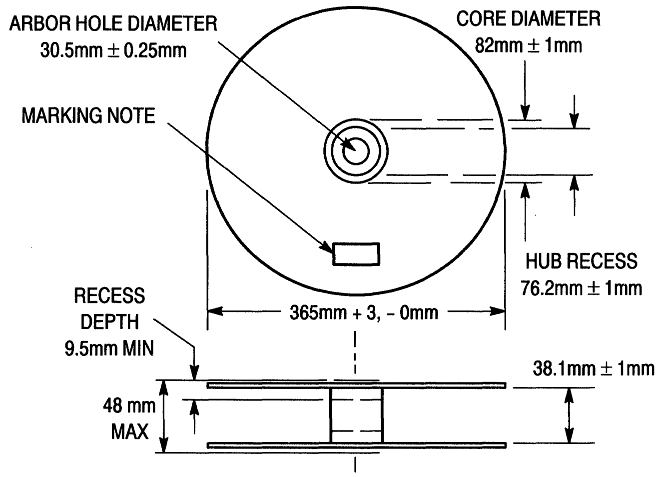


There shall be no deviation in the leads and no component leads shall be pulled free of the tape with a 500 gram load applied to the component body for 3 ± 1 second.

Figure 10. Test #3

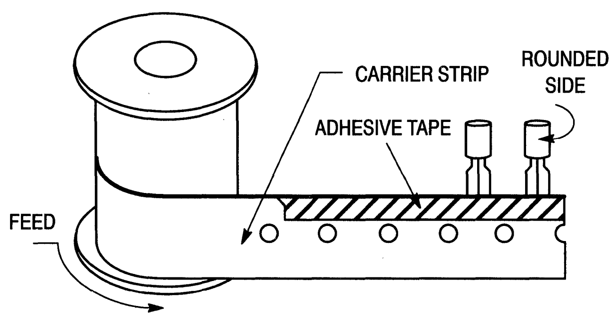
Packaging Specifications: TO-92 EIA Radial Tape In Fan Fold Box Or On Reel **(continued)**

Reel Styles



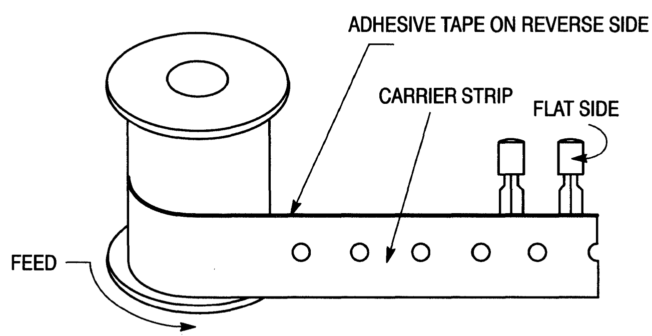
Material used must not cause deterioration of components or degrade lead solderability

Figure 11. Reel Specifications



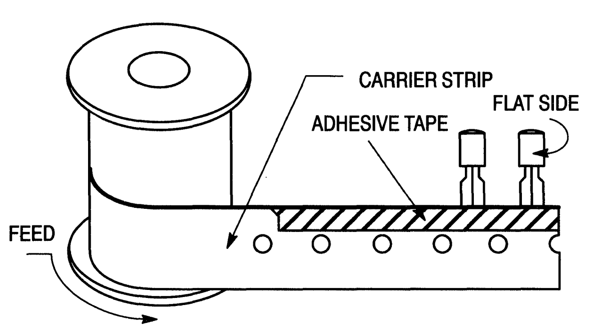
Rounded side of transistor and adhesive tape visible.

Figure 12. Style A



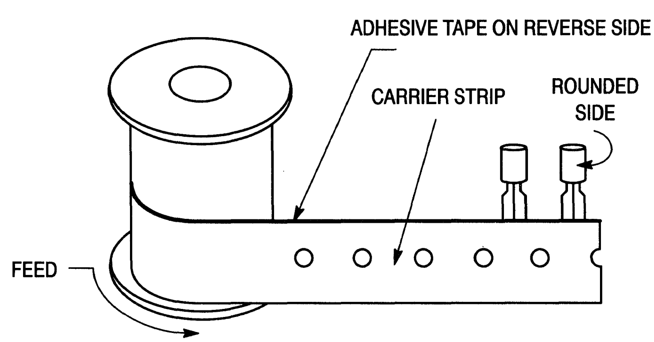
Flat side of transistor and carrier strip visible
(adhesive tape on reverse side).

Figure 13. Style B



Flat side of transistor and adhesive tape visible.

Figure 14. Style E



Rounded side of transistor and carrier strip visible
(adhesive tape on reverse side).

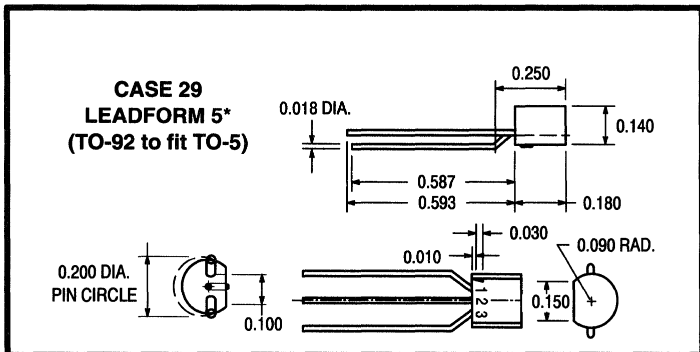
Figure 15. Style F

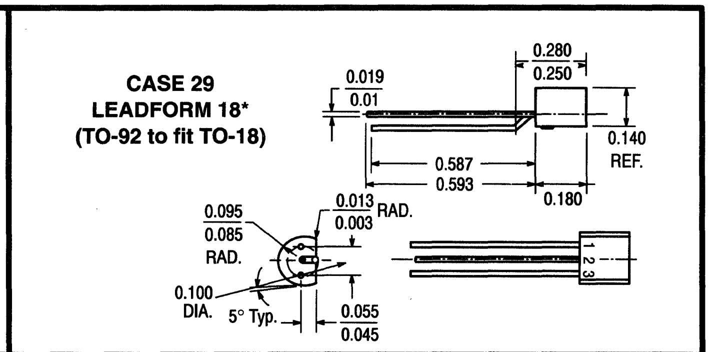
Leadform Options

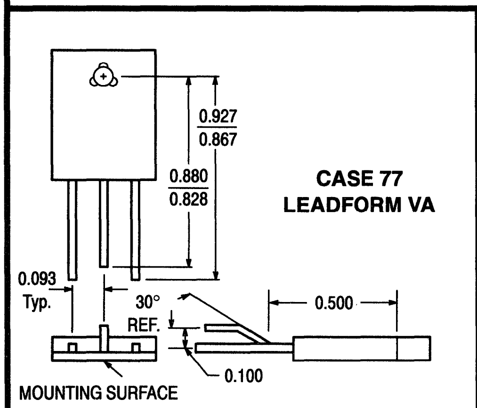
In Brief . . .

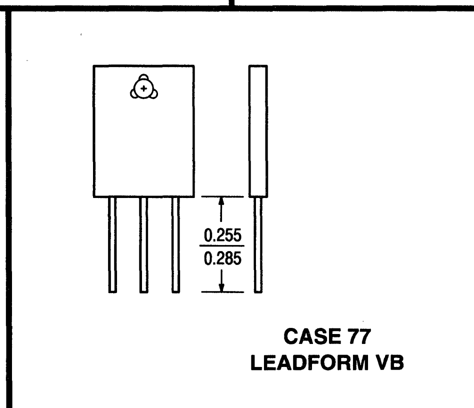
Plastic packaged semiconductors may be leadformed to a variety of configurations for insertion into sockets or circuit boards. Leadform options require assignment of a special part number before ordering. To order leadformed product, determine the desired leadform, the case number and applicable leadform number, then contact your local Motorola representative for the special part number and pricing. Leadform orders require a minimum order quantity and are non-cancellable after processing.

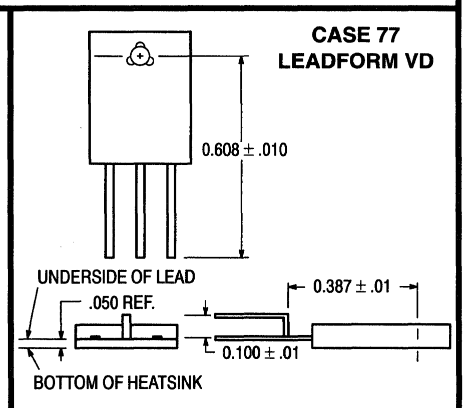
TO-92 (Case 29) & TO-225AA (Case 77)

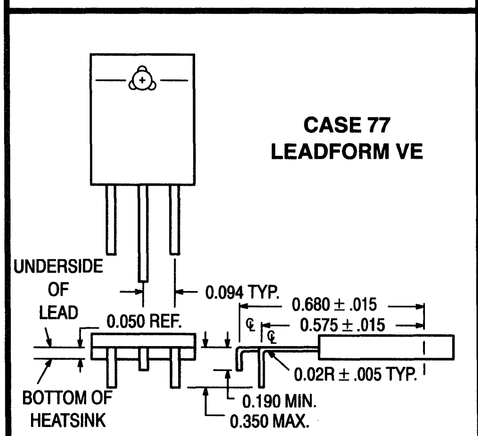


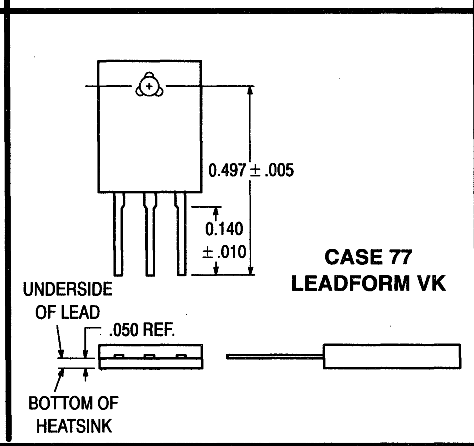


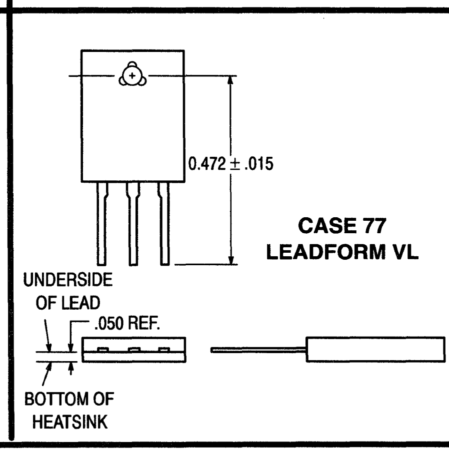


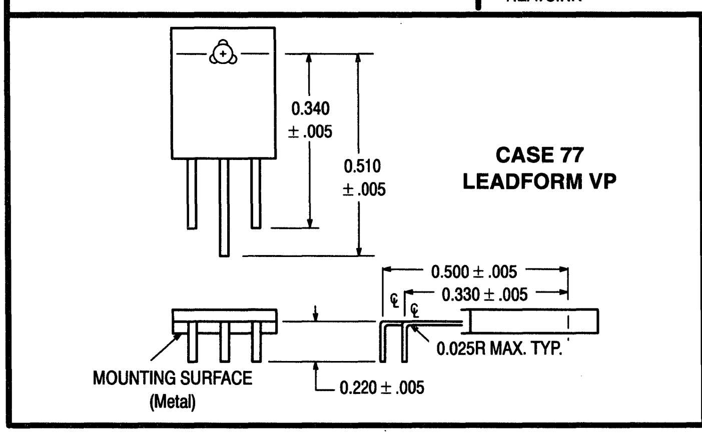


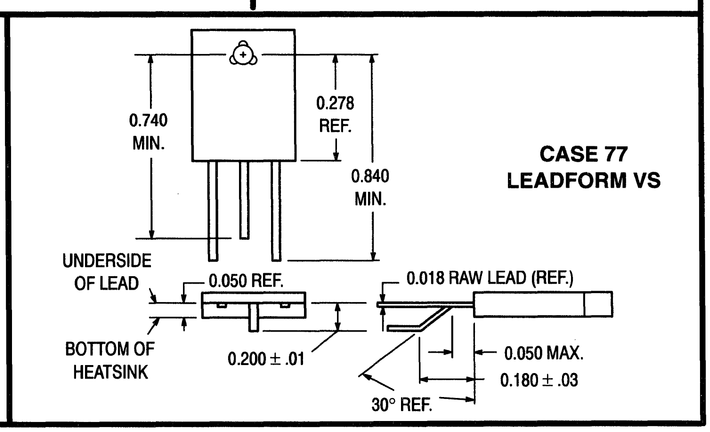








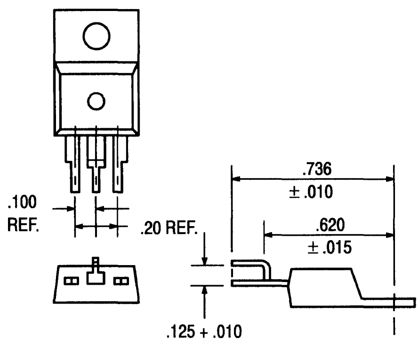




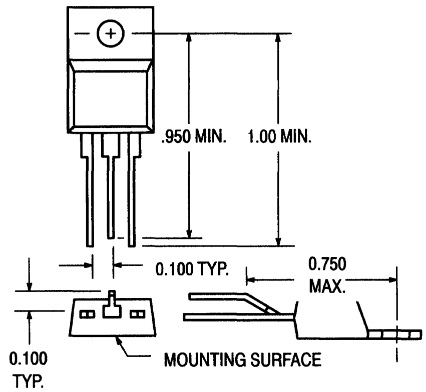
TO-220 (Case 221A)

- Leadform options require assignment of a special part number before ordering.
- Contact your local Motorola representative for special part number and pricing.
- 10,000 piece minimum quantity orders are required.
- Leadform orders are non-cancellable after processing.
- Leadforms apply to both Motorola Case 221A-04 and 221A-06 except as noted.

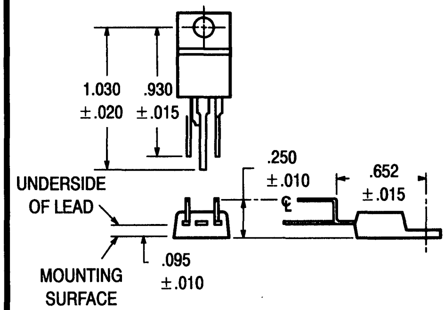
LEADFORM AS



LEADFORM BC

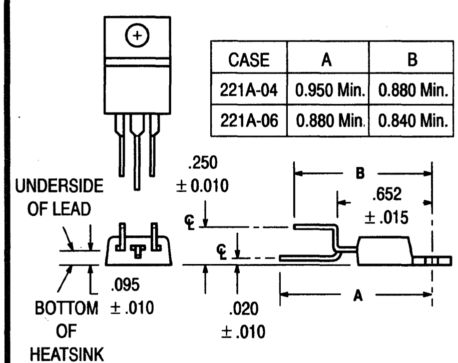


LEADFORM AC

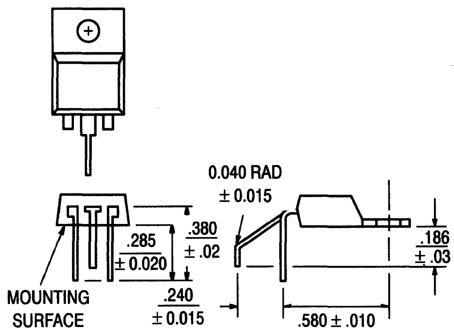


LEADFORM AD

CASE	A	B
221A-04	0.950 Min.	0.880 Min.
221A-06	0.880 Min.	0.840 Min.

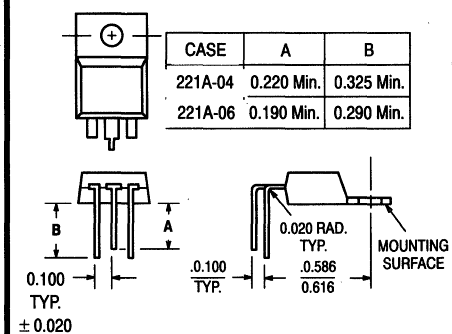


LEADFORM AN



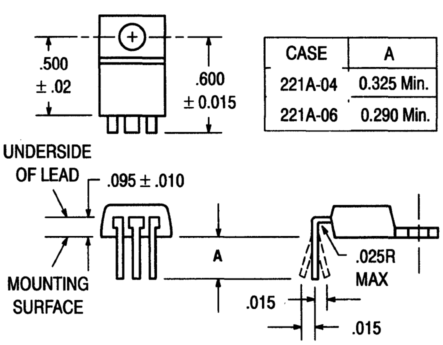
LEADFORM BA

CASE	A	B
221A-04	0.220 Min.	0.325 Min.
221A-06	0.190 Min.	0.290 Min.

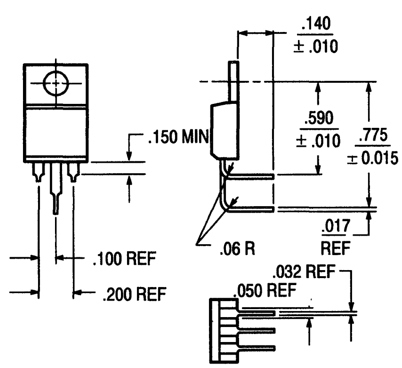


LEADFORM BL

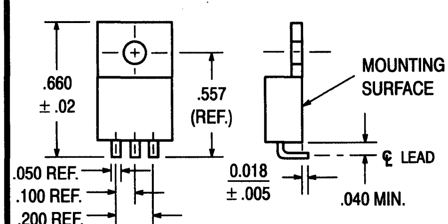
CASE	A
221A-04	0.325 Min.
221A-06	0.290 Min.



LEADFORM AK

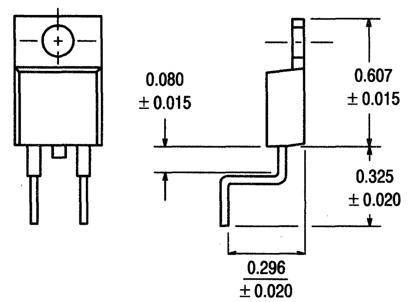


LEADFORM AF

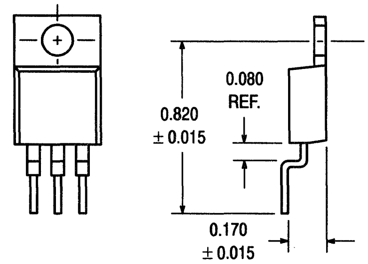


TO-220 (Case 221A) (continued)

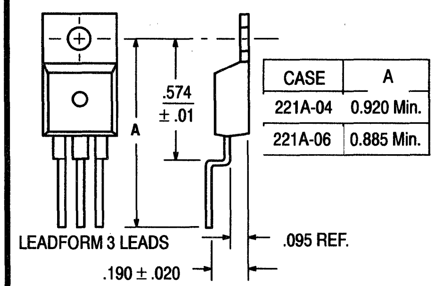
LEADFORM BS



LEADFORM BR

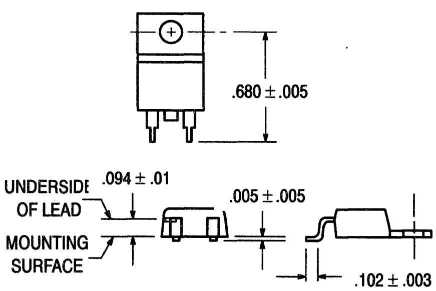


LEADFORM AU

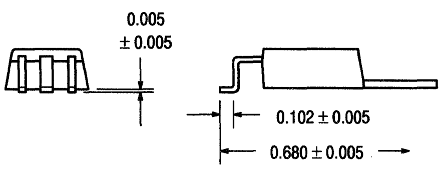


CASE	A
221A-04	0.920 Min.
221A-06	0.885 Min.

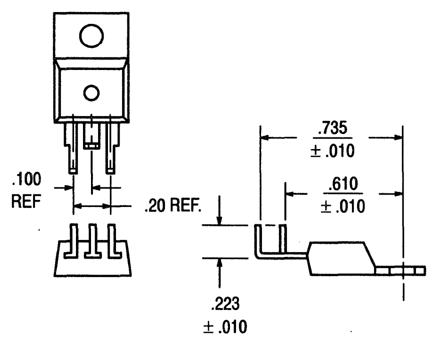
LEADFORM BU



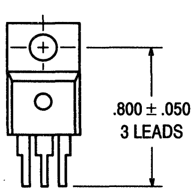
LEADFORM BV



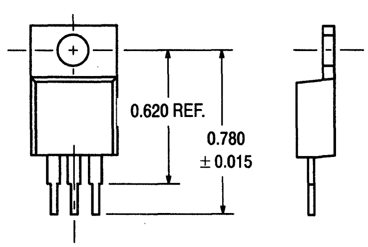
LEADFORM BD



LEADFORM DW

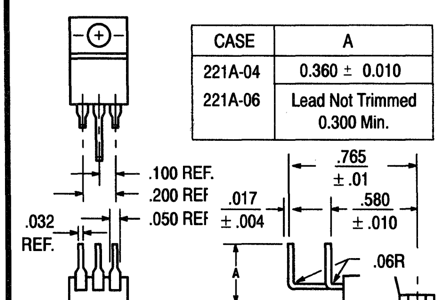


LEADFORM BG



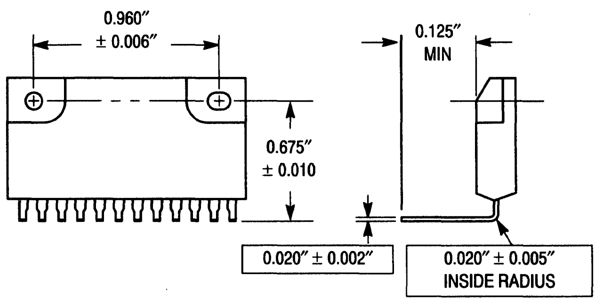
LEADFORM AJ

CASE	A
221A-04	0.360 ± 0.010
221A-06	Lead Not Trimmed 0.300 Min.

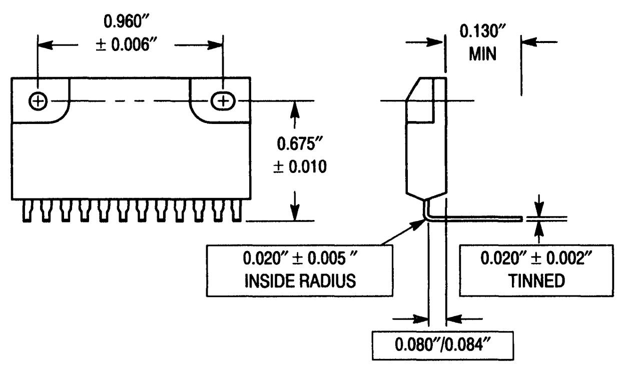


IcePAK Leadform Dimensions

- Leadform options require assignment of a special part number before ordering.
- Contact your local Motorola representative for special part number and pricing.
- 1350 piece minimum quantity orders are required.
- Leadform orders are non-cancellable after processing.
- Leadforms apply to Motorola Case 806-05.



Leadform A



Leadform B

Military Integrated Circuits and Discrete Products

In Brief . . .

Motorola, Inc. is one of the world's leading manufacturers of electronic equipment, systems and components. Motorola products include two-way radios, pagers, cellular and mobile telephones, defense and aerospace electronics, automotive and industrial equipment, data communications, information processing equipment and semiconductor products. Motorola is one of the few end-equipment manufacturers that can draw on a complement of government electronics and semiconductor technology.

Motorola has been an industry leader and consistent manufacturer of semiconductors since the advent of the technology, and has since emerged as a world-wide leader of leading-edge technology. Motorola's leadership position applies to products such as the 68000 series microprocessor including the 68040, the newest and most powerful member of the family, our DSP family including the DSP56001 and the new DSP 96000, logic, linear, discretes, memory components, ASIC and our state of the art 88000 RISC microprocessor.

Motorola has a long history of providing competitive products to the military and aerospace industry. Motorola supplies high reliability semiconductors to these markets through two major groups: the Military Products Operation (MPO) and the Discrete Military Operation (DMO). Together we represent over 60 years of successful partnerships with our military and aerospace customers.

MPO's charter is to provide a broad and balanced portfolio of defect-free, low cost products screened to MIL-M-38510 and MIL-STD-883C specifications, delivered on time, with superior service to the customer. Similarly, DMO's portfolio covers a broad range of 1N-- and 2N-- products tested to JAN, JTX, JTXV and JAN S specifications.

The Military Products Operation and Discrete Military Operation are 100% dedicated to the manufacture and supply of standard military products, with controlled engineering, manufacturing and administrative resources. Products are manufactured, screened and tested worldwide, on lines certified to the requirements of the pertinent military specifications.

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General Information

Rewarranty Policy

Military Products Operation

Paragraph 4.2 of MIL-M-38510J

"Procedures for lots held by manufacturers for more than 36 months. Microcircuits held by manufactures or distributors for a period exceeding 36 months from the date of the inspection lot identification code shall be demonstrated to be solderable in accordance with subgroup B-3 of test method 5005 of MIL-STD-883 prior to shipment. The devices shall retain the original inspection lot identification code (see 3.6.3), and an updated certificate shall accompany all shipments of devices to the Government or its contractors or subcontractors. Records of reinspection shall be maintained as specified in 30.1.2 of appendix A. The requirement for group A reinspection have been deleted. However, it is recommended that devices with inspection lot identification codes in excess of 36 months be demonstrated to be functional prior to the next level assembly (i.e., that the devices have not been damaged or degraded by storage or handling)."

Solderability Warranty Policy

Per the new requirements of paragraph 4.2 of MIL-M-38510J, microcircuits held by manufactures or distributors for a period exceeding 36 months from the date of the inspection lot identification code (date code) shall be demonstrated to be solderable in accordance with subgroup B-3 of test method 5005 of MIL-STD-883 prior to shipment.

Implementation date for this requirement was May 15, 1992; therefore, all product processed per the requirements of MIL-M-38510 and M5005 of MIL-STD-883 with date code 9220 or newer shall be processed in accordance with this requirement. However, all product with date codes 9219 or older shall be grandfathered and will not be processed in accordance with this requirement (Product shall not be returned to Motorola for rewarranty). For grandfathered product (product with date codes 9219 or older), Motorola shall guarantee the solderability of these parts. If these parts are not solderable at the customer's incoming inspection, Motorola will either rework or replace the parts free of charge.

The new warranty requirements shall be in effect for product with date codes 9220 or newer, and the following criteria shall apply:

- The entire lot shall be returned for rewarranty
- The returned lot shall be included in the distributor's allotted DSA for the Month that the product was returned
- MPO has the right to either replace or rework the material being returned

Process Flows

The process flows for our integrated circuit and discrete products are as follows:

JAN S	All discrete product assembled, screened and inspected per the applicable requirements of MIL-S-19500. Electrical parameters and marking requirements shall be as specified in the applicable detail specification. Product shall be manufactured in the U.S. on DESC certified lines. These products are most commonly produced for space applications.
Motorola S	All I/C product assembled, screened and inspected per the requirements of Motorola Processing Document 12MRM51815A. Electrical parameters and marking requirements shall be as specified in Motorola's Class S Master List: 48ARM51950A. Product shall be manufactured in the U.S. These products are most commonly produced for space applications, where fully compliant JANS is not required.
JAN	All discrete product assembled, screened and inspected per the applicable requirements of MIL-S-19500. Electrical parameters, test conditions, and marking requirements shall be as specified in the applicable detail specification. Product may be assembled in DESC approved off-shore facilities. Testing shall be done in the USA using DESC qualified facilities. These products are presently being removed from the QPL as the detail specifications are being revised. Recommended replacement is the JANTX level.
JAN B	All IC product assembled, screened and inspected per the applicable requirement of MIL- M-38510. Electrical parameters and marking requirements shall be as specified in the applicable detail specification. Product shall be manufactured in the U.S. on a DESC certified line. These products are produced for military applications.
JAN TX	All discrete product assembled, screened and inspected per the applicable requirements of MIL-S-19500. Electrical parameters, test conditions and marking requirements shall be as specified in the applicable specification. Product assembly and high temperature storage life may be done in DESC approved off-shore facilities. Screening and testing must be done in the USA on DESC certified lines. These products are produced for general military applications.
JAN TXV	All discrete product assembled, screened and inspected per the applicable requirements of MIL-S-19500. Electrical parameters, test conditions and marking requirements shall be as specified in the applicable detail specifications. Product must be assembled in DESC approved USA facilities. Testing shall be performed in the USA using DESC qualified facilities. These products are recommended when higher level of reliability than JTX is required.
SMD	All IC product assembled, screened, inspected and certified to the requirements of paragraph 1.2.1. of MIL-STD-883. Electrical parameters and marking requirements shall be as specified in the SMD. These products are produced for military applications.
DESC Drawings	All discrete product assembled, screened and inspected per the applicable requirements of MIL-S-19500. Electrical parameters and test conditions are specified in the detail specification. Fabrication, assembly, screening and testing are not limited to USA facilities. These products are produced for all levels of military applications where no MIL-S-19500 detail specification exists. DESC drawings are similar to SMD devices for integrated circuits.
883	All I/C product assembled, screened and inspected per the requirements of Paragraph 1.2.1 of MIL-STD-883. Electrical parameters shall be as specified in the applicable detail specification. Marking shall be in accordance with JEDEC Publication 101. Fabrication, assembly, screening and inspection are not restricted to domestic facilities. However, the facilities must be certified per the requirements of Paragraph 1.2.1. These products are produced for military applications.

* Generic and Lot Traceability Data are provided at a nominal Fee. Please contact your local sales office or the Military Service Center for more information.

Process Flows (continued)

MEP1	Integrated circuits which are assembled per the standard commercial flow, except for the addition of PIND, pre burn-in electrical tests, burn-in, final electrical tests and Group A & B inspections which shall be per MIL-STD-883. Electrical parameters shall be as specified in the applicable detail specification. Marking requirements are in accordance with those specified in JEDEC Publication 101, except the class designator "EP1" which replaces class designator "B" and the JEDEC designator "JC" and the "C" are omitted. Fabrication, assembly, screening and inspection are not restricted to domestic or certified facilities. These products are produced for military applications which do not require JAN, SMD or 883 compliant product.
MEP2	Same as MEP 1 flow with the following exceptions: PIND is not performed and the part number class designator shall be "EP2."
MEP3	Same as MEP 1 flow with the following exceptions: PIND testing, pre burn-in electrical tests and burn-in is omitted and the part number class designator shall be "EP3."
MIL-Processed	All discrete product assembled, screened and inspected per the applicable requirements of MIL-S-19500. Electrical parameters and test conditions are specified in the Motorola military data sheet. Assembly, screening and testing are not limited to USA facilities. These products are produced for all levels of military applications where no MIL-S-19500 detail specification exists.

* Generic and Lot Traceability Data are provided at a nominal Fee. Please contact your local sales office or the Military Service Center for more information.

MPO Class "S" Product Assurance Requirements

Motorola offers a higher level of IC processing than 883 Class B for our customers' use patterned after the 38510 Class "S" flow. This process captures the essence of 38510 "S" in most all methods and is particularly useful to customers requiring JAN "S" devices but are unable to obtain them. This process is completely captured in Motorola Specification 12MRM51815A and is available to our customers upon request. A comparison of JAN "S", JAN "B" and Motorola's basic requirements appears in the table below.

Table 1. MPO Class "S" Product Assurance Requirements

Requirements	JAN 38510		Motorola Class "S"
	Class "S"	Class "B"	(12MRM51815A)
Qualifications, General			
Line Certification	X	X	X (By MPO)
Device & Package Qual/MIL-M-38510	X	X	X (By MPO)
Change Control/MIL-M-38510	X	X	X
Wafer Lot Acceptance	X	—	X (Per internal spec Similar to 5007. SEM or Current Density)
Traceability	X	X	X
GSI	X	X	X
In Process Inspection	X	X	X
Screening (5004)			
Precap Visual	2010A (GSI/CSI)	2010B or Alt. Per 38510	(CSI/GSI) 2010A with modifications specified in (12MRM51815A)
Temp. Cycle	X	X	X (50 Cycle Min. when alternate inspection is used.
Constant Acceleration	X	X	X
PIND	X	—	X
Serialization	X	—	X (Lot Size Not Limited)
Interim Electrical	X	—	X
Burn-In	240 Hrs.	160 Hrs. or Equivalent	240 Hrs. or Equivalent
Seal (Fine/Gross Leak)	X	X	X
Final Electric	X	X	X
Radiographic	X	—	X
External Visual	X	X	X
Non Destruct 100% Bond Pull	X	—	X
Quality Conformance (5005)	X	X	X
Group A (Each Lot/Sublot)	X	X	X
Group B (Each Lot)	X	X or Alt. B	X or Alt. B
Group C	X	X	X(1)
Group D	X	X	X(1)

(X Indicates Requirement)
(1)Shipment prior to completion of groups C, D, with customer approval.

Table 2. Military Standard Process Flows

Screen	STANDARD MIL DRAWING (SMD) MIL-STD-883		MIL-M-38510 JAN	
	Method	Requirement	Method	Requirement
Internal Visual (Precap)	2010 Condition B and 38510(1)	100%	2010 Condition B and 38510(1)	100%
Stabilization Bake	1008 24 hours minimum Cond. C or equivalent(11)	—	1008 24 hours minimum Cond. C or equivalent(11)	—
Temperature Cycling	1010 Condition C	100%	1010 Condition C	100%
Constant Acceleration	2001 Condition E (min.) in Y 1 Plane(2)	100%	2001 Condition E (min.) in Y 1 Plane(2)	100%
Seal Fine Leak	1014, Condition B(10)	100%	1014, Condition B(10)	100%
Seal Fluorocarbon Gross Leak	1014, Condition C3(10)	100%	1014, Condition C3(10)	100%
Interim Electrical	Per applicable device specification	Optional	JAN slash sheet electrical specification	Optional
Burn-In Test	1015 160 hours @ 125°C or equivalent(3)	100%	1015 160 hours @ 125°C or equivalent(3)	100%
Final Electrical Tests (A) Static Tests (1) 25°C (Subgroup 1, Table 1, 5005)(9) (2) Max & Min rated operating temperature (Subgroups 2 & 3, Table 1, 5005) (B) Dynamic Test or Switching Tests 25°C (Subgroup 4 or 9, Table 1, 5005) (C) Functional Test 25°C (Subgroup 7, Table 1, 5005)	Per applicable device specification	100% 100% 100% 100%	JAN slash sheet electrical specifications	100% 100% 100% 100%
Quality Conformance Inspection Group A (A) Static (1) 25°C (Subgroup 1) (2) Temperature (Subgroup 2 & 3) (B) Dynamic Test or Switching Tests (1) 25°C (Subgroup 4 or 9) (2) Temperature (Subgroup 5 & 6 or 10 & 11) (C) Functional (1) 25°C (Subgroup 7) or –55° & +125°C (Subgroup 8)	5005 Class B	(4)	5005 Class B	(4)
Group B	5005 Class B	(5)	5005 Class B	(5)
Group C	5005 Class B	(6),(8)	5005 Class B	26 wks prod
Group D	5005 Class B	(7),(8)	5005 Class B	36 wks pkg prod
External Visual	2009	100%	2009	100%

(1) Alternate screens per Paragraph 3.3 of Method 5004, MIL-STD-883 will be used on bipolar logic and memory product.
(2) For packages with cavity perimeter of > 2 inches or a package mass > 5 grams, or per JAN slash sheet, lesser stress levels will be used.
(3) Burn-in time/temperature per Table 1 of Method 1015, MIL-STD-883. PDA per method 5004, MIL-STD-883.
(4) Sample size selection (for lots greater than 500 units) per 12MRM 03627A.
(5) Each package and lead finish for each lot of each assembly location.
(6) JAN generic data may be used. If JAN generic data is not available, Group C inspection shall be periodically performed per general provisions paragraph 1.2.1 of MIL-STD-883.
(7) Group D inspection shall be periodically performed per general provision paragraph 1.2.1. of MIL-STD-883 for each assembly location.
(8) Endpoint electrical endpoints for Group(s) C and D inspection shall be subgroups 1, 2, & 3 of the applicable device specifications.
(9) Lead Finish "A" applied after post burn-in electrical (A1) but before the final static electrical insertion.
(10) Fine and Gross leak may be performed anywhere between constant acceleration and external visual.
(11) This screen is performed on Bipolar Analog devices only.
Note 1: When limits are available per applicable device specifications. For SSI Class B Devices, tests are performed as a part of Group C. For MSI and greater complexity Class B devices, tests are performed as a part of Group A.

Table 3. Military Products Operation MEP Product Flow

Screening and Quality Conformance Testing Requirements Motorola Enhanced Product

Operation	Methods	MEP 1	MEP 2	MEP 3
Assembly	Per appropriate commercial flow for each package type	Each wafer visually sampled and sawn. The die are die bonded, wire bonded and sealed.		
Seal Fine and Gross	Method 1014 Conditions B and C	100%	100%	100%
Interim Electrical	Optional	Per the applicable Military electrical specification		
Burn-in Test	1015 160 hours @ 125°C or equivalent	100%	100%	—
PIND	2020 Condition A	100%	—	—
Final Electrical Test	JAN Slash Sheet or SMD/DESC Dwg or Motorola Spec	Per the applicable Military electrical specification		
(A) Static Test (1) 25°C (96 hr Req't and PDA Apply)	Subgroup 1, Table 1, 5005	100%	100%	100%
(2) Max and Min rated oper. temperatures	Subgroup 2 and 3 Table 1, 5005	100%	100%	100%
(B) Dynamic Test or Switching Test 25°C	Subgroup 4 or 9, Table 1, 5005	100%	100%	100%
(C) Functional Test 25°C	Subgroup 7, Table 1, 5005	100%	100%	100%
Quality Conformance Inspection:	QCI per 5005 Class B Table 1	The sample size/rejects allowed is 116/0 per 5005 for each subgroup or predefined set of subgroup (tests defined defined in appropriate Military device specification).		
Group A (A) Static Tests (1) 25°C (2) Max and Min rated oper. temperatures	Subgroup 1 Subgroup 2 and 3			
(B) Dynamic or Switching Tests (1) 25°C (2) Max and Min rated oper. temperatures	Subgroup 4 or 9 or 10 and 11			
(C) Functional Tests (1) 25°C	Subgroup 7			
Group B (B02, B03, B05)	5005 Class B	Each Inspection Lot (Except no B05 MEP 3)		
External Visual	2009	100%	100%	100%
Assembly/Test Location		Malaysia	Malaysia	Malaysia
Data		C of C	C of C	C of C

Motorola's MEP flow is designed specifically to meet shorter lead times associated with the design-in of new products in Military programs. The MEP flow is also ideal for Military and Industrial applications that do not require MIL-STD-883 product.
*MEP product processing is covered by general specification 12MRY01742.

Table 4. MEP Numbering System

Package	Device	Speed	Class	Process	Case	Lead Finish
1) Dual-In-Line (DIL)	Part Number	-XX	/EP	1, 2 or 3	(See Table)	(See Table)
2) Leadless Ceramic Chip Carrier (LCCC)	Part Number	-XXM**	/EP	1, 2 or 3	(See Table)	(See Table)
3) Ceramic Leaded Chip Carrier (CLCC)	Part Number	-XX	/EP	1, 2 or 3	(See Table)	(See Table)
4) Cerflat (FP)	Part Number	-XX	/EP	1, 2 or 3	(See Table)	(See Table)
5) Metal Can (CAN)	Part Number	-XX	/EP	1, 2 or 3	(See Table)	(See Table)
6) Pin Grid Array (PGA)	Part Number	-XX	/EP	1, 2 or 3	(See Table)	(See Table)

XX Applicable only on microprocessors and memories.

Table 5. Case Outline Table

Case Outline Table		
Letter	**MIL-M-1835 Designation**	**Description**
A	F-1	14-lead FP (1/4" X 1/4")
B	F-3	14-lead FP (3/16" x 1/4")
C	D-1	14-lead DIL (1/4" x 3/4")
D	F-2	14-lead FP (1/4" x 3/8")
E	D-2	16-lead DIL (1/4" x 7/8")
F	F-5	16-lead FP (1/4" x 3/8")
G	A-1	8-lead CAN
H	F-4	10-lead FP (1/4" x 1/4")
I	A-2	10-lead CAN
J	D-3	24-lead DIL (1/2" x 1-1/4")
K	F-6	24-lead FP (3/8" x 5/8")
L	D-9	24-lead DIL (1/4" x 1-1/4")
M	A-3	12-lead CAN
*N		Unassigned by Motorola
P	D-4	8-lead DIL (1/4" x 3/8")
Q	D-5	40-lead DIL (9/16" x 2-1/16")
R	D-8	20-lead DIL (1/4" x 1-1/16")
S	F-9	20-lead FP (1/4" x 1/2")
*T		J Lead
*T		SMD/JAN — See detail dwg.
*U		LCCC for Motorola 883
*U		SMD/JAN — See detail dwg.
V	D-6	18-lead DIL (1/4" x 15/16")
W	D-7	22-lead DIL (3/8" x 1-1/8")
*X		DIL for Motorola 883
*X		SMD/JAN — See detail dwg.
*Y		FP for Motorola 883
*Z		All other Motorola 883 configurations
*Z		SMD/JAN — See detail dwg.
2	C-2**	20-Terminal SQ. LCCC (.350" x .350")
3	C-4	28-Terminal SQ. LCCC (.450" x .450")

**Motorola Case Outline Table
M = Motorola designation for the 75 MIL Multi-Layer Leadless Chip Carrier, (Meets C2a Designation Criteria).   Maximum height dimension 0.075 inches.
Lead Finish
A-Kovar or Alloy 42, with hot solder dip   B-Kovar or Alloy 42, with fused matte tin plate   C-Kovar, Alloy 42, or Co-Fired, with gold plate   X-Any of above, for ordering purposes only.
Check with your local Motorola representative for price and delivery.

*Undesignated in MIL-M-1835.

Table 6. 100% Processing Requirements for JANTX, JANTXV and JANS Products

Inspections and tests must be performed in the order specified.

Subgroup Screen		MIL-STD-750 Test Method	JANTX	JANTXV	JANS
Internal Visual		2072/3/4	N/A	100%	100%
High Temperature Storage		1032	100%	100%	100%
Thermal Shock		1051	100%	100%	100%
Constant Acceleration		2006	100%	100%	100%
P.I.N.D.		2052	N/A	N/A	100%
Instability Shock (Diodes only)					
	FIST	2081	N/A	N/A	100%
	BIST	2082	N/A	N/A	100%
Hermetically		1071	100%	100%	100%
Serialization		—	N/A	N/A	100%
Electricals, Read & Record			Go/No-Go	Go/No-Go	100%
H.T.R.B.					
	Transistors	1039	100%	100%	100%
	Diodes	1038	100%	100%	100%
Electricals, Read & Record			100%	100%	100%
Power Burn-In					
	Transistors	1039	160 Hrs	160 Hrs	240 Hrs
	Diodes	1038	96 Hrs	96 Hrs	240 Hrs
	Thyristors	1040	96 Hrs	96 Hrs	140 Hrs
Electricals, Detail Spec			100%	100%	100%
Deltas, within 96 Hrs			100%	100%	100%
Hermetically		1071	Optional	Optional	100%
X-Ray		2076	N/A	N/A	100%
External Visual		2071	N/A	N/A	100%

The above tests shall be followed by Group A, B, and C tests on a sample basis.
N/A = Not Applicable

Process Flows: Certificate of Compliance

"The following policy change refers to the Military Integrated Circuit Products only"

We have recently designed and implemented a new and improved data information packet to be shipped with each lot. It is much more concise, easier to understand, and clearer in format than the bulky, complicated report we previously provided. The reverse side of this notice is more generic in nature, but provides the "essentials" in terms of lot identification, military methods utilized for processing, and a clear summarization of the different steps the product goes through prior to shipment. Also on the same form is the required certificate of compliance.

We understand that for a very small percentage of customers who have specific attribute data requirements imposed on them by contract, this lot data may be insufficient. In those limited cases, we will be happy to research the records and provide "supplementary" data which consists of more specific lot history on Groups A, B, C and D and any extra processing which may have been completed. We will charge only $300.00 per shipment for this additional information effective January 1, 1990 and will require a separate line item entry.

Preliminary inputs that we have received from our customers and the sales field have been very positive. Our cycle time, administrative quality and overall customer responsiveness will be improved as a result. For further information please contact your local sales office or the Military Service Center at 1-800-521-6274.

Process Flows: Certificate of Compliance

Lot Data And Certificate Of Compliance

MOTOROLA P/N	***JM38510/30402BCA***	**CUSTOMER P/N**	***990-3525-064***	
CUSTOMER NAME:	***T.C.S. CORP***	FACTORY ORDER #:	***441019***	
		FACTORY O/L #:	***01***	***00***
PO. NUMBER:	***INLE-2789-707***	QUANTITY:	***10,000***	

T.C.S. CORP.
PRODUCTION AVENUE
TEMPE, AZ 85284

LOT NO	SEAL/SOLDER D/C	RESOLDER D/C	SOLDER VERF. DATE	QUANTITY
R98084A	***KK8917***	***9330***	***NA***	***10000***

IT IS HEREBY CERTIFIED THAT ALL ARTICLES LISTED ABOVE ARE IN THE QUANTITIES SHOWN AND ARE IN COMPLIANCE WITH ALL OF THE SCREENING AND QUALITY CONFORMANCE INSPECTION REQUIREMENTS OF MIL-M-38510, MIL-STD-883 (PARA 1.2.1 FOR SMD AND 883 PRODUCTS) AND THE APPLICABLE DETAIL SPECIFICATIONS. RECORDS OF TRACEABILITY, INSPECTION, AND TEST PROVIDING OBJECTIVE EVIDENCE OF THE FOREGOING ARE ON FILE AT MOTOROLA AND ARE AVAILABLE UPON REQUEST.

____
QUALITY ASSURANCE INSPECTOR

DATE: ______________________________

Process Flows: Certificate of Compliance

Screening and Inspection Requirements for Motorola's JAN/SMD/883/JEDEC Programs

Operation	**100% screening per method 5004, Mil-STD-883, Level B:**
Internal Visual	Method 2010 Condition B And Para. 3.3.1 of M5004, see Note 1
Stabilization Bake	Method 1008 Condition C, 24 hours min (applies only to select analog product)
Temperature Cycling	Method 1010, Condition C: 10 or 50 cycles (–65°C to 150°C), see Note 1
Constant Acceleration	Method 2001, Y1 axis only: see Note 2 for test conditions
Fine & Gross Leak	Method 1014 Condition B & C (respectively)
Burn-in	Method 1015, Condition A, C or D; 160 Hrs @ +125°C (or equivalent)
Final Electrical	The following electrical subgroups are tested (see Note 6) per the applicable detail specification (after + 25°C screening, all lead finish "A" product is solder dipped, see Note 7): • Subgroups 1, 4, 7 and/or 9 (+25°C screening per Note 3). • Subgroups 2, 5, 8 and/or 10 (+125°C screening per Note 3). • Subgroups 3, 6, 8 and/or 11 (–55°C screening per Note 3).
	Quality conformance inspection
QCI Operation	**Per Method 5005, Mil-STD-883, Level B: Note 4**
Group A	**Performed on each lot (& burn-in partial) per Para. 3.5.1:** • Sample Size ≥116/0
Group B	**Performed on each lot per table lib:** • Resistance to solvents, Method 2015: sample size = 4/0. • Solderability, Method 2003 (@ 245 ± 5°C): Ltpd/Acc# = 10/0 minimum. • Bond strength, Method 2011, Condition D: Ltpd/Acc# = 15/0.
Group C	**Performed periodically (see Note 5) per Table III, on the most complex device type from each microcircuit group:** • Steady-state life test per Method 1005, Cond. A, C Or D for 1000 hrs. @ +125°C (or equivalent) with Ltpd/Acc# = 5/2 max
Group D	**Performed every 29 weeks, per Table IV, on each package family:** • Subg. 1: Physical dimensions (M2016) with Ltpd/Acc# = 15/0. • Subg. 2: Lead integrity with seal endpoints (M1014, Cond. B & C) per M5005, per applicable family. • Subg. 3: Thermal Shock (M1011, Cond B, 15 cycles), Temp. Cycle (M1010, Cond. B, 100 Cycles), Moisture Resistance (M1004) with visual (Criteria Per M1004), Seal (M1014, Cond. B & C), and Electrical (per the applicable detail spec.) endpoints. Ltpd/Acc# = 15/ Max. • Subg. 4: Mech. Shock (M2002, Cond. B), Var. Freq. Vibration (M2007, Cond. A), Constant Acceleration (M2001, see Note 2 for test cond.) with Seal (M1014, Cond. B & C), Visual (Criteria Per M1004), and Electrical (per the applicable detail spec.) Endpoints. Ltpd/Acc# =15/2 Max. • Subg. 5: Salt Atmosphere (M1009, Cond. A) with Seal (M1014, Cond. B & C), Visual (Criteria Per M1009) Endpoints. Ltpd/Acc# = 15/0. • Subg. 6: Internal Water-vapor Content (M1018, 5k Ppm Max @ 100°C), Sample Size = 3/0 or 5/1. • Subg. 7: Adhesion of lead finish (M2025). Ltpd/Acc# = 15/0. • Subg. 8: Lid Torque (M2024) per applicable package family. sample size = 5/0.

1a. All bipolar logic product receives 100% visual inspection per M2010, Condition B and the alternate criteria specified in Para. 3.3.1 of M5004, which specifies the following additional requirements: 50 temperature cycles (in lieu of the specified 10 cycles) and special electrical screening tests as defined by Para. 3.3.2 (screening shall be performed during the 100% electrical probe test at the wafer level).
1b. All other product receives the normal M2010 visual inspection and 10 temperature cycles.
2. Standard test condition is E (30kg's); however, if the package has an inner seal or cavity perimeter of 2 inches or more in total length, or which have a package mass of 5 or more grams, the product will be screened (or tested) at 20kg's, except for the selected VLSI packages, which maybe screened (or tested) at values less than 20kg's.
3. The electrical subgroups tested shall be as specified in the applicable detail specification.
4. The sample size includes the acceptance criteria as follows: "sample size = 4/0" indicates that the sample size is 4 units and that the acceptance level is zero rejects.
5. Group C periodical testing: JAN: once every quarter; SMD/883/JEDEC: once every fourth quarter. testing performed on the most complex device available at the time of selection.
6. All testing is performed on a "go/no go" basis (or per applicable detail specifications).
7. Solder dipping is performed approximately four weeks after seal; however, the same date code shall apply for both seal and solder. MPO has implemented an internal procedure to resolder and functionally test any factory inventory with date codes that are 24 months or older, prior to shipment. The resolder date code shall be identified.

Manufacturing, Quality & Test

Manufacturing

Manufacturing Excellence is one of the six key "Sector Imperative" goals all Motorolans strive to achieve. Our objective is to combine advanced technological processes and talented problem-solving, goal oriented individuals to create world class products.

Our diverse product portfolio demands are satisfied by dedicated, certified fabrication facilities around the world:

Bipolar I	Mesa, AZ
Bipolar II	Mesa, AZ
Bipolar III	Mesa, AZ
Lansdale	Santa Monica, CA
MOS I	EKB, Scotland
MOS II	Austin, TX
MOS III	Austin, TX
MOS V	Mesa, AZ
MOS VIII	Austin, TX

We are already achieving one micron integrated circuit dimensions on six-inch CMOS wafers. This facility is primarily dedicated to the fabrication of Memories and ASIC's.

Our assembly facilities accommodate both on-shore and off-shore manufacturing and market demands. Our in-house facility in Tempe, AZ is certified to JAN and MIL-STD-883 requirements, while our off-shore facilities in Kuala Lumpur, Malaysia and Seoul, Korea are both 883 certified. Internal self-audits and inspections by DESC, Underwriters Labs and various customers are conducted regularly to ensure compliance to Motorola and Military requirements.

Quality

Motorola was one of the first semiconductor manufacturers to realize the importance of product, process and administrative quality in reducing cost, eliminating non-value added activity, improving productivity and ultimately, satisfying our customers.

Ten and hundred-fold improvement programs were implemented and goals achieved. Average outgoing quality levels for both electrical and visual-mechanical inspection are consistently less than 50 parts per million (PPM) in the military products operation and major efforts are in place to reduce the number further.

To do this requires implementation of statistical process control (SPC) in all critical processes, continuing to reduce opportunities for error through improved manufacturing and administrative systems and implementation of continuous improvement programs by our cross-functional involvement teams. The result will be "Total Customer Satisfaction."

Test

Motorola's Military Products Operation (MPO) utilizes state-of-the-art VLSI testers to test high-frequency, large pin count devices, (currently to 451 leads). Also, in order to increase our quality standards and to simplify our testing procedures we test most MPO products to JAN level test programs. The benefit to our customers is obvious: the best available test programs yield the best available product for our customers.

Federal Supply Commission Manufacturing Number (FSCM#)

Motorola's FSCM# is 04713

Vendor Address:	Motorola 5005 East McDowell Road Phoenix, AZ 85008
DMO:	Motorola 5005 East McDowell Road Phoenix, AZ 85008
MPO:	Motorola 2100 East Elliot Road Tempe, AZ 85284 Cage Code: 82393

Certified Facilities

Our broad MIL-STD-883 and MIL-M-38510 certified resource base, domestic and off-shore, guarantees our customers product support from a variety of manufacturing, assembly and test facilities. Our 883 facilities are audited and certified to MIL-STD-38510 specification (qualification excluded). The Foundation of Standard Military Product is the basis for program administration (JAN and/or 883). The following tables expand on our production capabilities.

Table 7. MIL-M-38510 Certified Facilities

Technology	Wafer Fab	Assembly	Burn-In	Test	QCI
Linear	Bipolar-1/Mesa, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ
LS/MECL10K	Bipolar-2/Mesa, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ
FAST/Memory	Bipolar-2/Mesa, AZ	MPO/Temp, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ
HCMOS Logic	MOS-2/Austin, TX	MPO/Tempe, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ	MPO/Tempe, AZ

Table 8. MIL-STD-883 Certified Facilities

Technology	Wafer Fab	Assembly	Burn-In	Test	QCI
Linear	Bipolar-1/Mesa, AZ	Malaysia, Korea	Malaysia, Korea, Tempe	Malaysia, Korea, Tempe	Malaysia, Korea, Tempe
LS/MECL 10K	Bipolar-2/Mesa, AZ	Malaysia	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ
MECL 10KH	Bipolar-2/Mesa, AZ	Malaysia	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ
FAST/DRAM	Bipolar-2/Mesa, AZ	Malaysia	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ
FACT	MOS-2/Austin, TX	Malaysia	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ
CMOS Logic	MOS-1/Scotland	Malaysia	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ
HCMOS Logic	MOS-2/Mesa, AZ	Malaysia	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ	Malaysia, Tempe, AZ
MPU-6800	MOS-3/Austin, TX	Malaysia	Tempe, AZ	Tempe, AZ	Tempe, AZ
MPU-68000	MOS-5/Mesa, AZ	Malaysia	Tempe, AZ	Tempe, AZ	Tempe, AZ
68020/68030	MOS-8/Austin, TX	Malaysia	Tempe, AZ	Tempe, AZ	Tempe, AZ
88100/88200	MOS-8/Austin, TX	Malaysia	Tempe, AZ	Tempe, AZ	Tempe, AZ
SRAM	MOS-8/Austin, TX	Malaysia	Tempe, AZ	Tempe, AZ	Tempe, AZ

Table 9. Process Flow Quality Ratings

Our wide range of certified manufacturing, assembly and test areas offer our customers several different levels of screening and qualification: JAN, SMD/DESC, 883 and MEP (Motorola Enhanced Product). The table below illustrates the variety of processes available to our customers.*

Motorola Process	Quality Level	Process Description	Quality Factor π Q
None	S	Procured in full accordance with MIL-M-38510 Class S requirements. Class S listing on QPL-38510.	0.25
None	S-1	Procured in full compliance with the requirements of MIL-STD-975 or MIL-STD-1547 and have procuring activity specification approval.	0.75
Motorola Quasi “S”	S-2	Procured in full compliance with Motorola Document 12MRM51815A.	0.8 (EST)
MIL-M-38510	B	Procured in full accordance with MIL-M-38510 Class B Requirements. Class B listing on QPL-38510.	1.0
SMD/DESC	B-1	Fully compliant with all requirements of Paragraph 1.2.1 of MIL-STD-883 and procured to a Military or DESC Drawing or other approved documentation.	2.0
MIL-STD-883**	B-2	Fully compliant with requirements of Paragraph 1.2.1 MIL-STD-883 and procured to approved documentation including vendor's equivalent Class B requirements.	5.0
MEP	D	Hermetically sealed parts with normal reliability screening and manufacturer's quality assurance practices.	10.0
Commercial	D-1	Commercial (non-military) flow	20.0

Federal Supply Commission Manufacturing Number (FSCM#)
For reference purposes, Motorola's FSCM# is 04713
* Reference Table 5.1.2.7-1 MIL HNBK217E
** Motorola's 883 flow is identical to the SMD/DESC requirements and is fully compliant to MIL-STD-883 but may be electrically tested to a JAN/SMD/DESC drawing or to a Motorola drawing as indicated in the test program column in the 883 section. For most standard device types, the 883 version is identical to the SMD/DESC version.

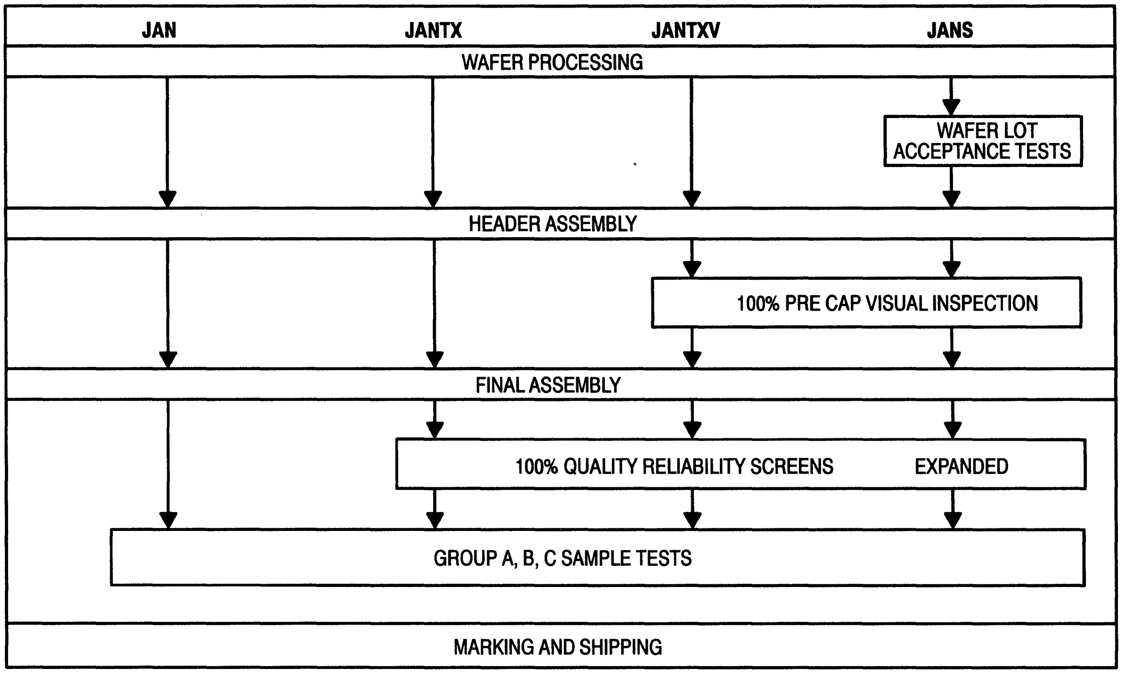


Figure 11. The MIL-S-19500 Semiconductor Process Flow

MIL-Qualified Semiconductors

MIL-type semiconductors are high reliability components that exhibit long product life under severe operating conditions. They are specified for use in most complex systems supplied to the military market and utilized extensively to provide the required accuracy for today's missile systems and the long operational life demanded by spacecraft. To ensure optimum component reliability, the Department of Defense has established a complex system of Specifications and Standards involving all phases of manufacturing, including Facility Certification as well as Product Processing, Testing and Screening. A manufacturer of MIL-Qualified components must rigidly conform to these standards throughout all worldwide facilities.

The MIL-S-19500 Specification

To ensure compliance with the requirements, the Department of Defense controls the procurement of semiconductor devices used in military equipment through a general specification, MIL-S-19500. (The latest revision of this specification is MIL-S-19500H, dated April 30, 1990.) This is maintained by the Department of the Navy but is approved for use by all departments and agencies of the Department of Defense and their military OEM subcontractors. It covers the basic requirements for the manufacture of MIL-Qualified semiconductor devices and through a series of associated "Methods documents" (MIL-STD-750) it prescribes the detailed procedures for satisfying these requirements.

Table 10. The MIL-S-19500 "Methods" Compendium

MIL-S-19491	Packaging of Semiconductors
FED-STD-209	Clean Room, Work Stations, Controlled Environments
FED-STD-H28	Screw-Thread Standards
MIL-STD-105	Sampling Procedures
MIL-STD-129	Marking for Shipment Storage
MIL-STD-750	Test Methods for Semiconductors
MIL-STD-45662	Calibration Systems Requirements

The JAN Progression

Test methods for semiconductor devices are detailed in MIL-STD-750 which covers qualification procedures for four successively higher levels of quality assurance: JAN, JANTX, JANTXV and JANS.

The term "JAN" is a U.S. Government Certification Mark, registered by the U.S. Patent Office as number 504860, and its assignment to a specific product signifies:

— Manufacturer has complied with all requirements for the manufacture of MIL-type components.

— Product has satisfied all the applicable test requirements.

— Test data will remain on file for at least three years.

— Data will be available for on-sight review by government representatives upon request.

— That JAN data is available and may be obtained from the supplier.

A simplified production flow chart for each of the four JAN levels, including the applicable tests and screens, is shown in the illustration.

JAN Products

JAN was the initial government classification for products requiring special reliability assurances. It signifies that the products so classified are taken from a controlled and isolated lot (or batch) of devices, and that samples from this lot have satisfactorily passed the ascribed electrical, thermal, mechanical, environmental, life and storage requirements in accordance with the associated Slash Sheet(1). If the sample lot has passed the specified statistical criteria, the entire lot is qualified as JAN, and all devices in the lot may be marked accordingly.

JANTX Products

With increasing system complexity came the need for a reduction in the number of defective devices per lot and for a longer "Mean Time Between Failures" (MTBF). This led to the JANTX (JTX) specification and to the concept of 100% screening. This involves subjecting all devices in the proposed qualification lot to a stringent program of stress tests that must precede the sample tests associated with conventional JAN processing. These tests seek to weed out potential failures, as well as those that might pass undetected in JAN lots where only samples of the lot are investigated.

JANTXV Products

JANTXV (JTXV) testing is essentially the same as JTX, except that the JTXV products undergo an additional 100% Precap Visual inspection. Visual screening procedures involve microscopic inspection of the semiconductor assembly, before capping the package, to uncover potential failures due to chip imperfection or imperfect die or wire bonds. While the U.S. government has qualified off-shore facilities for the assembly of JAN and JANTX devices, JANTXV products must be manufactured in the U.S. due to the visual precap inspection requirement. One exception to this is a clear-glass-encapsulated diode line which can be inspected after assembly.

JANS Products

In the early '70s, developments in the aerospace industry dictated the accommodation of more hostile operating environments as well as extended MTBF demands. This helped drive the concept of wafer lot acceptance(2) prior to encapsulation, and spurred additional and even tighter 100% test limits after encapsulation. The resulting JANS specification reflects the most critical test sequence in effect today.

JAN Qualification Tests And Procedures

The initial set of slash-sheet-prescribed sample tests associated with the JAN qualification consists of three separate groups. These were developed to:

1. Verify conformance to electrical specifications. (Group A)
2. Assure manufacturing integrity and reliability in tactical and ground support applications. (Group B)
3. Provide evidence of long-term reliability under harsh environmental conditions where severe mechanical and life/environmental stresses exist (Group C).

Table 11. Group A Testing

Type of Test	Vis/Mech	Electrical					
Test Subgroups	A1	A2	A3	A4	A5	A6	A7
		DC Tests	Hi/Lo Temp	AC Tests	SOA Tests	Current Surge	Selected
Test Parameters	Package: Dimensions Marking	$V_{(BR)CBO}$ $V_{(BR)CEO}$ $V_{(BR)EBO}$ I_{CBO} I_{EBO} $V_{BE(sat)}$* $V_{CE(sat)}$* h_{FE}	I_{CBO} @ 150°C h_{FE} @ −55°C	$\lvert h_{fe} \rvert$ h_{fe} C_{obo} C_{ibo} NF* t_{on} t_{off}	SOA @ 25°C* Power Transistors	Diodes Rectifiers	As Specified

* These parameters are tested under two or more operating conditions

(1) A slash sheet is a numbered document describing the detailed characteristics of each individual semiconductor product. It is so called because each specific document number is appended to MIL-S-19500 by a "/" (slash) e.g. MIL-S-19500/135.

(2) Wafer lot acceptance involves detailed documentation and verification of the selection and processing of wafer destined for JANS qualification, including specification of sample size, control of wafer thickness, cleanliness, junction and surface preparation, metal deposition and thickness, etching, alloying and other processing steps.

Group A tests consist of visual, mechanical and electrical tests that verify "form, fit and function" of a particular group of devices. The procedure begins with the selection of a representative sample from a MIL-designated lot that has been fully processed. The sample is subjected to a test sequence that begins with a visual and mechanical inspection per MIL-STD-750 (subgroup A1), followed by a comprehensive series of electrical tests (subgroups A2 through Ax). The number of subgroups in the electrical test sequence may vary considerably, depending on the nature of the device and its potential applications. The test sequence shown depicts the procedure for a 2N3498 transistor.

The visual/mechanical inspection for the Group A tests are performed in accordance with MIL-STD-750, METHOD 2071. It consists of a sample (LTPD = 5) which is examined to determine that the devices meet the applicable materials, design, construction, marking and workmanship standards.

A typical electrical test sequence begins with the verification of the major DC parameters of the device operating under normal (25°C) temperature conditions, Subgroup A2. Usually this is followed by testing a sample of several parameters at either high and/or low temperature limits to verify satisfactory performance over the entire temperature range for which it is specified, Subgroup A3. Then the AC (dynamic) parameters are investigated (Subgroup A4). For power transistors, the Safe Operating Area (SOA) is verified (Subgroup A5). Surge current for diodes and rectifiers is tested in Subgroup A6. Finally, Subgroup A7 provides for tests that are unique to certain products but do not fit into a general classification.

Successful completion of this test sequence provides assurance that the devices are capable of operating in accordance with their design parameters.

Table 12. Group B Testing

Test Subgroups	B1	B2*	B3*	B4	B5	B6*
Type of Test	Solderability	Thermal Shock	Steady State Operating Life	Decap Visual	Thermal Resistance	High Temp Life (non-operating)
	Resistance to Solvents	Surge	Intermittent	SEM when specified		
		Hermetic Seal	Operation Life	Bond Strength		
		Fine	Blocking Life			
		Gross				

Table 13. Group C Testing

Test Subgroups	C1	C2*	C3*	C4	C5	C6
Type of Test	Physical	Thermal Shock	Mech. Shock	Salt	Not	Steady State or Intermittent or Blocking
	Dimensions	(Glass Strain)	Vibration (Variable Freq.)	Atmosphere	Applicable	Operation Life
		Terminal	Constant Acceleration			
		Strength				
		Hermetic Seal				
		Moisture				
		Resistance				

* The tests in this subgroup are preceded and followed by electrical tests of the most susceptible parameters — h_{FE}, I_{CBO}, $V_{CE(sat)}$ and $V_{BE(sat)}$.

This sequence includes screens that are intended to verify that the devices are mechanically sound and that they can be expected to continue to operate satisfactorily over time and under adverse operating conditions. Since a number of these screens involve stress factors that could result in ultimate performance degradation, the electrical parameters expected to be affected are tested before and after the applied screen to ascertain that the performance change remains within prescribed limits. Group B tests are run on a lot by lot basis.

Group C tests must be performed on samples from the initial lot as well as on samples from subsequent lots formed at six-month periodic intervals. These tests consist of mechanical, environmental and life tests intended to provide assurance that the devices will continue to perform reliably in long term harsh environments where severe mechanical and life/environmental stresses exist.

JANTX, TXV, JANS QUALIFICATION — 100% PROCESSING

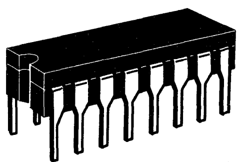
Higher levels of reliability assurance require more extensive and more elaborate reliability test procedures. For these, the sample tests for JAN devices have been supplemented with the processing screens described in the table on the following page. These screens are performed immediately after lot identification, prior to the Group A, B, and C sample tests. They are applied to 100% of the devices in the lot and include procedures developed to eliminate any marginal devices that would pass all normal operational tests but might fail under hostile environmental conditions. The most comprehensive screening procedure applies to the JANS classification which not only demands the greatest number of tests and screens after header assembly, but imposes Wafer Lot Acceptance criteria as well.

Packaging and Mechanical Data

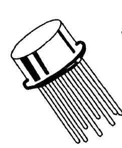
Military Products Operation Integrated Circuits Packages

MPO products are offered in several application specific and cost effective hermetically sealed ceramic packages. Our packages conform to the mechanical requirements of MIL-M-1835. We offer our products in the following ceramic packages: Dual In-Line package (DIL), solder seal Dual In-Line (Side Brazed DIL), ceramic FlatPack (FP or CERFLAT), Leadless Ceramic Chip Carrier (LCCC), Ceramic Leaded Chip Carrier (CLCC), several metal can packages (CAN) and Pin Grid Array (PGA).

All MPO packages are offered in a variety of pin patterns and lead finishes. The following pages will help you determine the proper combination of package, pin count and lead finish for your specific application. For your convenience, we have also included a "Supplier Package Cross Reference" which will help you cross other suppliers packaging codes to Motorola package codes.

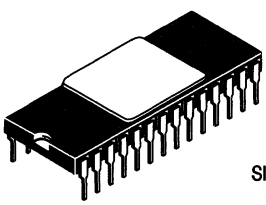


DIL (DUAL IN-LINE)

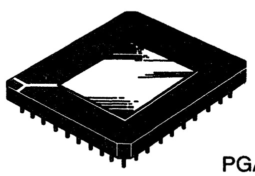


TO - 5

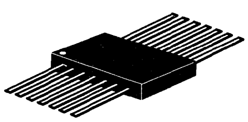
CAN (8,10 LEAD)



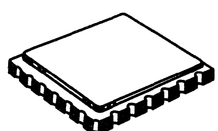
SIDEBRAZE DIL



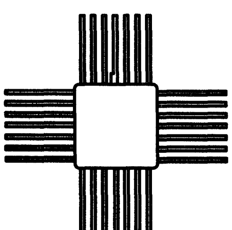
PGA (PIN GRID ARRAY)



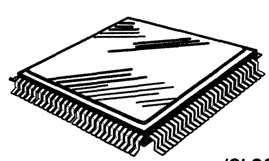
FP (FLAT PACK)



LCCC (LEADLESS CERAMIC CHIP CARRIER)



CQF (CERAMIC QUAD FLAT)



(CLCC) CERAMIC LEADED CHIP CARRIER

Packaging and Mechanical Data (Order Quantities)

Table 14. Multiple Packaging Quantities

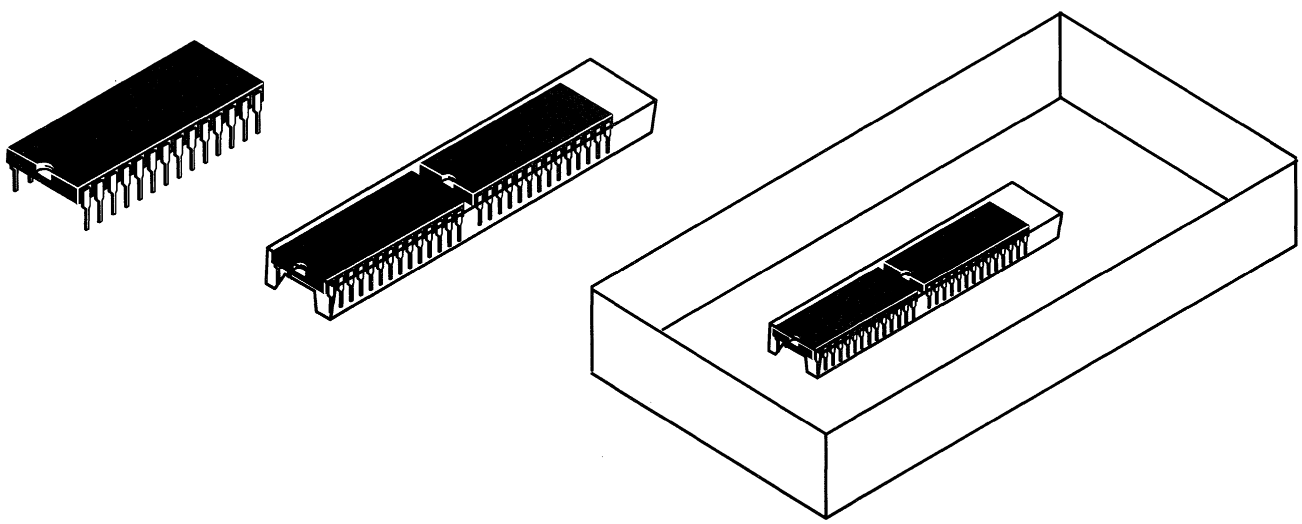
Package Type	Package Description	Package	S.O.Q.	M.P.Q.	P.O.Q.
0017	14 LD Cerflat	D	1	150 Rail	1800 Box
0027	8 LD TO-5 Can	G	1	100 Bag	500 Bag
0028	10 LD TO-5 Can	I	1	100 Bag	500 Bag
0039	18 LD Cerdip	V	1	21 Rail	420 Box
0079	8 LD Cerdip	P	1	48 Rail	480 Box
0080	14 LD Cerdip	C	1	25 Rail	1500 Box
0081	16 LD Cerdip	E	1	25 Rail	1500 Box
0120	24 LD Cerdip	J	1	15 Rail	450 Box
0634	20 LD LCC	2	1	55 Rail	550 Box
0681	20 LD Cerdip	R	1	20 Rail	1000 Box
0862	16 LD Cerflat	F	1	150 Rail	1800 Box
0863	20 LD Cerflat	S	1	105 Rail	420 Box
0864	24 LD Cerflat	K	1	90 Rail	180 Box

M.P.Q will apply to FAST, LS, MECL, FACT, CMOS and ANALOG only.

S.O.Q.
SAMPLE ORDER QUANTITY

M.P.Q.
MULTIPLE PACKAGING QUANTITY

P.O.Q.
PREFERRED ORDER QUANTITY



Military Semiconductor Integrated Circuits

Analog/Telecom & Special Function

Table 15. Analog

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
10319	24	High Speed 8-Bit A/D Flash Converter			/B	JA			
108	14	Precision Operational Amplifier			/B	CA			
	8				/B	PA		GA	
108A	14	Precision Operational Amplifier			/B	CA			
	8		10104		/B	PA		GA	
111	8	High Performance Voltage Comparator	10304			PA			
124	14	Quad Low Power Operational Amplifier	11005		/B	CA			
139	14	Quad Single Supply Comparator	11201		/B	CA			
139A	14	Quad Single Supply Comparator			/B	CA			
1488	14	Quad MDTL Line Driver [T_A = 0°C to +75°C]			LTR	CA			
1489	14	Quad MDTL Line Rcvr [T_A = 0°C to +75°C]			LTR	CA			
1489A	14	Quad MDTL Line Receiver [T_A = 0°C to +75°C]			LTR	CA			
1508	16	8-Bit Multiplying D/A Converter			/B	EA			
1525A	16	Pulse Width Modulation Control Circuit	12602	5962-8951101	/B	TBD			
1526	18	Pulse Width Modulation Control Circuit	12603	8551501	/B	VA			
1527A	16	Pulse Width Modulation Control Circuit	12604	5962-8951102	/B	TBD			
1536	8	High-Voltage Operational Amplifier			/B	PA		GA	
1537	14	Dual Operational Amplifier			/B	CA			
1539	14	High Slew-Rate Operational Amplifier			/B	CA			
	8				/B	PA		GA	
1545	14	Wideband Amplifier		5962-8671201	/B	CA			
	10			5962-8671201	/B			IA	
1550	10	RF/IF Amplifier			/B			IA	
1554	10	1-Watt Power Amplifier			/B			IA	
1555	8	Timing Circuit			/B	PA		GA	
1556	14	High Performance Operational Amplifier			/B	CA			
	8				/B	PA		GA	
1558	14	Dual Operational Amplifier, Low Noise			/B	CA			
	8				/B	PA		GA	
1558S	14	High Slew-Rate Dual Operational Amplifier			/B	CA			
	8				/B	PA		GA	
1563	10	Adjustable Negative Voltage Regulator			/B			IA	
1568	14	Dual Positive/Negative ±15 Volt Tracking Reg.			/B	CA			
	10				/B			IA	
1569	10	Adjustable Positive Voltage Regulator			/B			IA	

TBD To Be Determined (Based on Customer Demands)
*Offshore Commercial Wafer Flow

Table 15. Analog (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
158	8	Dual Low Power Operational Amplifier		5962-8771001	/B	PA		GA	
1590	8	Wideband Amplifier with AGC		5962-8765701	/B			GA	
1594	16	Four-Quadrant Multiplier			/B	EA			
1595	14	Four-Quadrant Multiplier			/B	CA			
1596	14	Balanced Modulator-Demodulator		5962-8857101	/B	CA			
	10			5962-8857101	/B			IA	
1709	14	General Purpose Operational Amplifier			/B	CA			
	8				/B	PA		GA	
1723	14	Adjustable Positive or Negative Voltage Reg			/B	CA			
	10				/B			IA	
1733	14	Differential Video Amplifier		8418501	/B	CA			
	10			8418501	/B			IA	
1741	14	General Purpose Operational Amplifier			/B	CA			
	8				/B	PA		GA	
1741S	8	High Slew-Rate Operational Amplifier			/B	PA		GA	
1747	14	Dual 1741 Operational Amplifier			/B	CA			
	10				/B			IA	
193	8	Dual Comparator			/B			GA	
193A	8	Dual Comparator			/B			GA	
2003A	16	Darlington Driver	14103		/B	EA			
26LS31	16	Quad RS-422 Line Driver w/ 3-State Outputs		5962-7802301	/B	EA	FA		
	20			5962-7802301					2A
26LS32	16	Quad RS-422/23 Line Rec. – 3-State Outputs		5962-7802001	/B	EA	FA		
	20			5962-7802001					2A
35035	24	DC Brushless Motor Controller			/B	LA			
35039	8	DC Brushless Motor Controller Adapter			*	1Q93			
35063	8	DC to DC Converter Control Circuit		5962-90757	/B	PA			
35074	14	Quad High-Perform. Single-Supply Op Amp		5962-8996901	/B	CA			
	20				/B				2A
35074A	14	Quad High-Perform. Single-Supply Op Amp		5962-8996902	/B	CA			
	20				/B				2A
35102	8	Dual Sleep Mode Op-Amp			/B	PA			
35161	8	Universal Voltage Monitor			/B	1Q93			
35164	8	Undervoltage Lockout		In Process	/B	PA			
3517	16	Continuously Variable-Slope Delta Mod/Demod		5962-8764301	/B	EA			
	20			5962-8764301	/B				2A

TBD To Be Determined (Based on Customer Demands)
*Offshore Commercial Wafer Flow

Table 15. Analog (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
35174	14	Low Power Single Supply Op Amp			/B	CA			
35179	14	Quad Low Noise OpAmp			/B	CA			
35204	16	Quad 1.8 V Rail to Rail Op Amp			/B	2Q93			
3523	8	Overvoltage Sensing Circuit		5962-8978001	/B	PA			
35304	14	Quad 1.8 V Rail to Rail Sleep Mode Op Amp			/B	TBD			
431	8	Programmable Precision References	14801	8410901	/B	PA			

TBD To Be Determined (Based on Customer Demands)
*Offshore Commercial Wafer Flow

Table 16. Telecom & Special Functions

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
55107	14	Dual Line Receiver	10401		/B	CA			
56156	112	16-Bit General Purpose RAM DSP with ΣΔ Codec			/B				4Q93
56ADC16	20	16-Bit ΣΔ A/D			/B				3Q93
6875A	16	6800 MPU Clock Generator/Driver			/B	EA			
145406	16	RS232/V.28 Driver Receiver			/B	EA			
145407	20	RS232D/V.28 Driver Receiver (5.0 Volt only)			/B	2Q93			
145152-2	28	PLL Parallel Programmable			/B	XA			
145151-2	28	PLL Parallel Programmable			/B	XA			
145146-2	20	PLL 4-Bit Data Bus Programmable			/B	2Q93			
145155-2	18	PLL Serial Input			/B	VA			
145157-2	16	PLL Serial Input			/B	EA			
145156-2	20	PLL Serial Input			/B	RA			
145158-2	16	PLL Serial Input			/B	EA			
145190		1.1 GHz UHF PLL Frequency Synthesizer Low Voltage			/B	2Q93			
145191		1.1 GHz UHF PLL Frequency Synthesizer Low Voltage			/B	2Q93			
145192		1.1 GHz UHF PLL Frequency Synthesizer Low Voltage			/B	2Q93			

Logic Products

ECL & ECLinPS (Emitter Coupled Logic in Pico-Seconds)

Table 17. **100K ECLinPS Logic**

JM38510/, SMD#, MIL-STD-883

						Package Type and Lead Finish			
Device	Pins	Description	JM38510/	SMD#	883	DIL	FP	CAN	LCCC
10E416	28	8-Bit Synchronous Binary Up Counter			/B		2Q92		
10E501	28	Quad 4-Input OR/NOR Gate			/B		2Q92		
10E504	28	Quint 2-Input AND/NAND Gate			/B		2Q92		
10E507	28	Quint 2-Input XOR/XNOR Gate			/B		2Q92		
10E511	28	1:9 Differential Clock Driver, Low Skew, Enable, V_{BB}, Differential Outputs			/B		2Q92		
10E516	28	Quint Differential Line Receiver			/B		2Q92		
10E531	28	4-Bit D Flip-Flop			/B		2Q92		
10E541	28	8-Bit Shift Register			/B		2Q92		
10E542	28	9-Bit Shift Register			/B		TBD		
10E543	28	9-Bit Hold Register			/B		TBD		
10E551	28	6-Bit D Register			/B		2Q92		
10E558	28	5-Bit 2:1 Multiplexer			/B		TBD		
10E851	28	6-Bit D Register, Diff. Data Clock Inputs			/B		4Q92		
100E416	28	8-Bit Synchronous Binary Up Counter			/B		3Q92		
100E501	28	Quad 4-Input OR/NOR Gate			/B		3Q92		
100E504	28	Quint 2-Input AND/NAND Gate			/B		3Q92		
100E507	28	Quint 2-Input XOR/XNOR Gate			/B		3Q92		
100E511	28	1:9 Differential Clock Driver Low Skew, Enable, V_{BB}, Differential Output			/B		2Q92		
100E516	28	Quint Differential Line Receiver			/B		2Q92		
100E531	28	4-Bit D Flip-Flop			/B		3Q92		
100E541	28	8-Bit Shift Register			/B		3Q92		
100E542	28	9-Bit Shift Register			/B		TBD		
100E543	28	9-Bit Hold Register			/B		TBD		
100E551	28	6-Bit D Register			/B		3Q92		
100E558	28	5-Bit 2:1 Multiplexer			/B		TBD		
100E851	28	6-Bit D Register, Differential Data & Clk Inputs V_{BB}, Common Reset, Single Ended Output			/B		2Q92		

TBD To Be Determined (Based on Customer Demands)

MECL (Motorola Emitter Coupled Logic)

Table 18. MECL 10K

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
10500	16	Quad 2-Input NOR Gate with Strobe			/B	EA	FA		2A
10501	16	Quad OR/NOR Gate	06001		/B	EA	FA		2A
10502	16	Quad 2-Input NOR Gate	06002		/B	EA	FA		2A
10503	16	Quad 2-Input OR Gate			/B	EA	FA		2A
10504	16	Quad 2-Input AND Gate	06201		/B	EA	FA		2A
10505	16	Triple 2-3-2-Input OR/NOR Gate	06003		/B	EA	FA		2A
10506	16	Triple 4-3-3-Input NOR Gate	06004		/B	EA	FA		2A
10507	16	Triple 2-Input Exclusive OR Exclusive NOR Gate	06005		/B	EA	FA		2A
10509	16	Dual 4-5-Input OR/NOR Gate	06006		/B	EA	FA		2A
10513	16	Quad Exclusive OR Gate			/B	EA	FA		2A
10514	16	Triple Line Receiver			/B	EA	FA		2A
10515	16	Quad Line Receiver			/B	EA	FA		2A
10516	16	Triple Line Receiver		7800901	/B	EA	FA		2A
10517	16	Dual 2-Wide 2-3-Input OR-AND/OR-AND-INVERT Gate			/B	EA	FA		2A
10518	16	Dual 2-Wide 3-Input OR-AND Gate			/B	EA	FA		2A
10519	16	4-Wide 4-3-3-3-Input OR-AND Gate			/B	EA	FA		2A
10521	16	4-Wide OR-AND/OR-AND-INVERT Gate		5962-8857701	/B	EA	FA		2A
10523	16	Triple 4-3-3 Input Bus Driver			/B	EA	FA		2A
10524	16	Quad TTL-to-MECL Translator	06301		/B	EA	FA		2A
10525	16	Quad MECL-to-TTL Translator	06302		/B	EA	FA		2A
10530	16	Dual Latch			/B	EA	FA		2A
10531	16	Dual Type D Master-Slave Flip-Flop	06101		/B	EA	FA		2A
10533	16	Quad Latch			/B	EA	FA		2A
10535	16	Dual J-K Master-Slave Flip-Flop	06104		/B	EA	FA		2A
10536	16	Universal Hexadecimal Counter			/B	EA	FA		2A
10537	16	Universal Decade Counter			/B	EA	FA		2A
10538	16	Bi-Quinary Counter			/B	EA	FA		2A
10539	16	32 x 8 Bit PROM			/B	EA	FA		2A
10541	16	4-Bit Universal Shift Register		5962-8855701	/B	EA	FA		2A
10545	16	64-Bit Register File (RAM)		5962-8856001	/B	EA	FA		2A
10549	16	256 x 4 Bit PROM			/B	EA	FA		2A
10552	16	256 x 1 Bit RAM			/B	EA	FA		2A
10553	16	Quad Latch (Negative Clock)			/B	EA	FA		2A
10558	16	Quad 2-Input Multiplexer (Non-inverting)		5962-8779201	/B	EA	FA		2A

Table 18. MECL 10K (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
10560	16	12-Bit Parity Generator-Checker			/B	EA	FA		2A
10561	16	Binary to 1-8 Line Decoder (Low)			/B	EA	FA		2A
10562	16	Binary to 1-8 Line Decoder (High)			/B	EA	FA		2A
10563	16	Error Detection and Correction Circuit (IBM Pattern)			/B	EA	FA		2A
10564	16	8-Line Multiplexer		5962-8852701	/B	EA	FA		2A
10565	16	8-Input Priority Encoder			/B	EA	FA		2A
10566	16	5-Bit Magnitude Comparator			/B	EA	FA		2A
10568	16	Quad Latch (Common Clock)			/B	EA	FA		2A
10570	16	9+2-Bit Parity Generator-Checker			/B	EA	FA		2A
10571	16	Dual Binary to 1-4-Decoder (Low)			/B	EA	FA		2A
10572	16	Dual Binary to 1-4-Decoder (High)			/B	EA	FA		2A
10573	16	Quad 2-Input Multiplexer/Latch			/B	EA	FA		2A
10574	16	Dual 4-to-1 Multiplexer			/B	EA	FA		2A
10575	16	Quint Latch			/B	EA	FA		2A
10576	16	Hex D Master-slave Flip-Flop	06103		/B	EA	FA		2A
10578	16	Binary Counter			/B	EA	FA		2A
10579	16	Look-ahead Carry Block			/B	EA	FA		2A
10580	16	Dual 2-Bit High-Speed Adder/Subtracter			/B	EA	FA		2A
10581	24	4-Bit Arithmetic Logic Unit/Function Generator			/B	JA	KA		N/A
10582	16	2-Bit Arithmetic Logic Unit/Function Generator			/B	EA	FA		2A
10586	16	Hex D Master-Slave Flip-Flop With Reset		5962-8779301	/B	EA	FA		2A
10590	16	Quad IBM (MST)-to-MECL Translator			/B	EA	FA		2A
10591	16	Hex MECL-to-IBM (MST) Translator			/B	EA	FA		2A
10595	16	Hex Inverter/Buffer			/B	EA	FA		2A
10597	16	Hex AND Gate	06202		/B	EA	FA		2A
10598	16	Monostable Multivibrator		5962-8777301	/B	EA	FA		2A
10610	16	High Speed Dual 3-Input/3-Output OR Gate			/B	EA	FA		2A
10611	16	High Speed Dual 3-Input/3-Output NOR Gate			/B	EA	FA		2A
10612	16	High Speed Dual 3-Input/3-Output OR/NOR Gate		5962-8775001	/B	EA	FA		2A
10616	16	High Speed Triple Line Receiver			/B	EA	FA		2A
10631	16	High Speed Dual D Master-Slave Flip-Flop	06102		/B	EA	FA		2A

Logic Products (continued)

Table 19. MECL 10KH

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
10H416	16	Binary Counter		5962-8759001	/B	EA	FA		2A
10H500	16	Quad 2-Input NOR w/Strobe			/B	EA			
10H501	16	Quad OR/NOR Gate		5962-8750301	/B	EA	FA		2A
10H502	16	Quad 2-Input NOR Gate		5962-8755701	/B	EA	FA		2A
10H503	16	Quad 2-Input OR Gate		5962-8756501	/B	EA	FA		2A
10H504	16	Quad 2-Input AND Gate		5962-8750401	/B	EA	FA		2A
10H505	16	Triple 2-3-2 Input OR/NOR Gate		5962-8750701	/B	EA	FA		2A
10H506	16	Triple 4-3-3 Input NOR Gate		5962-8756401	/B	EA	FA		2A
10H507	16	Triple 2-Input/Exclusive NOR Gate		5962-8772701	/B	EA	FA		2A
10H509	16	Dual 4-5 Input OR/NOR Gate			/B	EA	FA		2A
10H513	16	Quad Exclusive OR Gate		5962-8755801	/B	EA	FA		2A
10H515	16	Quad Line Receiver		5962-8750101	/B	EA	FA		2A
10H516	16	Triple Line Receiver		5962-8750201	/B	EA	FA		2A
10H517	16	Dual 2-Wide 2-3 Input OR-AND/OR-AND-INVERT Gate			/B	EA	FA		2A
10H518	16	Dual 2-Wide 3-Input OR/AND Gate		5962-8755901	/B	EA	FA		2A
10H519	16	4-Wide 4-3-3-3 Input OR-AND Gate		5962-8772801	/B	EA	FA		2A
10H521	16	4-Wide OR-AND/OR-AND INVERT Gate		5962-8773001	/B	EA	FA		2A
10H524	16	Quad TTL-to-MECL Translator		5962-8756001	/B	EA	FA		2A
10H525	16	Quad MECL-to-TTL Translator		5962-8750801	/B	EA	FA		2A
10H531	16	Dual D Master Slave Flip-Flop		5962-8756101	/B	EA	FA		2A
10H536	16	Universal Hexadecimal Counter		5962-8700101	/B	EA	FA		
10H541	16	4-Bit Universal Shift Register		5962-8751101	/B	EA	FA		2A
10H558	16	Quad 2-Input Multiplexer (Non-inverting)		5962-8756601	/B	EA	FA		2A
10H560	16	12-Bit Parity Generator-Checker		5962-8756201	/B	EA	FA		2A
10H561	16	Binary to 1-8 Line Decoder (Low)		5962-8756701	/B	EA	FA		2A
10H562	16	Binary 1-8 Line Decoder (High)			/B	EA	FA		2A
10H564	16	8-Line Multiplexer		5962-8772901	/B	EA	FA		2A
10H571	16	Dual Binary to 1-4 Line Decoder (Low)		5962-8756801	/B	EA	FA		2A
10H574	16	Dual 4-1 Multiplexer		5962-8750601	/B	EA	FA		2A
10H576	16	Hex D Master-Slave Flip-Flop		5962-8751201	/B	EA	FA		2A
10H581	24	4-Bit Arithmetic Logic Unit/Function Generator			/B	JA	KA		N/A
10H586	16	Hex D Master-Slave Flip-Flop w/Common Reset		5962-8756301	/B	EA	FA		2A
10H588	16	Hex Buffer w/Enable		5962-8750901	/B	EA	FA		2A
10H589	16	Hex Inverter w/Enable		5962-8751001	/B	EA	FA		2A

TBD To Be Determined (Based on Customer Demands)

Table 19. MECL 10KH (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
10H609	16	Dual 4-5-Input OR/NOR Gate		5962-8756901	/B	EA	FA		2A
10H610	16	High Speed Dual 3 Input/3 Output OR Gate		5962-8754101	/B	EA	FA		2A
10H750	16	ECL-to-TTL Translator (Quad), SinglePower Supply (–5.2 V or +5.0 V)			/B	EA	4Q92		2A
10H751	20	Quad TTL/NMOS to MECL Translator			/B	RA	4Q92		2A
10H1000	28	9-Bit TTL to ECL Translator			/B		TBD		TBD
100H1000	28	9-Bit TTL to ECL Translator			/B		TBD		TBD
10H1001	28	9-Bit ECL to TTL Translator			/B		TBD		TBD
100H1001	28	9-Bit ECL to TTL Translator			/B		TBD		TBD
10H1002	28	9-Bit Latch /TTL to ECL Translator			/B		TBD		TBD
100H1002	28	9-Bit Latch /TTL to ECL Translator			/B		TBD		TBD
10H1003	28	9-Bit Latch /ECL to TTL Translator			/B		TBD		TBD
100H1003	28	9-Bit Latch /ECL to TTL Translator			/B		TBD		TBD
10H1040	28	68030/040 ECL/TTL Clock Driver			/B		TBD		TBD
100H1040	28	68030/040 ECL/TTL Clock Driver			/B		TBD		TBD
10H1041	28	Single Supply ECL/TTL 1:9 Clock Driver			/B		TBD		TBD
100H1041	28	Single Supply ECL/TTL 1:9 Clock Driver			/B		TBD		TBD
10H1042	28	68030/040 ECL/TTL Clock Driver		5962-9207501	/B		3Q92		TBD
100H1042	28	68030/040 ECL/TTL Clock Driver		5962-9207502	/B		3Q92		TBD
10H1043	28	Dual Supply ECL/TTL 1:8 Clock Driver			/B		TBD		TBD

TBD To Be Determined (Based on Customer Demands)

MECL III

Table 20. MECL III

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
1648M	14	Voltage Controlled Oscillator, [T_A = –55°C to +125°C]		5962-8977801	/B	CA	DA		2A
1650	16	Dual A/D Converter [T_A = –30°C to +85°C]			LTR	EA	FA		
1651	16	Dual A/D Converter [T_A = –30°C to +85°C]			LTR	EA	FA		
1654	16	Binary Counter [T_A = –30°C to +85°C]			LTR	EA			
1660	16	Dual 4-Input Gate [T_A = –30°C to +85°C]			LTR	EA	FA		
1662	16	Quad 2-Input NOR Gate [T_A = –30°C to +85°C]			LTR	EA	FA		
1664	16	Quad 2-Input OR Gate [T_A = –30°C to +85°C]			LTR	EA	FA		
1670	16	Master-Slave Flip-Flop [T_A = –30°C to +85°C]			LTR	EA	FA		

Table 20. MECL III (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
1672	16	Triple 2-Input Exclusive OR Gate, [T_A = –30°C to +85°C]			LTR	EA	FA		
1678	16	Bi-Quinary Counter [T_A = –30°C to +85°C]			LTR	EA			
1690	16	UHF Prescaler D Flip-Flop [T_A = –30°C to +85°C]			LTR	EA	FA		
1692	16	Quad Line Receiver [T_A = –30°C to +85°C]			LTR	EA	FA		

MECL

Table 21. MECL Phase-Locked-Loop (PLL)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
12502	14	Analog Mixer Double Balanced			/B	CA			
12509	16	Two-Modulus÷5/÷6, 600 MHz Typical		5962-8774801	/B	EA			
12511	16	Two-Modulus÷8/÷9, 600 MHz Typical		5962-8774301	/B	EA			
12513	16	Two-Modulus÷10/÷2, 600 MHz Typical			/B	EA			
12514	16	Counter-Control Logic			/B	EA			
12515	8	Low Power Two-Modulus Prescaler			/B	PA			
12540	14	Phase-Frequency Detector		5962-8775201	/B	CA			
12561	16	Crystal Oscillator (2-20 MHz)			/B	EA			

FACT

Advanced CMOS Technology

Table 22. CMOS Logic

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
54AC00	14	Quad 2-Input NAND Gate		 5962-87549	/B	CA 1Q93			
54ACT00	14	Quad 2-Input NAND Gate, with TTL Inputs		 5962-87699	/B	CA 1Q93			
54AC02	14	Quad 2-Input NOR Gate		 5962-87612	/B	CA 1Q93			
54ACT02	14	Quad 2-Input NOR Gate, with TTL Inputs			/B	CA			
54AC138	16	1-of-8 Decoder/Demultiplexer		5962-87622	/B	1Q93			
54ACT138	16	1-of-8 Decoder/Demultiplexer with TTL Inputs		 5962-87554	/B	EA 1Q93			
54ACT151	16	8-Input Multiplexer, with TTL Inputs		 5962-88756	/B	EA 1Q93			

Military Semiconductor Integrated Circuits

Table 22. CMOS Logic (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
54AC153	16	Dual 4-Input Multiplexer		5962-87625	/B	1Q93			
54AC174	16	Hex D Flip-Flop with Master Reset		5962-87626	/B	1Q93			
54AC240	20	Octal Buffer/Line Driver		 5962-87550	/B	RA 1Q93			
54AC244	20	Octal Buffer/Line Driver		 5962-87552	/B	RA 1Q93			
54ACT244	20	Octal Buffer/Line Driver with TTL Inputs		 5962-87760	/B	RA 1Q93			
54AC245	20	Octal Bidirectional Transceiver		5962-87758	/B	2Q93			
54ACT245	20	Octal Bidirectional Transceiver w/TTL Inputs		5962-87663	/B	2Q93			
54AC273	20	Octal D-Type Flip-Flop		5962-87756	/B	1Q93			
54AC299	20	8-Bit Shift/Store Register		5962-87754	/B	2Q93			
54AC373	20	Octal Transparent Latch, 3-State		5962-87555	/B	2Q93			
54ACT373	20	Octal Transparent Latch, 3-State, TTL		5962-87556	/B	2Q93			
54AC374	20	Octal D Flip-Flop		5962-87694	/B	2Q93			
54ACT374	20	Octal D Flip-Flop, TTL Compatible Inputs		5962-87631	/B	2Q93			
54AC540	20	Octal Buffer/Line Driver with 3-State Outputs		5962-87695	/B	TBD			
54AC541	20	Octal Buffer/Line Driver with 3-State Outputs		5962-88706	/B	TBD			
54ACT74	14	Dual D Flip-Flop, with TTL Inputs		 5962-87525	/B	CA 1Q93			
54AC86	14	Quad 2-Input EX-OR Gate		 5962-89550	/B	CA 1Q93			
88913	14	Hex Divide-by-Two Flip-Flops with two inverting and four non-inverting outputs		Planned	/B	1Q93	1Q93		
88914	14	Hex Divide-by-Two Flip-Flops with Synchronized Power and Reset		Planned	/B	1Q93	1Q93		
88915	28	Low Skew CMOS PLL Clock Driver with five Low Skew "Q" outputs, one $\overline{Q}$ output, one 2xQ output, and one Q/2 output		Planned	/B			1Q93	1Q93
88916	20	Low Skew CMOS PLL Clock Driver with Processor Reset and Low Skew "Q" outputs, one $\overline{Q}$ output, one 2xQ output, and one Q/2 output		Planned	/B	1Q93	2Q93		

Logic Products (continued)

FAST

Advanced Schottky TTL

Table 23. Bipolar Logic

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
54F00	14	Quad 2-Input NAND Gate	33001		/B	CA	DA		2A
54F02	14	Quad 2-Input NOR Gate	33301		/B	CA	DA		2A
54F04	14	Hex Inverter	33002		/B	CA	DA		2A
54F08	14	Quad 2-Input AND Gate	34001		/B	CA	DA		2A
54F10	14	Triple 3-Input NAND Gate	33003		/B	CA	DA		2A
54F109	16	Dual JK Flip-Flop with Preset	34102		/B	EA	FA		2A
54F11	14	Triple 3-Input AND Gate	34002		/B	CA	DA		2A
54F125	14	Quad Buffer, 3-State, Enable-LO			/B	CA	DA		2A
54F126	14	Quad Buffer, 3-State, Enable-HI			/B	CA	DA		2A
54F13	14	Dual 4-Input NAND Schmitt Trigger			/B	CA	DA		2A
54F132	14	Quad 2-Input NAND Schmitt Trigger			/B	CA	DA		2A
54F138	16	1-of-8 Decoder/Demultiplexer	33701		/B	EA	FA		2A
54F139	16	Dual 1-of-4 Decoder/Demultiplexer	33702		/B	EA	FA		2A
54F14	14	Hex Inverter Schmitt Trigger		5962-8875201	/B	CA	DA		2A
54F151	16	8-Input Multiplexer	33901		/B	EA	FA		2A
54F153	16	Dual 4-Input Multiplexer	33902		/B	EA	FA		2A
54F157A	16	Quad 2-Input Multiplexer	33903		/B	EA	FA		2A
54F158A	16	Quad 2-Input Multiplexer, Inverting	33904		/B	EA	FA		2A
54F161A	16	4-Bit Binary Counter, Asynchronous Reset	34301		/B	EA	FA		2A
54F174	16	Hex D Flip-Flop	34107		/B	EA	FA		2A
54F175	16	Quad D Flip-Flop	34104		/B	EA	FA		2A
54F182	16	Look-Ahead Carry Generator	33802		/B	EA	FA		2A
54F194	16	Universal Shift Register	33601		/B	EA	FA		2A
54F20	14	Dual 4-Input NAND Gate	33004		/B	CA	DA		2A
54F240	20	Octal Buffer/Line Driver/Inverting/3-State	33201		/B	RA	SA		2A
54F241	20	Octal Buffer/Line Driver, 3-State	33202	5962-8687401	/B	RA	SA		2A
54F242	14	Quad Non-Inverting Bus Transceiver/3-State	34801		/B	CA	DA		2A
54F243	14	Quad Bus Transceiver/Non-Inverting/3-State	34802		/B	CA	DA		2A
54F244	20	Quad Buffer Driver/Non-Inverting/3-State	33203		/B	RA	SA		2A
54F245	20	Octal Bus Transceiver	34803	8551101	/B	RA	SA		2A
54F251	16	8-Input Multiplexer/3-State			/B	EA	FA		2A
54F253	16	Dual 4-Input Multiplexer/3-State	33908		/B	EA	FA		2A
54F257	16	Quad 2-Input Multiplexer/3-State			/B	EA	FA		2A
54F258	16	Quad 2-Input Multiplexer/Inverting/3-State			/B	EA	FA		2A

Table 23. Bipolar Logic **(continued)**

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
54F280	14	9-Bit Odd/Even Parity Generator/Checker	34901		/B	CA	DA		2A
54F283	16	4-Bit Full Adder	34201		/B	EA	FA		2A
54F32	14	Quad 2-Input OR Gate	33501		/B	CA	DA		2A
54F352	16	Dual 4-Input Multiplexer	33909		/B	EA	FA		2A
54F353	16	Dual 4-Input Multiplexer/3-State	33910		/B	EA	FA		2A
54F373	20	Octal Transparent Latch/3-State	34601		/B	RA	SA		2A
54F374	20	Octal D Flip-Flop/3-State	34105		/B	RA	SA		2A
54F378	16	Hex Parallel D Register with Enable	34108	5962-8855501	/B	EA	FA		2A
54F379	16	Quad Parallel Register with Enable	34109		/B	EA	FA		2A
54F381	20	4-Bit ALU	33803	5962-8671001	/B	RA	SA		2A
54F382	20	4-Bit ALU	33804		/B	RA	SA		2A
54F398	20	Quad 2-Port Register	35001		/B	RA	SA		2A
54F399	16	4-Bit Register with Non-Inverting Outputs	35002		/B	EA	FA		2A
54F521	20	Octal Comparator			/B	RA	SA		2A
54F533	20	Octal Transparent Latch/3-State	34602		/B	RA	SA		2A
54F534	20	Octal D-Type Flip-Flop/3-State	34106		/B	RA	SA		2A
54F64	14	4-2-3-2 Input AND-OR-INVERT Gate	33401		/B	CA	DA		2A
54F74	14	Dual D Flip-Flop	34101		/B	CA	DA		2A
54F803	14	Clock Driver with Matched Propagation Delays			/B	CA	3Q92		2A
54F86	14	Quad 2-Input Exclusive OR Gate	34501		/B	CA	DA		2A

HCMOS (High Speed CMOS Logic)

Table 24. CMOS Logic

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
54HC00	14	Quad 2-Input NAND Gate		8403701	/B	CA			2A
54HC02	14	Quad 2-Input NOR Gate		8404101	/B	CA			2A
54HC03	14	Quad 2-Input NAND, Open Drains		5962-8764701	/B	CA			2A
54HC04	14	Hex Inverter		8409801	/B	CA			2A
54HCU04	14	Hex Unbuffered Inverter		8601001	/B	CA			2A
54HCT04	14	Hex Unbuffered Inverter, with TTL Inputs		5962-8974701	/B	CA			2A
54HC08	14	Quad 2-Input AND Gate		8404701	/B	CA			2A
54HC10	14	Triple 3-Input NAND Gate		8403801	/B	CA			2A
54HC109	16	Dual JK Flip-Flop with Set/Reset, Positive Edge Triggered		8415001	/B	EA			2A
54HC11	14	Triple 3-Input AND Gate		8404801	/B	CA			2A

Table 24. CMOS Logic (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
54HC112	16	Dual JK Flip-Flop with Set/Reset, Negative Edge Triggered		8408801	/B	EA			2A
54HC113	14	Dual JK Flip-Flop with Set, Negative Edge Triggered		5962-8969501	/B	CA			2A
54HC132	14	Quad 2-Input Schmitt-Trigger NAND			/B	CA			2A
54HC138	16	1-of-8 Decoder/Demultiplexer		8406201	/B	EA			2A
54HC139	16	Dual 1-of-4 Decoder (Active Low Out)		8409201	/B	EA			2A
54HC14	14	Hex Schmitt-Trigger Inverter		8409101	/B	CA			2A
54HC151	16	8-Channel Digital Multiplexer		8412801	/B	EA			2A
54HC153	16	Dual 4-Channel Digital Multiplexer		8409301	/B	EA			2A
54HC157	16	Quad 2-Input Data Selector/Multiplexer		5962-8606101	/B	EA			2A
54HC158	16	Quad 2-Input Data Selector/Multiplexer, Inverted	66204	5962-8682301	/B	EA			2A
54HC161	16	Programmable 4-Bit Binary Counter, Asynchronous Clear		8407501	/B	EA			2A
54HC163	16	Programmable 4-Bit Binary Counter, Synchronous Clear		8607601	/B	EA			2A
54HC164	14	8-Bit Serial-In/Parallel-Out Shift Register	66501	8416201	/B	CA			2A
54HC165	16	8-Bit Serial-In or Parallel-In/Serial-Out Shift Register	66502	8409501	/B	EA			2A
54HC174	16	Hex D Flip-Flop with Common Clock and Reset		8407301	/B	EA			2A
54HC175	16	Quad D Flip-Flop		8408901	/B	EA			2A
54HC20	14	Dual 4-Input NAND Gate		8403901	/B	CA			2A
54HC240	20	Octal Buffer/Line Driver/Line Receiver, 3-State Inverting Output		8407401	/B	RA			2A
54HCT240	20	Octal Buffer/Line Driver/Line Receiver, 3-State Inverting Output, TTL Compatible Inputs		8550501	/B	RA			2A
54HCT241	20	Octal 3-State Non-Inverting Buffer/Line Driver/Line Receiver, w/LSTTL Compatible Inputs			/B	RA			2A
54HC244	20	Octal Buffer/Line Driver/Line Receiver, 3-State	65705	8409601	/B	RA			2A
54HCT244	20	Octal Buffer/Line Driver/Line Receiver, TTL inputs, 3-State		8513001	/B	RA			2A
54HCT245	20	Octal 3-State Non-inverting Bus Transceiver, TTL Compatible Inputs		8550601	/B	3Q92			3Q92
54HC251	16	8-Input Data Selector/Multiplexer, 3-State Outputs		8512501	/B	EA			2A
54HC257	16	Quad 2-Input Data Selector/Multiplexer, 3-State		8512401	/B	EA			2A
54HC27	14	Triple 3-Input NOR Gate		8404201	/B	CA			2A
54HC273	20	Octal D-type Flip-Flop with Common Clock/Reset		8409901	/B	RA			2A

Table 24. CMOS Logic (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
54HC30	14	8-Input NAND Gate		8404001	/B	CA			2A
54HC32	14	Quad 2-Input OR Gate		8404501	/B	CA			2A
54HC373	20	Octal D Transparent Latch		8407201	/B	RA			2A
54HCT373	20	Octal D Transparent Latch, 3-State, TTL Compatible Inputs		8686701	/B	RA			2A
54HC374	20	Octal D Flip-Flop, 3-State		8407101	/B	RA			2A
54HCT374	20	Octal D Flip-Flop, 3-State, TTL Compatible Inputs		8550701	/B	RA			2A
54HC390	16	Dual Decade Counter		8600901	/B	EA			2A
54HC393	14	Dual 4-Bit Binary Counter		8410001	/B	CA			2A
54HC4020	16	14-Stage Binary Ripple Counter		8500301	/B	EA			2A
54HC4024	14	7-Stage Binary Ripple Counter		8601201	/B	CA			2A
54HC4040	16	12-Stage Binary Ripple Counter		8500401	/B	EA			2A
54HC4060	16	14-Stage Binary Ripple Counter with Oscillator			/B	EA			2A
54HC4075	14	Triple 3-Input OR Gate		5962-8772201	/B	CA			2A
54HC4078	14	8-Input NOR/OR Gate		5962-8857401	/B	CA			2A
54HC42	16	BCD to 1-of-10 Decoder		5962-8682101	/B	EA			2A
54HC4538	16	Dual Precision Retriggerable/Resettable Monostable Multivibrator		5962-8688601	/B	EA			2A
54HC4543	16	BCD-to-7 Segment Latch/Decoder/Driver for Liquid Crystal Display			/B	EA			2A
54HC595	16	8-Bit Serial-to-Parallel Shift Register, 3-State		5962-8681601	/B	EA			2A
54HC73	14	Dual JK Flip-Flop with Reset		5962-8515301		CA			
					/B	CA			
54HC74	14	Dual D Flip-Flop with Set/Reset Positive Edge Triggered		8405601	/B	CA			2A
54HC85	16	4-Bit Magnitude Comparator		8601301	/B	EA			2A
54HC86	14	Quad 2-Input EX-OR Gate		8404601	/B	CA			2A

LS (Low Power Schottky)

Table 25. Bipolar Logic

JM38510, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
54LS00	14	Quad 2-Input NAND Gate	30001		/B	CA	DA		2A
54LS02	14	Quad 2-Input NOR Gate	30301			CA	DA		2A
					/B	CA			2A
54LS03	14	Quad 2-Input NAND Gate, Open-Collector	30002		/B	CA			
54LS04	14	Hex Inverter	30003		/B	CA	DA		2A

Table 25. Bipolar Logic **(continued)**

JM38510, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
54LS05	14	Hex Inverter, Open-Collector	30004		/B	CA			2A
54LS08	14	Quad 2-Input AND Gate	31004		/B	CA	DA		2A
54LS09	14	Quad 2-Input AND Gate, Open-Collector	31005			CA	DA		
				8001901	/B	CA			
54LS10	14	Triple 3-Input NAND Gate	30005			CA	DA		2A
					/B	CA			2A
54LS107A	14	Dual JK Flip-Flop with Clear	30108		/B	CA			
54LS109A	16	Dual JK Flip-Flop with Preset	30109		/B	EA	FA		
54LS11	14	Triple 3-Input Positive AND Gate	31001			CA	DA		
					/B	CA			
54LS112A	16	Dual JK Edge-Triggered Flip-Flop	30103			EA	FA		2A
					/B	EA			2A
54LS113A	14	Dual JK Edge-Triggered Flip-Flop	30104			CA	DA		
					/B	CA			
54LS114A	14	Dual JK Edge-Triggered Flip-Flop	30105			CA			
54LS12	14	Triple 3-Input NAND Gate, Open-Collector	30006			CA	DA		
54LS122	14	Retriggerable Monostable Multivibrator	31403			CA	DA		
				7600301	/B	CA			
54LS123	16	Dual Retriggerable Monostable Multivibrator	31401	7603901	/B	EA	FA		2A
54LS125A	14	Quad Buffer, Low Enable, 3-State	32301			CA	DA		2A
					/B	CA			2A
54LS126A	14	Quad Buffer, High Enable, 3-State	32302		/B	CA			
54LS13	14	Dual 4-Input Schmitt Trigger	31301			CA			
54LS132	14	Quad 2-Input Schmitt Trigger	31303			CA	DA		
				7600401	/B	CA			
54LS133	16	13-Input NAND Gate			/B	EA			
54LS138	16	1-of-8 Decoder/Multiplexer	30701	7600501	/B	EA	FA		2A
54LS139	16	Dual 1-of-4 Decoder/Multiplexer	30702	7600701	/B	EA	FA		2A
54LS14	14	Hex Schmitt Trigger	31302			CA	DA		2A
					/B	CA			2A
54LS15	14	Triple 3-Input AND Gate	31002			CA			
54LS151	16	8-Input Multiplexer	30901	7601001		EA	FA		2A
					/B	EA	FA		2A
54LS153	16	Dual Input Multiplexer	30902			EA	FA		2A
				7601101	/B	EA			
54LS155	16	Dual 1-to-4 Decoder	32601		/B	EA			
54LS156	16	Dual 1-to-4 Decoder, Open Collector			/B	EA			
54LS157	16	Quad 2-Input Multiplexer, Non-Inverting	30903	7600201	/B	EA	FA		2A
54LS158	16	Quad 2-Input Multiplexer, Inverting	30904	7603301	/B	EA			

Table 25. Bipolar Logic **(continued)**

JM38510, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
54LS160A	16	BCD Decade Counter, Asynchronous Reset	31503	7700901	/B	EA			
54LS161A	16	4-Bit Binary Counter, Asynchronous Reset	31504		/B	EA	FA		2A
				7600801		EA	FA		
54LS162A	16	BCD Decade Counter, Synchronous Reset	31511			EA			
54LS163A	16	4-Bit Binary Counter, Synchronous Reset	31512			EA	FA		
				7603401	/B	EA	FA		2A
54LS164	14	8-Bit Serial-In/Parallel-Out Shift Register	30605			CA	DA		2A
					/B	CA			2A
54LS165	16	8-Bit Parallel-In/Serial-Out Shift Register	30608			EA	FA		2A
					/B	EA			2A
				7700601		EA	FA		
54LS166	16	8-Bit Parallel-In/Serial-Out Shift Register	30609	8001701	/B	EA	FA		
54LS169	16	Up/Down Binary Counter			/B	EA			
54LS173	16	4-Bit D Register, 3-State			/B	EA			
54LS174	16	Hex D Flip-Flop with Clear	30106			EA	FA		
					/B	EA	FA		2A
54LS175	16	Quad D Flip-Flop with Clear	30107		/B	EA	FA		2A
54LS181	24	4-Bit ALU	30801		/B	JA	KA		N/A
54LS190	16	Up/Down Decade Counter	31513			EA			
54LS191	16	Up/Down Binary Counter	31509			EA	FA		2A
				7600901	/B	EA			
54LS192	16	Up/Down Decade Counter with Clear	31507	7603601	/B	EA			
54LS193	16	Up/Down Binary Counter with Clear	31508			EA	FA		
				7600601					2A
					/B	EA			
54LS194A	16	4-Bit Right/Left Shift Register	30601		/B	EA	FA		
54LS195A	16	4-Bit Shift Register (9300 Type)	30602			EA	FA		
					/B	EA			2A
54LS20	14	Dual 4-Input NAND Gate	30007			CA	DA		
					/B	CA			2A
54LS21	14	Dual 4-Input AND Gate	31003			CA	DA		
					/B	CA			
54LS221	16	Dual One-Shot (Very Stable)	31402			EA	FA		
				7604201	/B	EA			
54LS22	14	Dual 4-Input NAND Gate	30008			CA			
54LS240	20	Octal Bus/Line Driver, Inverting 3-State	32401			RA	SA		2A
				7801201	/B	RA			2A
54LS241	20	Octal Bus/Line Driver, 3-State	32402		/B	RA			
54LS242	14	Quad Bus Transceiver, Inverting, 3-State	32801	8002001		CA			

Table 25. Bipolar Logic (continued)

JM38510, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
54LS243	14	Quad Bus Transceiver, Non-Inverting, 3-State	32802		/B	CA	DA		
				8002002					2A
54LS244	20	Octal Driver, Non-Inverting, 3-State	32403	7705701	/B	RA	SA		2A
54LS245	20	Octal Bus Transceiver, Non-Inverting, 3-State	32803	8002101	/B	RA	SA		2A
54LS251	16	8-Input Multiplexer, 3-State	30905			EA	FA		
					/B	EA			
54LS253	16	Dual 4-Input Multiplexer, 3-State	30908			EA	FA		
				7601701		EA			
					/B	EA			2A
54LS257A	16	Quad 2-Input Multiplexer, Non-Inverting	30906			EA	FA		2A
				7603701		EA			
					/B	EA			2A
54LS258A	16	Quad 2-Input Multiplexer, Inverting, 3-State	30907	7603801	/B	EA			
54LS259	16	8-Bit Addressable Latch (9334)	31603			EA	FA		
					/B	EA			2A
54LS26	14	Quad 2-Input NAND, High Voltage	32102		/B	CA			
54LS266	14	Quad Exclusive NOR Gate, Open-Collector	30303		/B	CA			
54LS27	14	Triple 3-Input NOR Gate	30302			CA	DA		
					/B	CA			
54LS273	20	Octal D Flip-Flop with Clear	32501			RA	SA		
				7801001	/B	RA	SA		2A
54LS279	16	Quad Set/Reset Latch	31602			EA	FA		
				7601801	/B	EA			2A
54LS28	14	Quad 2-Input NOR Buffer	30204			CA			
54LS280	14	9-Bit Odd/Even Parity Generator/Checker	32901			CA	DA		
					/B	CA	DA		2A
54LS283	16	4-Bit Full Adder (Rotated LS83A)	31202			EA			
				7604301	/B	EA			2A
54LS298	16	Quad 2-Multiplexer, with Output Register	30909	7601901		EA	FA		
					/B	EA			
54LS30	14	8-Input NAND Gate	30009			CA	DA		
					/B	CA			
54LS32	14	Quad 2-Input OR Gate	30501		/B	CA	DA		2A
54LS365A	16	Hex Buffer, Common Enable, 3-State	32201		/B	EA	FA		
54LS366A	16	Hex Inverter, Common Enable, 3-State	32202			EA			
54LS367A	16	Hex Buffer, 4-Bit and 2-Bit, 3-State	32203			EA	FA		
					/B	EA	FA		2A
54LS368A	16	Hex Inverter, 4-Bit and 2-Bit, 3-State	32204			EA	FA		2A

Table 25. Bipolar Logic (continued)

JM38510, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
					/B	EA			
54LS37	14	Quad 2-Input NAND Buffer	30202		/B	CA	DA		
54LS373	20	Octal Transparent Latch, 3-State	32502		/B	RA	SA		2A
54LS374	20	Octal D Flip-Flop	32503	7801101	/B	RA	SA		2A
54LS375	16	Quad Latch	31604		/B	EA	FA		2A
54LS377	20	Octal D Flip-Flop with Enable	32504			RA	SA		
					/B	RA			2A
54LS38	14	Dual 4-Input NAND Buffer	30203			CA	DA		2A
					/B	CA			
54LS390	16	Dual Decade Counter	32701			EA	FA		2A
				7802601	/B	EA			
54LS393	14	Dual 4-Bit Binary Counter	32702			CA	DA		2A
					/B	CA			
54LS399	16	Quad 2-Input Multiplexer with Output Register			/B	EA			
54LS40	14	Dual 4-Input NAND Buffer	30201			CA	DA		
54LS42A	16	1-of-10 Decoder	30703			EA	FA		
				7603101	/B	EA			
54LS47	16	BCD to 7-Segment Decoder/Driver	30704	7604501	/B	EA			
54LS51	14	Dual AND-OR-INVERT Gate	30401			CA	DA		
					/B	CA			2A
54LS569	20	$-Bit Up/Down Counter, 3-State			/B	RA			
54LS645	20	Octal Bus Transceiver, Non-Inverting, 3-State			/B	RA			2A
54LS670	16	4 x 4 Register File, 3-State	31901	7704201	/B	EA			2A
54LS716	16	Programmable Modulo-N Counter			/B	EA			
54LS718	16	Programmable Modulo-N Counter			/B	EA			
54LS719	16	Programmable Modulo-N Counter			/B	EA			
54LS73A	14	Dual JK Flip-Flop	30101			CA	DA		
					/B	CA			
54LS74A	14	Dual D Flip-Flop	30102		/B	CA	DA		2A
54LS75	16	4-Bit Bi-Stable Latch with Q and $\overline{Q}$	31601	7601201	/B	EA	FA		
54LS76A	16	Dual JK Flip-Flop	30110			EA	FA		
54LS85	16	4-Bit Magnitude Comparator	31101			EA	FA		
					/B	EA			2A
54LS86	14	Quad Exclusive OR Gate	30502			CA	DA		2A
					/B	CA			
54LS95B	14	4-Bit Shift Register			/B	CA			

Metal Gate CMOS

Table 26. CMOS Logic

JM385610/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
14001A	14	Quad 2-Input NOR Gate			/B	CA			
14001B	14	Quad 2-Input NOR Gate			/B	CA			
14002A	14	Dual 4-Input NOR Gate			/B	CA			
14007A	14	Dual Complementary Pair plus Inverter			/B	CA			
14011A	14	Quad 2-Input NAND Gate			/B	CA			
14011B	14	Quad 2-Input NAND Gate			/B	CA			
14012B	14	Dual 4-Input NAND Gate			/B	CA			
14013B	14	Dual D Flip-Flop			/B	CA			
14014B	16	8-Bit Static Shift Register			/B	EA			
14015B	16	Dual 4-Bit Static Shift Register			/B	EA			
14016B	14	Quad Analog Switch/Quad Multiplexer			/B	CA			
14017B	16	Decade Counter/Divider			/B	EA			
14018B	16	Presettable Divide-by-N Counter			/B	EA			
14020B	16	14-Bit Binary Counter			/B	EA			
14021B	16	8-Bit Static Shift Register			/B	EA			
14023A	14	Triple 3-Input NAND Gate			/B	CA			
14023B	14	Triple 3-Input NAND Gate			/B	CA			
14024B	14	7-Stage Ripple Counter			/B	CA			
14025A	14	Triple 3-Input NOR Gate			/B	CA			
14025B	14	Triple 3-Input NOR Gate			/B	CA			
14027B	16	Dual JK Flip-Flop			/B	EA			
14028B	16	BCD-to-Decimal Decoder			/B	EA			
14029B	16	4-Bit Presettable Up/Down Counter			/B	EA			
14040B	16	12-Bit Binary Counter			/B	EA			
14042B	16	Quad Latch			/B	EA			
14043B	16	Quad NOR R-S Latch			/B	EA			
14044B	16	Quad NOR R-S Latch			/B	EA			
14046B	16	Phased-Locked Loop			/B	EA			
14049A	16	Hex Inverter/Buffer			/B	EA			
14050B	16	Hex Buffer			/B	EA			
14051B	16	8-Channel Analog Multiplexer			/B	EA			
14052B	16	Analog Multiplexer, Dual 4-Channel			/B	EA			
14053B	16	Triple 2-Channel Analog Multiplexer			/B	EA			
14066B	14	Quad Analog Switch			/B	CA			
14069A	14	Hex Inverter			/B	CA			
14070B	14	Quad Exclusive OR Gate			/B	CA			
14071B	14	Quad 2-Input OR Gate			/B	CA			

Table 26. CMOS Logic **(continued)**

JM385610/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
14072B	14	Dual 4-Input OR Gate		7706001	/B	CA			
14073B	14	Triple 3-Input AND Gate		7705101	/B	CA			
14075B	14	Triple 3-Input OR Gate			/B	CA			
14076B	16	Quad D Register			/B	EA			
14081B	14	Quad 2-Input AND Gate		7702401	/B	CA			
14082B	14	Dual 4-Input AND Gate		7705901	/B	CA			
14093B	14	Quad 2-Input NAND Schmitt Trigger			/B	CA			
14094B	16	8-Bit Bus Compatible Shift/Store/Latch			/B	EA			
14099B	16	8-Bit Addressable Latch			/B	EA			
14161B	16	Binary Counter, Asynchronous Clear			/B	EA			
14174B	16	Hex D Flip-Flop			/B	EA			
14175B	16	Quad D Flip-Flop			/B	EA			
14490A	16	Hex Contact Bounce Eliminator		5962-8764601	/B	EA			
14502B	16	Strobed Hex Inverter/Buffer		7702001	/B	EA			
14503B	16	Hex 3-State Buffer			/B	EA			
14504B	16	Triple TTL or CMOS-to-CMOS Level Shifter			/B	EA			
14511B	16	BCD-to-7 Segment Latch/Decoder/Driver			/B	EA			
14512B	16	8-Channel Data Selector			/B	EA			
14517B	16	Dual 64-Bit Static Shift Register			/B	EA			
14518B	16	Dual BCD Up Counter			/B	EA			
14519B	16	4-Bit AND/OR Selector			/B	EA			
14520B	16	Dual Binary Up Counter			/B	EA			
14532B	16	8-Bit Priority Encoder			/B	EA			
14536B	16	Programmable Timer			/B	EA			
14538B	16	Dual Precision Monostable Multivibrator			/B	EA			
14539B	16	Dual 4-Channel Data Selector/Multiplexer			/B	EA			
14541B	14	Programmable Oscillator-Timer			/B	CA			
14555B	16	Dual Binary to 1-to-4 Decoder			/B	EA			
14557B	16	1-to-64 Bit Variable Length Shift Register		7901601	/B	EA			
14572A	16	Hex Gate			/B	EA			
14584B	14	Hex Schmitt Trigger		5962-8550102	/B	CA			
14585B	16	4-Bit Magnitude Comparator			/B	EA			

Logic Products (continued)

TTL (Transistor To Transistor) Logic

Table 27. Bipolar Logic

JM385610/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
4324	14	Dual Voltage-Controlled Multivibrator				CA	DA		
4344	14	Phase-Frequency Detector		5962-8780301		CA	DA		

Memories

Table 28. Bipolar Memories

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
10539	16	32 x 8-Bit ECL PROM, 17 ns			/B	EA	FA		
10545	16	64-Bit ECL Register File, RAM, 18 ns		5962-8856001	/B	EA	FA		
10549	16	256 x 4-Bit ECL PROM, 30 ns			/B	EA	FA		
10552	16	256 x 1-Bit ECL RAM, 15 ns			/B	EA	FA		
93415	16	1024 x 1-Bit RAM, Open-Collector			/B	EA	FA		
93422	22	256 x 4-Bit RAM, 3-State Output, 60 ns	23110		/B	WA			
	24				/B				UA
93L422A	22	256 x 4-Bit RAM, 3-State Output, 55 ns, Low Power			/B	WA			
	24				/B				UA
93L422	22	256 x 4-Bit RAM, 3-State Output, 75 ns, Low Power	23112		/B	WA			
	24				/B				UA
93425	16	1024 x 1-Bit RAM, 3-State Output			/B	EA	FA		

Table 29. Specialty SRAMs

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
56824A-25	52	8K x 24 DSP RAM, 25 ns			/B			4Q92	
56824A-30	52	8K x 24 DSP RAM, 30 ns			/B			4Q92	
56824A-35	52	8K x 24 DSP RAM, 35 ns			/B			4Q92	
62110-15	52	32K x 9 Sync. FSRAM, 15 ns, Dual I/O			/B		2Q93		
62110-25	52	32K x 9 Sync. FSRAM, 25 ns, Dual I/O			/B		2Q93		
62110-35	52	32K x 9 Sync. FSRAM, 35 ns, Dual I/O			/B		2Q93		
62486A-15	52	32K x 9 Sync. FSRAM, 15 ns, w/Burst Counter			/B		3Q93		
62486A-25	52	32K x 9 Sync. FSRAM, 25 ns, w/Burst Counter			/B		3Q93		
62486A-35	52	32K x 9 Sync. FSRAM, 35 ns, w/Burst Counter			/B		3Q93		

Table 29. Specialty SRAMs (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
6294-30	28	16K x 4 Sync. FSRAM, 30 ns, Out Reg's			/B	XA			
	32	O/E							UA
6294-35	28	16K x 4 Sync. FSRAM, 35 ns, Out Reg's			/B	XA			
	32	O/E							UA
6294-40	28	16K x 4 Sync. FSRAM, 40 ns, Out Reg's			/B	XA			
	32	O/E							UA
62940A-15	52	32K x 9 Sync. FSRAM, 15 ns, w/Burst Counter			/B		3Q93		
62940A-25	52	32K x 9 Sync. FSRAM, 25 ns, w/Burst Counter			/B		3Q93		
62940A-35	52	32K x 9 Sync. FSRAM, 35 ns, w/Burst Counter			/B		3Q93		
62995A-15	52	32K x 9 Sync. FSRAM, 15 ns, For R3000/96000			/B		4Q93		
62995A-25	52	32K x 9 Sync. FSRAM, 25 ns, For R3000/96000			/B		4Q93		
62995A-35	52	32K x 9 Sync. FSRAM, 35 ns, For R3000/96000			/B		4Q93		
62S950A-15	32	32K x 9 Sync. FSRAM, 15 ns			/B				1Q93
62S950A-25	32	32K x 9 Sync. FSRAM, 25 ns			/B				1Q93
62S950A-35	32	32K x 9 Sync. FSRAM, 35 ns			/B				1Q93

Table 30. Bi CMOS SRAMs

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
6706-15	28	32K x 8 BiCMOS FSRAM, 15 ns, O/E, TTL I/O			/B	2Q93			
6706-20	28	32K x 8 BiCMOS FSRAM, 20 ns, O/E, TTL I/O			/B	2Q93			
6726-15	32	128K x 8 BiCMOS FSRAM, 15 ns, TTL I/O			/B	2Q93			
6726-20	32	128K x 8 BiCMOS FSRAM, 20 ns, TTL I/O			/B	2Q93			
6727-15	28	1M x 1 BiCMOS FSRAM, 15 ns, TTL I/O			/B	2Q93			
6727-20	28	1M x 1 BiCMOS FSRAM, 20 ns, TTL I/O			/B	2Q93			

Table 31. CMOS DRAMs

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
511000A8	18	1M x 1 High Speed DRAM, Fast Page Mode, 80 ns			/B	2Q93			
51L1000A8	18	1M x 1 High Speed DRAM, Fast Page Mode, 80 ns (Low Power)			/B	2Q93			
511000A8	20	1M x 1 High Speed DRAM, Fast Page Mode, 80 ns			/B				2Q93

TBD To Be Determined (Based on Customer Demands)

Table 31. CMOS DRAMs (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
51L1000A8	20	1M x 1 High Speed DRAM, Fast Page Mode, 80 ns (Low Power)			/B				2Q93
511000A9	18	1M x 1 High Speed DRAM, Fast Page Mode, 90 ns			/B	2Q93			
51L1000A9	18	1M x 1 High Speed DRAM, Fast Page Mode, 90 ns (Low Power)			/B	2Q93			
511000A9	20	1M x 1 High Speed DRAM, Fast Page Mode, 90 ns			/B				2Q93
51L1000A9	20	1M x 1 High Speed DRAM, Fast Page Mode, 90 ns (Low Power)			/B				2Q93
511000A11	18	1M x 1 High Speed DRAM, Fast Page Mode, 110 ns			/B	2Q93			
51L1000A11	18	1M x 1 High Speed DRAM, Fast Page Mode, 110 ns (Low Power)			/B	2Q93			
511000A11	20	1M x 1 High Speed DRAM, Fast Page Mode, 110 ns			/B				2Q93
51L1000A11	20	1M x 1 High Speed DRAM, Fast Page Mode, 110 ns (Low Power)			/B				2Q93
511000A12	18	1M x 1 High Speed DRAM, Fast Page Mode, 120 ns			/B	2Q93			
51L1000A12	18	1M x 1 High Speed DRAM, Fast Page Mode, 120 ns (Low Power)			/B	2Q93			
511000A12	20	1M x 1 High Speed DRAM, Fast Page Mode, 120 ns			/B				2Q93
51L1000A12	20	1M x 1 High Speed DRAM, Fast Page Mode, 120 ns (Low Power)			/B				2Q93
514256A8	20	256K x 4 DRAM, Fast Page Mode, 80 ns			/B	2Q93			2Q93
51L4256A8	20	256K x 4 DRAM, Fast Page Mode, 80 ns			/B	2Q93			2Q93
514256A9	20	256K x 4 DRAM, Fast Page Mode, 90 ns			/B	2Q93			2Q93
51L4256A9	20	256K x 4 DRAM, Fast Page Mode, 90 ns			/B	2Q93			2Q93
514256A11	20	256K x 4 DRAM, Fast Page Mode, 110 ns			/B	2Q93			2Q93
51L4256A11	20	256K x 4 DRAM, Fast Page Mode, 110 ns			/B	2Q93			2Q93
514256A12	20	256K x 4 DRAM, Fast Page Mode, 120 ns			/B	2Q93			2Q93
51L4256A12	20	256K x 4 DRAM, Fast Page Mode, 120 ns			/B	2Q93			2Q93
514400A7	20	1M x 4 DRAM, Fast Page Mode, 70 ns			MEP	2Q93			
514400A8	20	1M x 4 DRAM, Fast Page Mode, 80 ns			MEP	2Q93			
514400A9	20	1M x 4 DRAM, Fast Page Mode, 90 ns			MEP	2Q93			

TBD To Be Determined (Based on Customer Demands)

Table 32. **High Speed CMOS III Static Memories**

JM38510/, SMD#, MIL-STD-883

						Package Type and Lead Finish			
Device	Pins	Description	JM38510/	SMD#	883	DIL	FP	CAN	LCCC
6205C-15	32	32K x 9 Fast Static RAM, 15 ns, ± C/E's O/E			/B	1Q93	2Q93		
6205C-20	32	32K x 9 Fast Static RAM, 20 ns, ± C/E's O/E			/B	1Q93	2Q93		
6205C-25	32	32K x 9 Fast Static RAM, 25 ns, ± C/E O/E			/B	1Q93	2Q93		
6206C-15	28	32K x 8 Fast Static RAM, 15 ns, ± C/E O/E			/B	1Q93	1Q93		
6206C-20	28	32K x 8 Fast Static RAM, 20 ns, ± C/E's O/E			/B	1Q93	1Q93		
6206C-25	28	32K x 8 Fast Static RAM, 25 ns, ± C/E O/E			/B	1Q93	1Q93		
6206-35	28	32K x 8 Fast Static RAM, 35 ns, ± C/E O/E		5962-8866205	/B	XA			
6206-45	28	32K x 8 Fast Static RAM, 45 ns, ± C/E O/E		5962-8866204	/B	XA			
6206-55	28	32K x 8 Fast Static RAM, 55 ns, ± C/E O/E		5962-8866203	/B	XA			
6206-70	28	32K x 8 Fast Static RAM, 70 ns, ± C/E O/E		5962-8866202	/B	XA			
6206-100	28	32K x 8 Fast Static RAM, 100 ns, ± C/E O/E		5962-8866201	/B	XA			
6226A-25	32	128K x 8 Fast Static RAM, 25 ns, ± C/E's O/E			/B	3Q93	3Q93		3Q93
6226A-30	32	128K x 8 Fast Static RAM, 30 ns, ± C/E's O/E			/B	3Q93	3Q93		3Q93
6226A-35	32	128K x 8 Fast Static RAM, 35 ns, ± C/E's O/E			/B	3Q93	3Q93		3Q93
6226A-45	32	128K x 8 Fast Static RAM, 45 ns, ± C/E's O/E			/B	3Q93	3Q93		3Q93
6229A-25	28	256K x 4 Fast Static RAM, 25 ns, ± C/E's O/E			/B	3Q93			
6229A-25	32	256K x 4 Fast Static RAM, 25 ns, ± C/E's O/E			/B		TBD		TBD
6229A-30	28	256K x 4 Fast Static RAM, 30 ns, ± C/E's O/E			/B	3Q93			
6229A-30	32	256K x 4 Fast Static RAM, 30 ns, ± C/E's O/E			/B		TBD		TBD
6229A-35	28	256K x 4 Fast Static RAM, 35 ns, ± C/E's O/E			/B	3Q93			
6229A-35	32	256K x 4 Fast Static RAM, 35 ns, ± C/E's O/E			/B		TBD		TBD
6229A-45	28	256K x 4 Fast Static RAM, 45 ns, ± C/E's O/E			/B	3Q93			
6229A-45	32	256K x 4 Fast Static RAM, 45 ns, ± C/E's O/E			/B		TBD		TBD
6264C-15	28	8K x 8 Fast Static RAM, 15 ns, ± C/E's		5962-3829419	/B	1Q93			
6264C-15	32	8K x 8 Fast Static RAM, 15 ns, ± C/E's		5962-3829419	/B				1Q93
6264C-25	28	8K x 8 Fast Static RAM, 25 ns, ± C/E's		5962-3829415	/B	1Q93			
6264C-25	32	8K x 8 Fast Static RAM, 25 ns, ± C/E's		5962-3829415	/B				1Q93
6264-35	28	8K x 8 Fast Static RAM, 35 ns, ± C/E's		5962-3829413	/B	MXA			
6264-45	28	8K x 8 Fast Static RAM, 45 ns, ± C/E's		5962-3829411	/B	MXA			
6268C-15	20	4K x 4 Fast Static RAM, 15 ns, C/E			/B	1Q93	2Q93		1Q93
6268C-25	20	4K x 4 Fast Static RAM, 25 ns, C/E			/B	1Q93	2Q93		1Q93
6268-35	20	4K x 4 Fast Static RAM, 35 ns, C/E		5962-8670503		RA	YA		XA
					/B	RA	YA		UA
6268-45	20	4K x 4 Fast Static RAM, 45 ns, C/E		5962-8670505		RA	YA		XA
					/B	RA	YA		UA
6268-55	20	4K x 4 Fast Static RAM, 55 ns, C/E		5962-8670507		RA	YA		XA
					/B	RA	YA		UA
6268-70	20	4K x 4 Fast Static RAM, 70 ns, C/E		5962-8670509		RA	YA		XA

TBD To Be Determined (Based on Customer Demands)

Table 32. **High Speed CMOS III Static Memories (continued)**

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
					/B	RA	YA		UA
6287-35	22	64K x 1 Fast Static RAM, 35 ns, C/E		5962-8601501		XA			ZA
					/B	XA			UA
6287-45	22	64K x 1 Fast Static RAM, 45 ns, C/E		5962-8601503		XA			ZA
					/B	XA			UA
62L87-35	22	64K x 1 Fast Static RAM, 35 ns, C/E L/Pwr		5962-8601501		XA			ZA
					/B	XA			UA
62L87-45	22	64K x 1 Fast Static RAM, 45 ns, C/E L/Pwr		5962-8601504		XA			ZA
					/B	XA			UA
6288C-15	22	16K x 4 Fast Static RAM, 15 ns, C/E			/B	1Q93			1Q93
6288C-20	22	16K x 4 Fast Static RAM, 20 ns, C/E			/B	1Q93			1Q93
6288C-25	22	16K x 4 Fast Static RAM, 25 ns, C/E			/B	1Q93			1Q93
6288-35	22	16K x 4 Fast Static RAM, 35 ns, C/E		5962-8685924		TA			ZA
					/B	XA			UA
6288-45	22	16K x 4 Fast Static RAM, 45 ns, C/E		5962-8685922		TA			ZA
					/B	XA			UA

TBD To Be Determined (Based on Customer Demands)

8-, 16- and 32-Bit Microprocessors & Microcontrollers

Table 33. **8-Bit Microprocessors**

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
6800	40	8-Bit Microprocessor			/B	QA			
6802	40	8-Bit Microprocessor with Clock and Optional RAM			/B	QA			
6809	40	8-Bit Microprocessor with Clock			/B	QA			
68A09	40	1.5 MHz 8-Bit Microprocessor with Clock			/B	QA			
68B09	40	2.0 MHz 8-Bit Microprocessor with Clock			/B	QA			
6821	40	8-Bit Peripheral Interface Adapter			/B	QA			
68A21	40	1.5 MHz 8-Bit Peripheral Interface Adapter			/B	QA			
68B21	40	2.0 MHz 8-Bit Peripheral Interface Adapter			/B	QA			
6840	28	Programmable Timer Module			/B	XA			
6845	40	CRT Controller			/B	QA			
68488	40	GPIA Support Module			/B	QA			

Military products are not necessarily pin-for-pin compatible with their commercial product counterparts. If there are any questions as to the compatibility please contact Product Marketing (602) 897-3782 for detailed information.

Table 33. 8-Bit Microprocessors (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
68A488	40	1.5 MHz GPIA Support Module			/B	QA			
68B488	40	2.0 MHz GPIA Support Module			/B	QA			
6850	24	Asynchronous Communications Interface Adapter			/B	JA			
68A50	24	1.5 MHz Asynchronous Communications Interface Adapter			/B	JA			
68B50	24	2.0 MHz Asynchronous Communications Interface Adapter			/B	JA			
6852	24	Synchronous Serial Data Adapter			/B	JA			
6854	28	Advanced Data-Link Controller			/B	XA			
6875A	16	6800 Clock Generator/Driver			/B	EA			

Military products are not necessarily pin-for-pin compatible with their commercial product counterparts. If there are any questions as to the compatibility please contact Product Marketing (602) 897-3782 for detailed information.

Table 34. 16- and 32-Bit Microprocessors

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
68000-8*	64	16-Bit external/32-Bit internal		8202102		YA			
	68			8202102			TA		UC
	64				/B	XA			
	68				/B		ZA		YC
68000-10*	64	16-Bit external/32-Bit internal		8202103		YA			
	68			8202103			TA		UC
	64				/B	XA			
	68				/B		ZA		YC
68020-16	114	32-Bit external and internal		5962-8603202			XA		
	132	32-Bit external and internal		5962-8603202	/B				YC
	114				/B		ZA		
68020-20	114	32-Bit external and internal		5962-8603203			XA		
	132	32-Bit external and internal		5962-8603203	/B				YC
	114				/B		ZA		
68020-25	114	32-Bit external and internal		5962-86032			***		
	132	32-Bit external and internal		5962-86032	/B				***
	114				/B		ZA		YC
68030-16	128	32-Bit external and internal w/built-in PMMU		5962-8946401			XA		
	132	32-Bit external and internal w/built-in PMMU		5962-8946401	/B				YC**

Military products are not necessarily pin-for-pin compatible with their commercial product counterparts. If there are any questions as to the compatibility please contact Product Marketing (602) 897-3782 for detailed information.
/1 Parts are shipped in Non-Conductive Ring (Non-Lead Formed).
* [T_C = – 55° to +110°C]
** This device includes thermal pad(s).
***SMD submitted to DESC

Table 34. 16- and 32-Bit Microprocessors (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
	128				/B		ZA		
68030-20	128	32-Bit external and internal w/built-in PMMU		5962-8946402			XA		
	132	32-Bit external and internal w/built-in PMMU		5962-8946402	/B				YC**
	128				/B		ZA		
68030-25	128	32-Bit external and internal w/built-in PMMU		5962-8946403			XA		
	132	32-Bit external and internal w/built-in PMMU		5962-8946403	/B				YC**
	128				/B		ZA		
68030-33	128	32-Bit external and internal w/built-in PMMU		5962-8946404			XA		
	132	32-Bit external and internal w/built-in PMMU		5962-8946404	/B				YC**
	128				/B		ZA		
68040-25	179	32-Bit external and internal w/built-in PMMU and FPU		TBD	/B		2Q93		
68040-25	196	32-Bit external and internal w/built-in PMMU and FPU		TBD	/B				2Q93 /1
68150	68	32-Bit to 32/18/8 Bit Dynamic Read/Write Bus Sizer		Planned	/B				2Q93
68882-16	68	Enhanced 16 MHz 32-Bit Floating Point		5962-89463			***		***
		Coprocessor			/B		ZA		YC
68882-20	68	Enhanced 20 MHz 32-Bit Floating Point		5962-89463			***		***
		Coprocessor			/B		ZA		YC
68882-25	68	Enhanced 25 MHz 32-Bit Floating Point		5962-89463			***		***
		Coprocessor			/B		ZA		YC
68882-33	68	Enhanced 33 MHz 32-Bit Floating Point		5962-89463			***		***
		Coprocessor			/B		ZA		YC
68HC000-8	64	16-Bit external/32-Bit internal HCMOS MPU		5962-89462		***			
	68	16-Bit external/32-Bit internal HCMOS MPU		5962-89462			***		***
	64				/B	XA			
	68				/B		ZA		YC
68HC000-10	64	16-Bit external/32-Bit internal HCMOS MPU		5962-89462		***			
	68	16-Bit external/32-Bit internal HCMOS MPU		5962-89462			***		***
	64				/B	XA			
	68				/B		ZA		YC
68HC000-12	64	16-Bit external/32-Bit internal HCMOS MPU		5962-89462		***			
	68	16-Bit external/32-Bit internal HCMOS MPU		5962-89462			***		***
	64				/B	XA			

Military products are not necessarily pin-for-pin compatible with their commercial product counterparts. If there are any questions as to the compatibility please contact Product Marketing (602) 897-3782 for detailed information.
/1 Parts are shipped in Non-Conductive Ring (Non-Lead Formed).
* [T_C = – 55° to +110°C]
** This device includes thermal pad(s).
***SMD submitted to DESC

Table 34. 16- and 32-Bit Microprocessors (continued)

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
	68				/B		ZA		YC
68HC001-8	68	Configurable 16-Bit or 8-Bit MPU		TBD	/B		ZA		***

Military products are not necessarily pin-for-pin compatible with their commercial product counterparts. If there are any questions as to the compatibility please contact Product Marketing (602) 897-3782 for detailed information.
/1 Parts are shipped in Non-Conductive Ring (Non-Lead Formed).
* [T_C = – 55° to +110°C]
** This device includes thermal pad(s).
***SMD submitted to DESC

Table 35. Single Chip Microcontrollers

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
68HC11A0	48	8-Bit Microcontroller with 256 Bytes RAM		5962-9051001		XA			
	52	8-Bit Microcontroller with 256 Bytes RAM		5962-9051001	/B				YC
68HC11A1	48	8-Bit Microcontroller, 256 Bytes RAM & 512 Bytes EEPROM		5962-9051002	/B	XA			
	52	8-Bit Microcontroller, 256 Bytes RAM &		5962-9051002					YC
		512 Bytes EEPROM			/B				YC
68HC16Z1	132	16-Bit MCU, with Analog to Digital Converter		Planned	/B		3Q93		
68HC711K4	84	8-Bit Microcontroller with 24K EPROM		Planned	/B		4Q93		
68HC811E2	48	8-Bit Microcontroller with 2K EEPROM		5962-8952701	/B	XA			
	52	8-Bit Microcontroller with 2K EEPROM		5962-8952701	/B				YC
68332	132	32-Bit Microcontroller		5962-91501			ZA		1Q93
68340	144	32-Bit MCU with DMA		Planned	/B		1Q93		
68F333	160	Flash EEPROM		Planned	/B		4Q93		4Q93

Military products are not necessarily pin-for-pin compatible with their commercial product counterparts. If there are any questions as to the compatibility please contact Product Marketing (602) 897-3782 for detailed information.

Data Communications

Table 36. Data Communications

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
68302	132	Integrated Multi-Protocol Processor		Planned	/B		ZA		

Digital Signal Processing (DSP)

Table 37. DSP

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
56001-20	88	56-Bit Digital Signal Processor		5962-8951201			XA		YC
	100	56-Bit Digital Signal Processor			/B		ZA		YC
56002-20	132	56-Bit General Purpose Digital Signal Processor			/B		2Q93		4Q93
96002-33	223	96-Bit Floating Point Digital Signal Processor		Planned			4Q92		TBD
	223	96-Bit Floating Point Digital Signal Processor			/B		4Q92		TBD

Reduced Instruction Set Computer (RISC)

Table 38. RISC

JM38510/, SMD#, MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
88100-20	180	32-Bit RISC		Planned	/B		ZA		
	200	32-Bit RISC		Planned	/B				2Q93 /1
88100-33	180	32-Bit RISC		Planned			4Q92		
	200	32-Bit RISC		Planned					3Q93 /1
88110	180	Second Generation RISC		Planned			TBD		TBD
88200-20	180	16K Cache/Memory Management Unit		Planned			ZA		
	200	16K Cache/Memory Management Unit		Planned					2Q93 /1
88200-33	180	16K Cache/Memory Management Unit		Planned			4Q92		
	200	16K Cache/Memory Management Unit		Planned					3Q93 /1

/1 Parts are shipped in Non-Conductive Ring (Non-Lead Formed).

Application Specific Integrated Circuit (ASIC)

Table 39. ASIC

MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish DIL	FP	CAN	LCCC
H4C018	136	18K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
H4C027	160	27K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	

/1 Parts are shipped in Non-Conductive Ring (Non-Lead Formed).

Table 39. ASIC (continued)

MIL-STD-883

Device	Pins	Description	JM38510/	SMD#	883	Package Type and Lead Finish			
						DIL	FP	CAN	LCCC
H4C035	176	35K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
H4C057	216	57K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
H4C086	256	86K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
H4C123	304	123K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
H4C161	344	161K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
H4C195	376	195K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
H4C267	436	256K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
H4C318	464	318K Gate Array in H4C Technology also available as CDA™			/B		ZA	YC /1	
68902A	68	USART CMOS version of 68901			/B		ZA	YC /1	

/1 Parts are shipped in Non-Conductive Ring (Non-Lead Formed).

Military Semiconductor Discrete Products

In brief, Motorola serves today's discrete military semiconductor market with the industry's broadest range of JAN, JANTX< JANTXV and JANS products. We are qualified suppliers of current 2N–QPLMil specifications, . . . and the inventory's expanding rapidly as additional qualifications are being actively pursued.

But the actual requirements for today's high technology military and space applications often go beyond the MIL-S-19500 qualified components. Normally, these additional needs are met with devices manufactured to each customer's unique specifications, resulting in low-volume production, high initial cost and long delivery time.

To reduce these detriments, Motorola now offers a supplementary line of popular packaged and unpackaged components (chips) for which no military specifications exist, but which have been processed to rigid MIL-S-19500 and MIL-STD-750 specifications, just as if they were built for JAN registration. Since no military slash sheets exist for these components, the electrical parameters are those applied to equivalent commercial products, but delta calculations and Group B and C test limits are selected to the same criteria as for MIL-5-19500 specifications.

Compared with custom equivalents, these components should result in significant savings in both cost and delivery time. Moreover, the life span of such devices will be considerably longer than that of custom-built "specials", so that cost effective replacements will be available for the foreseeable future.

This Selector Guide provides an overview of existing discrete products available off-the-shelf for the Hi-Rel market. Additional high reliability selections from Motorola's large repertoire of discrete products may be obtained on special order by contacting a sales representative at any Motorola sales office.

Page

Product Listing

MIL-Qualified Products

The following table lists Motorola-supplied devices which appear on the QPL-19500 list as JAN, JANTX, JANTXV and JANS qualified products. (Although Motorola will continue to supply components to JAN specifications where desired, this classification has been declared "inactive for new designs," per MIL-S-19500. The higher level JANTX classification is a recommended replacement.). As the detail specifications are being revised, JAN level is being removed. Consult your local sales office for specific JAN availability.

Table 40. Transistors

Type Number	Detailed Spec	Specification Levels			
		JAN	JTX	JTXV	JANS
Small Signal					
2N708	/312		X		
2N869A	/283		X		
2N918	/301	X	X	X	
2N930	/253	X	X		
2N2060	/270		X		X
2N2219A	/251	X	X	X	X
2N2222	/255	X	X		
2N2222A	/255	X	X	X	X
2N2369A	/317	X	X	X	X
2N2484	/376	X	X	X	X
2N2605	/354		X		X
2N2609	/296	X			
2N2904	/290		X		
2N2905A	/290	X	X	X	X
2N2906A	/291		X		
2N2907	/291	X	X		
2N2907A	/291	X	X	X	X
2N2920	/355	X	X	X	X
2N3013	/287		X		
2N3019S	/391	X	X	X	X
2N3227	/317		X		
2N3251A	/323	X	X		
2N3439	/368	X	X	X	
2N3440	/368		X	X	
2N3467	/348		X	X	
2N3486A	/392		X		
2N3501	/366	X	X	X	X
2N3506	/349		X	X	
2N3507	/349		X	X	
2N3584	/384	X	X	X	
2N3585	/384	X	X	X	

Table 40. Transistors (continued)

Type Number	Detailed Spec	Specification Levels JAN	JTX	JTXV	JANS
Small Signal					
2N3634 through	/357		X	X	
2N3636	/357		X	X	X
2N3700	/391	X	X	X	X
Power					
2N3715	/408		X		
2N3716	/408	X	X	X	
Small Signal					
2N3735	/395		X		
2N3737	/395		X		
Power					
2N3739	/402		X		
2N3740	/441	X	X	X	
2N3741	/441	X	X	X	
Small-Signal					
2N3743	/397		X	X	
2N3764	/396		X	X	X
Power					
2N3766	/518		X		
2N3767	/518	X	X	X	
2N3771	/413	X	X	X	
2N3772	/413	X	X	X	
2N3792	/379	X	X	X	
Small-Signal					
2N3810	/336	X	X		
2N3811	/336		X	X	X
2N3821	/375		X		X
Power					
2N3867S	/350		X		
2N3868S	/350	X	X	X	
2N3879	/526	X	X	X	
Small-Signal					
2N4033	/512	X	X	X	
2N4261	/511		X		
Power					
2N4399	/433		X	X	
Small-Signal					
2N4405	/448	X	X		
2N4416A	/428		X	X	
2N4449	/317		X		

Table 40. Transistors (continued)

Type Number	Detailed Spec	Specification Levels			
		JAN	JTX	JTXV	JANS
Small-Signal					
2N4854	/421		X	X	
2N4856 through 2N4858	/385		X	X	
2N4931	/397		X	X	
Power					
2N5038	/439	X	X	X	
2N5039	/439		X		
2N5302	/456	X	X	X	
2N5303	/456		X	X	
2N5339	/560	X	X	X	
Small-Signal					
2N5416S	/485	X	X		
2N5582	/423	X	X		
Power					
2N5683	/466		X		
2N5684	/466	X	X	X	
2N5685	/464		X		
2N5686	/464		X	X	
2N5745	/433		X	X	
Small-Signal					
2N5794	/495		X		
2N5796	/496		X		
Power					
2N6051	/501		X	X	
2N6052	/501	X	X	X	
2N6058	/502		X		
2N6059	/502	X	X	X	
2N6193	/561	X	X	X	
2N6211 through 2N6213	/461	X			
2N6274	/514	X	X	X	
2N6277	/514		X	X	
2N6283	/504		X		
2N6284	/504		X	X	
2N6286	/505		X		
2N6287	/505		X	X	
2N6298	/540		X		
2N6299	/540	X	X	X	
2N6300	/539		X		

Table 40. Transistors (continued)

Type Number	Detailed Spec	Specification Levels			
		JAN	JTX	JTXV	JANS
Power					
2N6301	/539	X	X	X	
2N6306	/498	X	X		
2N6308	/498		X		
2N6338	/509	X	X		
2N6341	/509	X	X	X	
2N6378	/515		X		
2N6379	/515		X		
2N6385	/523	X	X	X	
2N6437	/508	X	X	X	
2N6438	/508	X	X	X	
2N6546	/525		X		
2N6547	/525	X	X		
2N6650	/527	X	X	X	
2N6756	/542		X	X	
2N6758	/542		X	X	
2N6760	/542		X	X	
2N6762	/542		X	X	
2N6764	/543		X	X	
2N6766	/543		X	X	
2N6768	/543		X	X	
2N6770	/543		X	X	
Multiples					
2N6987	/558		X	X	
2N6988	/558			X	
2N6989	/559		X	X	
2N6990	/559			X	

Product Listing (continued)

MIL-Processed Products

The following type numbers represent standard part numbers that have been built and tested to MIL-S-19500 reliability specifications. For details, see page 6.1-15.

Table 41. Rectifiers

Type Number	Motorola Standard Part Number	Specification Levels JAN	JTX	JTXV
Schottky				
MBR5825	1N5825		HX	HXV
MBR6391	1N6391		HX	HXV
MBR6392	1N6392		HX	HXV

Table 42. Thyristor

Type Number	Motorola Standard Part Number	Specification Levels JAN	JTX	JTXV
MCR2323	2N2323	H		

Table 43. Transistors

Type Number	Motorola Standard Part Number	Specification Levels JAN	JTX	JTXV
Duals				
MD2219AF	2N2219A			HXV
MD2369A,AF	2N2369A		HX	HXV
MD2484F				HXV
MD2605F	2N2605			HXV
MD2905AF	2N2905A			HXV
MD3251A	2N3251A		HX	HXV
MD3251AF	2N3251A			HXV
MD3468	2N3468		HX	HXV
MD3468F	2N3468			HXV
MD6002	MD6002		HX	HXV
MD6002F	MD6002			HXV
MD918, F	2N918			HXV
TMOS				
MHM5N100			HX	HXV
MHM8N20			HX	HXV
MHM12N50			HX	HXV
MHM25N20			HX	HXV
MHM24N40			HX	HXV
MHM8P20			HX	HXV
Quads				
MHQ2369	2N2369A		HX	HXV
MHQ2484	2N2484		HX	HXV
MHQ3251A	2N3251A		HX	HXV
MHQ3468	2N3468		HX	HXV
MHQ6002	2N2222/2907		HX	HXV
MHQ918	2N918		HX	HXV
Bipolar Power				
MJ6316	2N6316		HX	HXV
MJ6318	2N6318		HX	HXV
MJ10016	MJ10016		HX	HXV

Table 43. Transistors (continued)

Type Number	Motorola Standard Part Number	Specification Levels: JAN	JTX	JTXV
Bipolar Power				
MJ11021	MJ11021		HX	HXV
MJ11022	MJ11022		HX	HXV
MJ11032	MJ11032		HX	HXV
MJ11033	MJ11033		HX	HXV
Surface Mount				
MMCM918	2N918			HXV
MMCM2222A	2N2222A			HXV
MMCM2369A	2N2369A			HXV
MMCM2484	2N2484			HXV
MMCM2605	2N2605			HXV
MMCM2907A	2N2907A			HXV
MMCM3251A	2N3251A			HXV
Quads, Flat Packs				
MQ2369A	2N2369A			HXV
MQ2484	2N2484			HXV
MQ2605	2N2605			HXV
MQ3251A	2N3251A			HXV
MQ3468	2N3468			HXV
MQ6002	MQ6002			HXV
MQ918	2N918			HXV
RF				
MRF522	MRF522			HXV
MRF2857	2N2857		HX	HXV
MRF3866A	2N3866A		HX	HXV
MRF4957	2N4957		HX	HXV
MRF5109	2N5109		HX	HXV
MRF5583	2N5583		HX	HXV
MRF6603	2N6603			HXV
MRF6604	2N6604			HXV
Rectifiers				
Ultrafast				
MUR2515	MUR2515		HX	HXV
MUR5010	MUR5010		HX	HXV
MUR5020	MUR5020		HX	HXV
MUR6304	IN6304		HX	HXV
MUR6305	IN6305		HX	HXV
MUR6306	IN6306		HX	HXV
MUR1620C			HX	HXV
MUR1640C			HX	HXV
MUR1660C			HX	HXV
MUR3020C			HX	HXV
MUR3040C			HX	HXV
MUR3060C			HX	HXV
MUR840C			HX	HXV
MUR20200C			HX	HXV
MUR20100C			HX	HXV
MUR2060C			HX	HXV
MUR2045C			HX	HXV
MUR3045C			HX	HXV

Product Listing (continued)

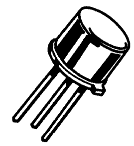
Table 44. Rectifiers

Type Number	Motorola Standard Part Number	Specification Levels		
		JAN	JTX	JTXV
MR836	MR836		HX	HXV
MR3910	1N3910		HX	HXV
MR3911	1N3911		HX	HXV
MR3913	1N3913		HX	HXV

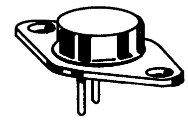
Product Selection Guide

MIL-Qualified Products

Motorola MIL qualified components are ordered by adding suffix JAN, JTX, JTXV or JANS to the part numbers indicated in the following tables. Although Motorola will continue to supply components to the JAN specification, this classification has been declared "inactive for new designs" per MIL-STD-19500. The higher level, JTX, is the recommended replacement.



CASE 79-04
TO-205AD (TO-39)



CASE 80-02
TO-213AA (TO-66)

Power Transistors

Table 45. Bipolar

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type		h_{FE} Min/Max	@ I_C Amp	t_{on}/t_{off} µs Max	$V_{CE(sat)}$ Max Vdc	@ I_C/I_B Amp	$P_{D(Case)}$ Watts @ 25°C
		NPN	PNP						
TO-204AA/AE (Formerly TO-3)									
8	250	2N6306		15/75	3	0.6/3	0.8	3/0.6	125
	350	2N6308		Oct–52	3	0.6/3	1.5	3/0.6	125
10	60	2N3715		50/150	1	—/2	1	5/0.5	150
	80	2N3716	2N3792	50/150	1	—/2	1	5/0.5	150
		2N6385#	2N6650	1k/20k	5	2.5/10	2	5/0.01	100**
12	80	2N6058#	2N6051#	1k/18k	6	2/10	2	6/0.024	150
	100	2N6059#	2N6052#	1k/18k	6	2/10	2	6/0.024	150
15	300	2N6546		6/—	10	1/4.7	5	15/3	175
	400	2N6547		6/—	10	1/4.7	5	15/3	175
20	75	2N5039		20/—	10	0.5/2	1	10/1	140
	80	2N5303		15/60	10	0.9*/1*	1	10/1	200
			2N5745	15/60	10	1.5*/1*	1	10/1	200
		2N6283#	2N6286#	1250/18k	10	2/10	2	10/0.04	175
	90	2N5038		20/—	12	0.5/2	1	12/1.2	140
	100	2N6284#	2N6287#	1250/18k	10	2/10	2	10/0.04	175
25	100		2N6437	30/120	10	0.5/1.25	1	10/1	200
	120		2N6438	30/120	10	0.5/1.25	1	10/1	200
30	60	2N5302		15/60	15	2*/1*	1	15/1.5	200
			2N4399	15/60	15	—/2.1	1	15/1.5	200
50	60	2N5685	2N5683•	15/60	25	1.5/3	1	25/2.5	300
	80	2N5686•	2N5684•	15/60	25	1.5/3	1	25/2.5	300
	100		2N6378•	30/120	20	0.5/1.05	1	20/2	250
	100	2N6274•		30/120	20	0.5/1.05	1	20/2	250
	120		2N6379•	30/120	20	0.5/1.05	1	20/2	250
	150	2N6277•		30/120	20	0.5/1.05	1	20/2	250

#Darlington, •TO-204AE; all others TO-204AA

t_r*/t_f*

**P_D = 85 for devices 2N6648, 2N6649 and 2N6650.

MIL-Qualified Products: Power Transistors (continued)

Table 45. Bipolar (continued)

I_C Cont Amps Max	$V_{CEO(sus)}$ Volts Min	Device Type NPN	Device Type PNP	h_{FE} Min/Max	@ I_C Amp	t_{on}/t_{off} µs Max	$V_{CE(sat)}$ Max Vdc	@ I_C/I_B A/mA	P_D(Case) Watts @ 25°C
TO-205AD (Formerly TO-39)									
3	40		2N3867S	40/200	1.5	65*/100*	0.75	1.5/150	10
	60		2N3868S	30/150	1.5	65*/100*	0.75	1.5/150	10
5	100	2N5339	2N6193	60/240	2	100*/200*	0.7	2/200	1
TO-213AA (Formerly TO-66)									
1	300	2N3739		40/200	0.1	1.5/3.5	0.75	0.1/10	20
4	60		2N3740	30/120	0.25	0.4/1	0.4	0.25/25	25
		2N3766		40/160	0.5	0.25/2.5	1	0.5/50	25
	80		2N3741	30/120	0.25	0.4/1	0.4	0.25/250	25
		2N3767		40/160	0.5	0.25/2.5	1	0.5/50	25
8	60	2N6300#	2N6298#	750/18k	4	2/8	4	4/16	75+
	80	2N6301#	2N6299#	750/18k	4	2/8	4	4/16	75+

Darlington; + T_C = 0°C for devices 2N6300, 2N6301

t_r*/t_f*

MOSFETs (TMOS)

Table 46. N-Channel — Case 1-06 TO-204AA (TO-3)

$V_{(BR)DSS}$ (Volts) Min	$R_{DS(on)}$ (Ohms) Max	@ I_D (Amps)	Device	I_D (Amps) Max	C_{iss} pF Max	P_D* (Watts) Max
500	1.5	3	2N6762	4.5	800	75
	0.4	7.75	2N6770	12	3000	150
400	1	3.5	2N6760	5.5	800	75
	0.3	9	2N6768	14	3000	150
200	0.4	6	2N6758	9	800	75
	0.085	19	2N6766	30	3000	150
100	0.18	9	2N6756	14	800	75
	0.055	24	2N6764	38	3000	150

*@ 25°C

Small-Signal Transistors

Bipolar

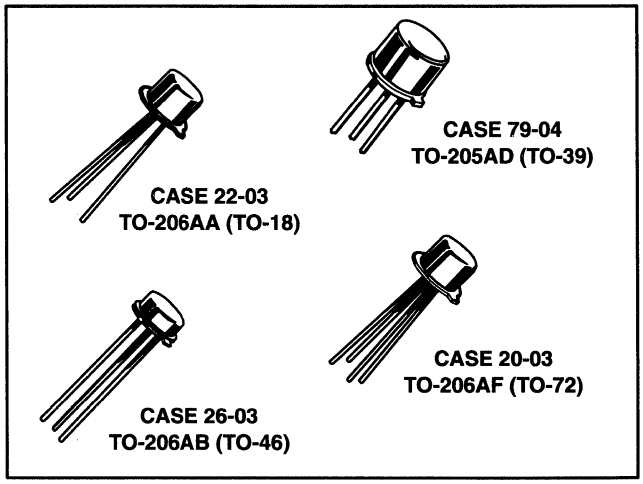


Table 47. General Purpose

Package	Device Number	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min	h_{FE} Max	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C/I_B mA
NPN								
TO-206AA (TO-18)	2N3700	80	1000	50	200	500	0.5	500/50
	2N2484	60	50	200	500	0.01	0.3	1.0/0.1
	2N2222A	50	800	75	325	1	1.2	150/15
	2N930	45	30	100	300	0.01	1	10/0.5
	2N2222	30	800	50	325	1	1.3	150/15
TO-205AD (TO-39)	2N3019S	80	1000	100	300	150	0.2	150/15
	2N2219A	50	800	100	300	150	0.3	150/15
TO-206AB (TO-46)	2N5582	50	800	100	300	150	0.3	150/15
PNP								
TO-206AA (TO-18)	2N2906A	60	600	40	120	150	0.4	150/15
	2N2907A	60	600	100	300	150	0.4	10/1.0
	2N3251A	60	200	100	300	10	0.25	10/1.0
	2N2907	40	600	100	300	150	0.4	150/15
T0-205AD (TO-39)	2N4033	80	1000	100	300	100	0.15	150/15
	2N4405	80	500	100	300	150	0.2	150/15
	2N2905A	60	600	100	300	1	0.4	150/15
	2N2904	40	600	40	120	1	0.4	150/15
TO-206AB (TO-46)	2N3486A	60	600	100	300	150	0.4	150/15
	2N2605	60	30	100	400	10	0.3	10/0.5

MIL-Qualified Products: Small-Signal Transistors — Bipolar (continued)

Bipolar

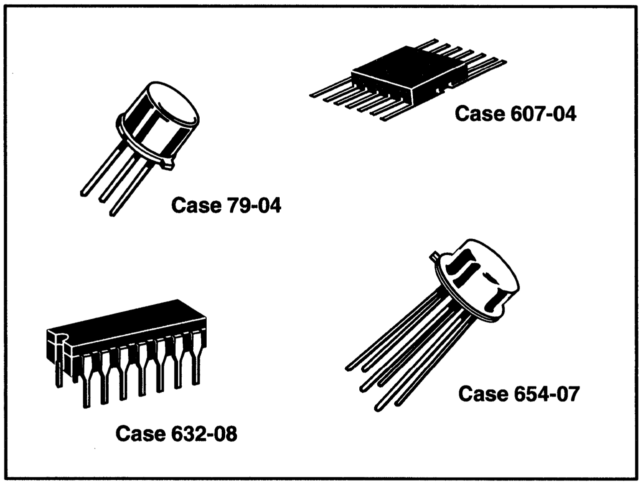


Table 48. High-Frequency Amplifiers/Oscillators

The transistors shown are designed for use as both oscillators and amplifiers at UHF and VHF frequencies.

Package	Device Number	$V_{(BR)CEO}$ Volts Min	h_{FE} Min	@ I_C mA	G_{pe} dB Min	NF dB Max	@ f MHz	$\lvert h_{fe} \rvert$ Min	@ f MHz	C_{obo} pF Max
NPN										
TO-206AF	2N918	15	20	3	15	6	60	6	100	1.7
PNP										
TO-206AF	2N4261	15	30	10	—	—	—	15	100	2.5

Table 49. Switching Transistors

The following devices are intended primarily for use in general-purpose switching, but can be used in amplifier and driver applications. Within each package group shown, the devices are listed in order of decreasing turn-on time (t_{on}).

Package	Device Number	t_{on} ns Max	& t_{off} ns Max	@ I_C mA	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min	h_{FE} Max	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	& I_B mA
NPN												
TO-206AA	2N914	40	40	200	15	150	30	120	10	0.3	10	1
	2N708	40	75	10	15	—	40	120	10	0.4	10	1
	2N3013	15	25	300	20	300	35	120	30	0.18	30	3
	2N2369A	12	18	10	15	200	40	120	10	0.2	10	1
	2N3227	12	18	10	20	200	100	300	10	0.2	10	1
TO-205AD	2N3735	—	60	1000	50	1500	20	80	1000	0.9	1000	100
	2N3506	30*	35*	1500	40	3000	40	200	1500	1	1500	150
	2N3507	30*	35*	1500	50	3000	30	150	1500	1	1500	150
	2N3737	—	60	1000	50	1500	20	80	1000	0.9	1000	100
TO-206AB	2N4449	12	18	10	15	200	40	120	10	0.2	10	1
PNP												
TO-206AA	2N869A	50	80	30	18	200	40	120	10	0.15	10	1
TO-205AD	2N3634	400	600	50	140	1000	50	150	50	0.6	50	5
	2N3635	400	600	50	140	1000	100	300	50	0.6	50	5
	2N3636	400	600	50	175	1000	50	150	50	0.6	50	5
	2N3637	400	600	50	175	1000	100	300	50	0.6	50	5
	2N4033	25*	35*	500	80	1000	100	300	100	0.15	150	15

t_r*/t_r*

Table 49. Switching Transistors (continued)

Package	Device Number	t_{on} ns Max	& t_{off} ns Max	@ I_C mA	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min	Max	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	& I_B mA
PNP												
TO-205AD	2N3467	30*	30*	500	40	1000	40	120	500	0.6	500	50
	2N4405	25*	50*	500	80	500	100	300	150	0.2	150	15
TO-206AB	2N3764	35*	35*	1	40	1500	30	120	1000	0.9	1000	100

t_r*/t_f*

Table 50. High-Voltage/High-Current Transistors

This following table lists Motorola standard devices that have high Collector-Emitter Breakdown Voltage. Devices are listed in decreasing order of $V_{(BR)CEO}$ within each package type.

Package	Device Number	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min/Max	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	& I_B mA
NPN								
TO-205AD	2N3439	350	1000	40/160	20	0.5	50	4
	2N3440	250	1000	40/160	20	0.5	50	4
	2N3501	150	300	100/300	150	0.4	150	15
PNP								
TO-205AD	2N5416S	350	1000	30/120	50	2	50	5
	2N3743	300	50	50/200	30	1.2	30	3
	2N4931	250	50	50/200	30	1.2	30	3
	2N3637	175	1000	100/300	50	0.6	50	5
	2N3636	175	1000	50/150	50	0.6	50	5
	2N3635	140	1000	100/300	50	0.6	50	5
	2N3634	140	1000	50/150	50	0.6	50	5

Table 51. Multiple Transistors

These multiple small-signal transistors include devices intended for amplifier and switching applications.

Device Number	Maximum Ratings			Electrical Characteristics					
	V_{CEO} V	I_C mA	$P_{D(Total)}$ W	I_{CBO} µA Max	h_{FE} Min/Max	@ I_C mA	$V_{CE(sat)}$ Volts Min	@ I_C mA	& I_B mA
QUAD — NPN Case 632-02									
2N6989	50	800	1.5	0.01	100/300	150	0.3	150	15
Case 607-04									
2N6990	50	800	0.4	0.01	100/300	150	0.3	150	15
QUAD — PNP Case 632-02									
2N6987	60	600	1.5	0.01	100/300	150	0.4	150	15
Case 607-04									
2N6988	60	600	0.4	0.01	100/300	150	0.4	150	15
DUAL — NPN Case 654-07									
2N2060	60	500	0.5	0.002	30/90	0.1	0.3	0.5	5
2N3819	60	30	0.5	0.002	300/1000	0.1	0.3	1	0.1
2N3820	60	30	0.5	0.002	150/600	0.1	0.3	1	0.1

Table 51. Multiple Transistors (continued)

These multiple small-signal transistors include devices intended for amplifier and switching applications.

Device Number	Maximum Ratings V_{CEO} V	Maximum Ratings I_C mA	Maximum Ratings P_D(Total) W	Electrical Characteristics I_{CBO} µA Max	h_{FE} Min/Max	@ I_C mA	$V_{CE(sat)}$ Volts Min	@ I_C mA	& I_B mA
DUAL — NPN Case 654-07									
2N3810	60	50	0.6	0.01	150/450	0.1	0.2	0.1	0.1
2N3811	60	50	0.6	0.01	300/900	0.1	0.2	0.1	0.1
2N4854	40	600	0.6	0.01	100/300	150	0.4	150	15
2N5794	40	600	0.6	0.01	100/300	150	0.6	150	15
2N5796	60	600	0.6	0.02	100/300	150	0.4	150	15

Small-Signal Transistors, JFETs

Table 52. N-Channel — Amplifiers, TO-206AF

Device	$\|Y_{fs}\|$ (µmho) Min	@ f (kHz)	$\|Y_{os}\|$ (µmho) Min	@ f (kHz)	C_{iss} (pF) Max	C_{rss} (pF) Max	NF (dB) Max	@ R_G=1 MΩ f (kHz)	$V_{(BR)}$ (V) Min	$V_{GS(off)}$ (V) Min	$V_{GS(off)}$ (V) Max	I_{DSS} (mA) Min	I_{DSS} (mA) Max
2N3821	1500	1	10	1	6	3	2.5	0.01	50	—	4	0.5	2.5
2N4416A	4500	1	50	1	4	0.8	4	400	35	2.5	6	5	15

Table 53. N-Channel — Switches and Choppers, TO-206AA

Device	$R_{DS(on)}$ (Ω) Max	@ I_D mA	$V_{GS(off)}$ (V) Min	$V_{GS(off)}$ (V) Max	I_{DSS} (mA) Min	I_{DSS} (mA) Max	$V_{(BR)}$ (V) Min	C_{iss} (pF) Max	C_{rss} (pF) Max	t_{on} (ns) Max	t_{off} (ns) Max
2N4856	25	0	4	10	50	—	40	18	8	6	25
2N4857	40	0	2	6	20	100	40	18	8	6	50
2N4858	60	0	0.8	4	8	80	40	18	8	10	100

Mil-Processed Discrete Semiconductors

The wide range of component requirements for today's high-technology military and space applications often go beyond the available MIL-S-19500-specified component complement. Normally, these needs are met with devices manufactured and tested to a customer's high-reliability specifications developed specifically for these custom parts. The result — high initial cost and long delivery time.

To reduce both of these detriments, Motorola now offers a standard, inventoried line of popular discrete products for which no military specifications exist, but which have been processed to rigid MIL-S-19500 and MIL-STD-750 specifications, just as if they were built for JAN registration. Since no military slash sheets exist for these components, the electrical parameters are those applied to equivalent Motorola commercial products. Delta calculations, however, and Group B and C test limits, are selected with the same considerations as for MIL-S-19500 specifications.

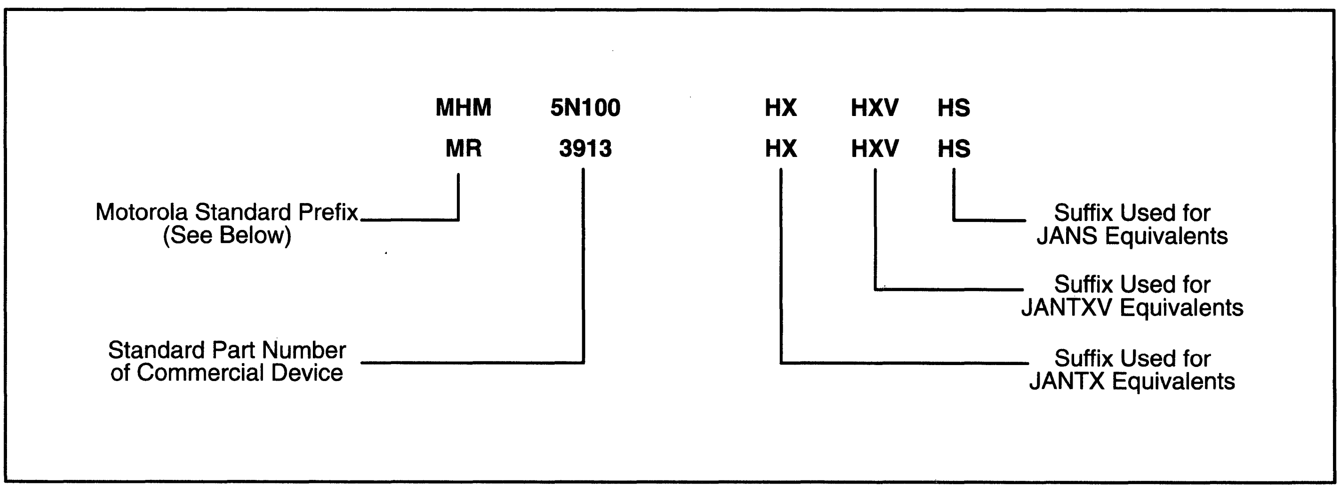
Compared with custom equivalents, customers able to utilize these components will find significant savings in both cost and delivery time. Moreover, the life span of such devices will be considerably longer than that of custom-built "specials", so that replacements will be available for the foreseeable future.

Parts Identification and Marking

For its packaged Military Processed Components, Motorola will use only hermetically sealed commercial products capable of being processed to MIL-S-19500 requirements. For identification, the products will have a prefix similar to those presently used for internal (non-EIA-registered) devices, e.g. MM, MHM, MRF, MCR etc., followed by the standard EIA or internal part number, and special JAN equivalent suffixes. The suffixes, HX, HXV and HS signify testing to JANTX, JANTXV and JANS respectively.

MIL-Processed devices will be marked with the Motorola Logo, the in-house part number and a four digit date code. Should a DESC Drawing become available, the DESC Drawing part number will also be marked. Re-marking is not available, due to permanency of the marking.

Should fully qualified JAN equivalents become available, Motorola will discontinue the MIL-Processed Devices unless there is a technical problem with supplying the JAN qualified device. In such cases the MIL-Processed devices will be retained and a detailed list of variations from the JAN equivalent will be provided.



Motorola Standard Prefixes

MBR — Rectifiers
MCR — Thyristors
MD — Dual Transistors (Bipolar)
MHM, MHT — Transistors, TMOS
MHQ — Quad Transistors (Bipolar)
MJ — Transistors, Bipolar Power
MJM — Transistors, Bipolar Power, TO-254
MR — Rectifiers
MRF — Transistors, RF
MUR — Rectifiers
MMCM — Transistor, Surface Mount

Table 54. JAN-Type Processing for Commercial Products

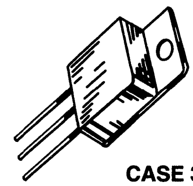
MIL-Processed devices will receive the following screens, tests and inspections.

Processing	Specification	Lot
HX Level, (JAN TX Equivalent) —		
High Temperature Non-operating Life	MIL-STD-750, Method 1032	Optional
Temperature Cycle	MIL-STD-750, Method 1051	100%
Surge (Rectifiers) when specified	MIL-STD-750, Method 4066	100%
Thermal Response when specified	MIL-STD-750, Method 3101-61	100%
Constant Acceleration	MIL-STD-750, Method 2006	Optional
Hermetic Seal Fine Leak, Condition G or H Gross Leak, Condition A, C, D, E or F	MIL-STD-750, Method 1071	100%
Interim Electrical Measurements	As Specified, when required	100%
High Temperature Reverse Bias Condition A	MIL-STD-750, Method 1039/9/42	
Interim Electrical Measurements	As specified, parameters as required	100%
Power Burn-in	MIL-STD-750, Method 1038/9/40/2	100%
Electrical Measurements, Delta Calculations	Parameters as Required	100%
Electrical Measurements	Subgroup A2 only	100%
Group A Inspection	MIL-S-19500	Sample
Group B Inspection	MIL-S-19500	Sample
Group C Inspection*	MIL-S-19500	Sample
HXV Level, (JAN TXV Equivalent) —		
Devices will receive all Level HX tests, plus Precap Visual Inspection	MIL-STD-750, Method 2069-74	100%
HS Level, (JAN S Equivalent) —		
Contact your Motorola Sales representative for processing details		

* Group C inspection will be run on the initial lot only. Data will be retained for seven years.

MIL-Processed Semiconductors (continued)

Selector Guide
Power Transistors



CASE 387-01
TO-254AA

Table 55. TMOS FETs

These TMOS Power FETs are designed for high speed power switching applications such as switching regulators, converters, solenoid and relay drivers, and PWM motor controls.

Device Number	Maximum Ratings			Electrical Characteristics					
	V_{DSS} Vdc	I_D A	P_D W	I_{DSS} mA Max	$R_{DS(On)}$ Ohms Max	@ I_D Adc	$V_{GS(th)}$ Vdc Min/Max	$t_{d(on)}$ ns Max	$t_{d(off)}$ ns Max
N-Channel — TO-254AA Package									
MHM5N100HX, HXV	1000	5	125	0.2	3	2.5	2/4.5	40	160
MHM8N20HX, HXV	200	8	75	0.2	0.4	4	2/4.5	40	200
MHM12N50HX, HXV	500	12	125	0.2	0.4	7	2/4.5	40	150
MHM25N20HX, HXV	200	25	125	0.2	0.1	12.5	2–Feb	40	150
P-Channel									
MHM8P20HX, HXV	200	8	75	0.2	0.4	4	2/4.5	40	200

MIL-Processed Semiconductors: Selector Guide Power Transistors (continued)

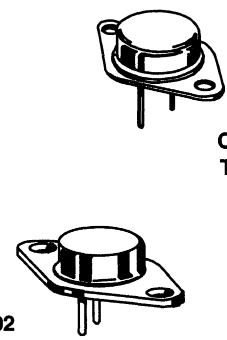


Table 56. Bipolar, Low Frequency

Device Number	Maximum Ratings			Electrical Characteristics					
	V_{CEO} Adc	I_C Adc	P_D W	h_{FE} Min/Max	@ I_C mA	t_r/t_f µs Max	@ I_C Adc	$V_{CE(sat)}$ Vdc Max	f_T MHz Min
TO-204AA/AE Package									
NPN									
MJ10016HX, HXV	120	30	200	200/—	30	—	—	4	—
MJ11022HX, HXV	250	15	175	400/15000	10000	1.2/10	10	2	3
MJ11032HX, HXV	120	50	300	400/—	50	—	—	3.5	—
PNP									
MJ11021HX, HXV	250	15	175	400/15000	10000	1.2/10	10	2	3
MJ11033HX, HXV	120	50	300	400/—	50	—	—	3.5	—
TO-213AA Package									
NPN									
MJ6316HX, HXV	80	7	90	20/100	2.5	0.7/0.8	2.5	1	4
PNP									
MJ6318HX, HXV	80	7	90	20/100	2.5	0.7/0.8	2.5	1	4

MIL-Processed Semiconductors (continued)

Small-Signal Transistors

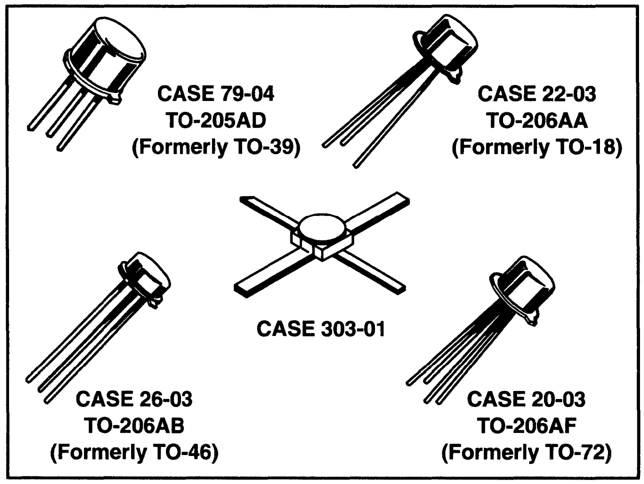


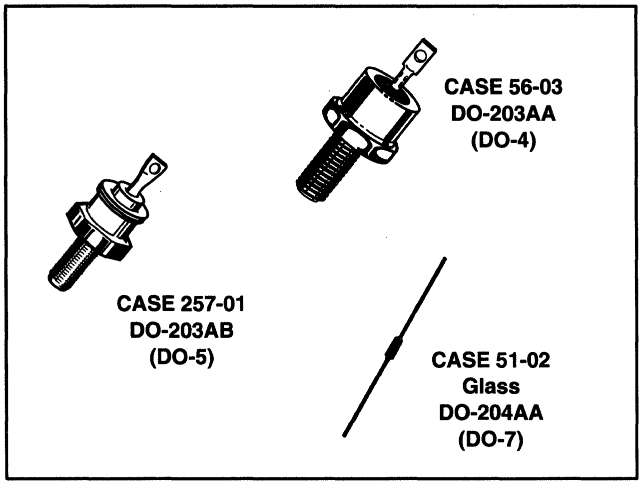
Table 57. Bipolar, RF

Device Number	Maximum Ratings			Electrical Characteristics								Package
	V_{CEO} Vdc	I_C mA	P_D W	I_{CBO} µAdc Max	h_{FE} Min/Max	f_T GHz Min/Max	@ I_C mA	NF dB Min/Max	@ f MHz	G_{PE} dB Min/Max	@ f MHz	
NPN												
MRF2857HX, HXV	15	40	0.3	—	30/150	—	3	–/4.5	450	12.5/21	450	CASE 303-01
MRF5109HX, HXV	20	400	1	—	40/150	—	50	–/3.5	200	11/–	200	CASE 205AD
MRF6603HX, HXV	15	30	0.3	—	30/200	—	15	1/2.5	1000	15/21	1000	CASE 303-01
MRF6604HXV	15	50	0.5	0.05	30/200	—	—	3	1000	15	1000	CASE 303-01
PNP												
MRF522HXV	10	50	—	10	25/125	—	0	3.5	1000	10	1000	CASE 303-01
MRF4957HX,HXV	30	30	0.2	0.1	30/165	1.2	2(I_E)	3.5	450	17	450	TO-206AF
MRF5583HX,HXV	30	500	5	0.05	25/100	1	40	—	—	—	—	TO-205AD

Table 58. RF Transistor, Bipolar NPN Power, V_{CC} = 28 Vdc

Device Number	Frequency MHz, Max	P_{OUT} W	@ P_{IN} W (Max)	η Gpe dB (Min)	Package
MRF3866AHX, HXV	400	1	0.15	45	79-034 (TO-39)

MIL-Processed Semiconductors (continued)



Rectifiers

Table 59. Rectifiers*

Device Number	Maximum Rating			Electrical Characteristics						Package
	I_O Amps	V_{RRM} Volts	I_{FSM} Amps	V_F Volts Max	@ I_F Amps	I_R µA Max	@ V_R Volts	t_{rr} µs Max	@ I_F Amps	
Fast Recovery										
MR836HX,HXV	3	600	100	1.1	3	500	600	0.2	1	CASE 60-01
MR3910HX,HXV	30	100	300	1.4	30	25	100	0.2	1	DO-203AB
MR3911HX,HXV		200	300	1.4	30	25	200	0.2	1	
MR3913HX,HXV		400	300	1.4	30	25	400	0.2	1	
Ultrafast Recovery										
MUR2515HX,HXV	25	150	500	0.95**	25**	10	150	0.05	1	DO-203AA
MUR5010HX,HXV	50	100	600	1.15	50	10	100	0.05	1	DO-203AB
MUR5020HX,HXV	50	200	600	1.15	50	10	200	0.05	1	DO-203AB
MURM1620CTHX,V	16	200	100	0.975	8	5	200	0.035	1	TO-254AA
MURM1640CTHX,V	16	400	100	1.3	8	10	400	0.06	1	TO-254AA
MURM1660CTHX,V	16	600	100	1.5	8	10	600	0.06	1	TO-254AA
MURM3020HX,V	30	200	150	1.05	15	10	200	0.035	1	TO-254AA
MURM3040HX,V	30	400	150	1.25	15	10	400	0.06	1	TO-254AA
MURM3060HX,V	30	600	150	1.5	15	10	600	0.06	1	TO-254AA
MUR5010HX,V	50	100	600	1.15	50	10	100	0.05	1	DO-5
MUR5020HX,V	50	200	600	1.15	50	10	200	0.05	1	DO-5
Schottky										
MBR5825HX,HXV	15	40	500	0.38	5	10000	40	—	—	CASE 60-01
MBR6391HX,HXV	35	45	600	0.68**	50**	1500**	45**	—	—	DO-203AA
MBR6392HX,HXV	60	45	800	0.78**	65**	70**	45**	—	—	DO-203AB
MBRM2045CTHX,V	20	45	150	0.8	10	150	45	—	—	TO-254AA
MBRM2060CTHX,V	20	60	150	0.8	10	150	60	—	—	TO-254AA
MBRM20100CTHX,V	20	100	150	0.8	10	150	100	—	—	TO-254AA

*All are available with HX and HXV classifications.
** = Instantaneous Values, e.g. vF(pk) @ iF(pk) and iR(pk) @ vR(pk)

Table 59. Rectifiers*

Device Number	Maximum Rating			Electrical Characteristics						Package
	I_O Amps	V_{RRM} Volts	I_{FSM} Amps	V_F Volts @ Max	I_F Amps	I_R µA @ Max	V_R Volts	t_{rr} µs @ Max	I_F Amps	
MBRM20200CTHX,V	20	200	150	0.8	10	150	200	—	—	TO-254AA
MBRM3045CTHX,V	30	45	200	0.6	20	1000	45	—	—	TO-254AA

*All are available with HX and HXV classifications.
** = Instantaneous Values, e.g. vF(pk) @ iF(pk) and iR(pk) @ vR(pk)

Multiple Transistors

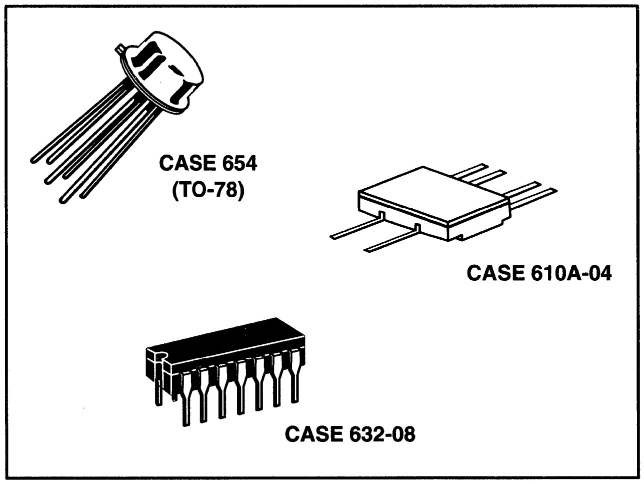


Table 60. Bipolar

Multiple transistors are multi-chip devices with two (duals) or four (quads) chips in a single package. The transistors are signal devices intended for switching and amplifier applications.

Device Number	Maximum Ratings			Electrical Characteristics						Package
	V_{CEO} Vdc	I_C mA	P_D* W	I_{CBO} µAdc Max	h_{FE} @ Min/Max	I_C mA	$V_{CE(sat)}$ Volts @ Max	I_C & mA	I_B mA	
DUALs – NPN										
MD2219AFHXV	50	800	0.0046	0.01	100/300	150	0.3	150	15	610A
MD2369AHX, HXV	15	200	0.36	0.02	40/120	10	0.02	10	1	654
MD2369AFHXV	15	200	0.36	0.02	40/120	10	0.02	10	1	610A
MD918HX, HXV	15	50	0.2	0.01	20/200	3	0.4	10	1	654
MD918FHXV	15	50	0.2	0.01	20/200	3	0.4	10	1	610A
DUALS — PNP										
MD2905AFHXV	60	600	0.6	0.01	100/300	150	0.4	150	15	610A
MD3251AHX, HXV	60	50	0.625	0.02	100/300	10	0.25	10	1	654
MD3251AFHXV	60	50	0.4	0.02	100/300	10	0.25	10	1	610A
MD3468HX,HXV	50	1000	0.65	0.1	25/75	500	0.3	150	15	654
MD3468FHXV	50	1000	0.4	0.1	25/75	500	0.3	150	15	610
DUALS — NPN/PNP										
MD6002HX, HXV	30	500	0.625	0.02	100/300	150	0.4	150	15	654

* All die, equal power
Available as DESC drawing 91010-01TX, TXV.

Table 60. Bipolar

Device Number	Maximum Ratings V_{CEO} Vdc	I_C mA	P_D* W	Electrical Characteristics I_{CBO} µAdc Max	h_{FE} Min/Max	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C mA	& I_B mA	Package
DUALS — NPN/PNP										
MD6002HX, HXV	30	500	0.625	0.02	100/300	150	0.4	150	15	654
MD6002FHXV	30	500	0.625	0.02	100/300	150	0.4	150	15	610
QUADs — NPN										
MHQ2484HX, HXV	60	50	2	0.005	200/500	0.01	0.3	1	0.1	632
MQ2484HXV	60	50	0.6	0.005	200/500	0.01	0.3	1	0.1	607
MHQ2369HX, HXV	15	500	1.5	0.2	40/120	10	0.2	10	1	632
MQ2369AHXV	15	500	0.6	0.2	40/120	10	0.2	10	1	607
MHQ918HX, HXV	15	50	1.6	0.01	20/200	3	0.4	10	1	632
MQ918HXV	15	50	0.4	0.01	20/200	3	0.4	10	1	607
QUADS – PNP										
MHQ3251AHX, HXV	60	200	1.5	0.02	100/300	10	0.25	10	1	632
MQ3251AHXV	60	200	0.6	0.02	100/300	10	0.25	10	1	607
MHQ3468HX, HXV	50	1000	2	0.1	25/75	500	0.35	150	15	632
MQ3468HXV	50	1000	0.6	0.1	25/75	500	0.35	150	15	607
QUADS – NPN/PNP										
MHQ6002HX, HXV**	30	500	1.9	0.02	100/300	150	0.4	150	15	632
MQ6002HXV	30	500	0.6	0.02	100/300	150	0.4	150	15	607

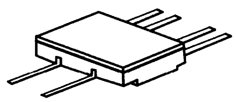
* All die, equal power
** All die, equal power
Available as DESC drawing 91010-01TX, TXV.

Thyristors

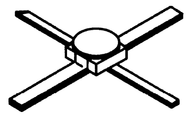
Table 61. SCRs

Device Number	V_{DRM} V Max	$I_{T(RMS)}$ A Max	I_{DRM} µA	V_{TM} V Max	I_{GT} µA Max	V_{GT} V Max	I_H mA Max	T_J °C Min/Max	Package
MCR2323H	50	1.6	10	1.5	200	0.8	2	–0.52	TO-205AD (TO-39)

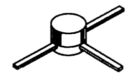
Surface Mounted Devices



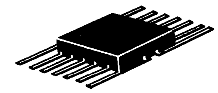
CASE 610A-04
6-LEAD FLAT PACK



CASE 303-01
100 MIL CERAMIC



CASE 176-02
MICRO-C



Case 607-04
14-LEAD FLAT PACK

Table 62. Surface Mounted Devices

Device Number	Mark	$V_{(BR)CEO}$ Vdc	h_{FE} Min/Max	I_C (mA)
Small Signal Transistors (Case 176-02)				
MMCM918HXV	918	15	20/200	3.0
MMCM2222AHXV	222	50	75/325	1.0
MMCM2369AHXV	369	15	40/120	10
MMCM2484HXV	484	60	250/800	1.0
MMCM2605HXV	605	60	150/450	0.5
MMCM2907AHXV	907	60	100/450	1.0
MMCM3251AHXV	251	60	100/300	10
RF Transistors (Case 303-01)				
MRF522HXV	522	10	25/125	30
MRF6603HXV		15	30/200	15
MRF6604AHXV		15	30/200	30
Small Signal Dual Transistors (Case 610A-04)				
MD918AFXV	MATCHED	15	20/200	3.0
MD2219AFHXV	NPN	50	75/325	1.0
MD2369AFHXV	NPN	15	40/120	10
MD2484FHXV	NPN	60	250/800	1.0
MD2605HXV	PNP	60	150/450	0.5
MD2905AFHXV	PNP	60	100/450	1.0
MD3251AFHXV	PNP	60	100/300	10
MD3468FHXV	PNP	50	25/75	500
MD6002FHXV	NPN/PNP	30	100/300	100
Small Signal Quad Transistors (Case 607-04)				
MQ918HXV	NPN	15	20/200	3.0
MQ2369AHXV	NPN	15	40/120	10
MQ2484HXV	NPN	60	250/800	1.0
MQ2605HXV	PNP	60	150/450	0.5
MQ3251AHXV	PNP	60	100/300	10
MQ3468HXV	PNP	50	25/75	500
MQ6002HXV	NPN/PNP	30	100/300	100
2N6988JTXV	PNP	60	100/450	1.0
2N6990JTXV	NPN	50	75/325	1.0

Discrete Military Operation Chips

Motorola's inventory of discrete military products qualified to JAN, JANTX, JANTXV and JANS specifications currently covers many devices listed on the QPL. From these, and from key internal product lines Motorola has designated a comprehensive selection of components in unencapsulated (chip) form to undergo stringent military type testing in order to serve the needs of customers manufacturing hybrid circuits for military and other high reliability applications. The chips are carried in stock by Motorola and by a number of authorized chip resellers, thereby avoiding much of the delay and some of the cost associated with the development of custom products for special applications. The chip line encompasses some of the most popular part numbers from various product categories and is expected to satisfy a substantial portion of a hybrid manufacturer's discrete chip requirements.

Presently the proposed Revision H of MIL-S-19500 includes Appendix H, which identifies a new level of military device, the JAN C chip. The Motorola DMO high reliability chips exceed the new JAN C chip. Since the JAN C device will be a standard, it will become the preferred chip for all military programs.

Chip Identification

For identification, all Motorola MIL-tested chips will carry the part numbers of their encapsulated counterpart, except for the prefix. For EIA-registered devices, instead of the 1N or 2N prefixes the MIL-tested chips will be labelled 1C and 2C. For Motorola internal part numbers, the letter "C" will be added to the standard internal part number prefix.

Chips processed to JANTXV type specifications are further identified by the suffix "HV" added to the chip part number. Additional processing to JANS type specifications (suffix "HS") can be initiated routinely through advance communications with any Motorola sales office. Examples:

Standard Part Numbers	Equiv. MIL-Tested Part Numbers
2N2222A	2C2222AHV (or HS)
MZ2.4A	MZC2.4AHV (or HS)

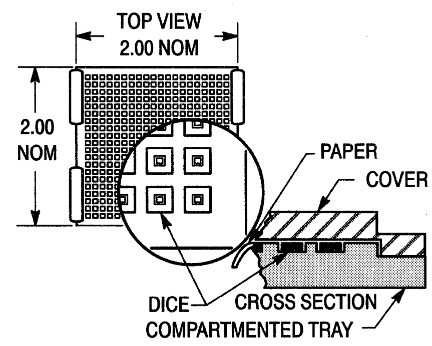


Figure 12. MIL-tested discrete semiconductor chips are now available off the shelf for high reliability hybrid (multi-chip) circuits.

Chip Qualification

Chips to be used in military and other high-reliability applications are tested to conform to the following military specifications where applicable:
MIL-C-45662 Calibration System Requirements
MIL-L-45208 Inspection System Requirements
MIL-STD-750 Test Methods for Semiconductors

To qualify, individual chips are probe tested to guarantee conformance with the dc parameters corresponding to those on the military slash sheets. Parts not covered by military specifications will be tested to Motorola data sheet electricals and MIL-S-19500 will be used as a guide.

Table 1 describes the test capabilities for discrete chip probing.

Parameters which cannot be tested in probe will be tested on encapsulated devices on a sample basis for quality conformance. Table 2 details the tests performed on the chips, as well as those performed on encapsulated Lot Acceptance Test Samples (LATS).

Table 63. Probe Test Capabilities

Parameter	Test Conditions	Limits
Breakdown Voltages	10 μA to150 mA	0 to 2000 V
Leakage Currents	0 to 2000 V	10 nA to 175 mA
Current Gain (hFE)	100 μA to 30 A	0 to 20 V
Saturation and "On" Voltages	100 μA to 30 A	0 to 10V
Forward Voltages	0 to 30 A	0 to 10 V

Discrete Military Chips (continued)

Table 64. JANTXV Process Flow for Motorola Discrete Military Products Chips

Processing	Chips	LATS*
Electrical Probe, +25°C DC Only	100%	100%
Wafer Saw-Through	100%	100%
Visual Inspection MIL-STD-750, Method 2072 or 2073	100%	100%
Assemble in Applicable Package	—	See Table 3
In-Package Tests High Temperature Storage MIL-STD-750, Method 1032	—	100%
Hermetic Seal Fine and Gross Leaks MIL-STD-750, Method 1071	—	100%
Serialization	—	100%
Electrical Parameters Read and Record, Group A Only	—	100%
High Temperature Reverse Bias (HTRB) MIL-STD-750, Method 1039, Cond. A Transistors Only	—	100%
Delta Calculations for HTRB Read and Record	—	100%
Burn-In, High Power MIL-STD-750, Method 1039, Cond. B, Transistors Method 1038, Cond. B, Diodes	—	100%
Delta Calculations for Burn-In Read and Record	—	100%
Final Electrical Parameters Read and Record	—	100%
Bond Pull & Die Shear MIL-STD-750, Method 2017 & 2037	—	5 Devices

* LATS = Lot Acceptance Test Samples.

Discrete Military Chips (continued)

Lot Acceptance Criteria

For lot acceptance tests, transistor die will be mounted in applicable TO-18, TO-205AD (TO-39), TO-204AA/AE (TO-3) packages and zener diode chips will be mounted in TO-18 packages.

In cases where there are more than 2500 chips on a wafer, a lot will consist of only one wafer and sample chips to be used for packaged devices will be selected randomly and uniformly from across the wafer. For larger die, with less than 2500 chips per wafer, samples will be selected from more than one wafer and traceability will be to the wafer lot.

Table 3 lists the lot acceptance criteria for various size chips.

Table 65. Lot Acceptance Criteria

Average Number of Electrically Good Die Per Wafer	Minimum Sample Size	Limits
Over 2500	77	LTPD = 5 Acceptance No. C = 1
1000 to 2499	55	LTPD = 7 C = 1
2 to 999	38	LTPD = 10 C = 1

For devices with more than 2500 die per wafer, QCI will be performed on each wafer.

Packaging

Motorola supplies all discrete semiconductor chips in the industry standard multi-pak. This is a 2" x 2" waffle type carrier with separate compartments for each die, Figure 1. The dice are covered with filter papers aligned with the top edge of the tray. The multi-pak itself is conductive, or covered with conductive material, to reduce the danger of damage to the die from electro-static discharge. For die 30 mil square or smaller, there will be 400 chips in each waffle pack. For a progressively larger die, waffle packs with 100, 49 and 25 chip compartments will be used. The waffle pack will be enclosed in a dry nitrogen filled or vacuum packed conductive bag and each waffle pack will contain chips from only one wafer. All will contain the following information:

Motorola Logo
Device Part Number
Inspection Lot Number (Wafer Number)
Date Code (Assembly Date of the LATS)
ESD Symbol as applicable, per MIL-STD-1285

Handling and Storage

When removing the cover from the waffle pack, the die may have a tendency to stick to the paper insert between the top cover and the tray. To resolve this problem, Figure 2, place the cover upside-down on the tray and apply light finger pressure to the cover. Then using tweezers, slide the paper from between the tray and the cover.

Chips should be stored at room temperature in an inert environment. Special electrostatic discharge (ESD) precautions should be taken to avoid chip damage. Storage in the original shipping package is recommended.

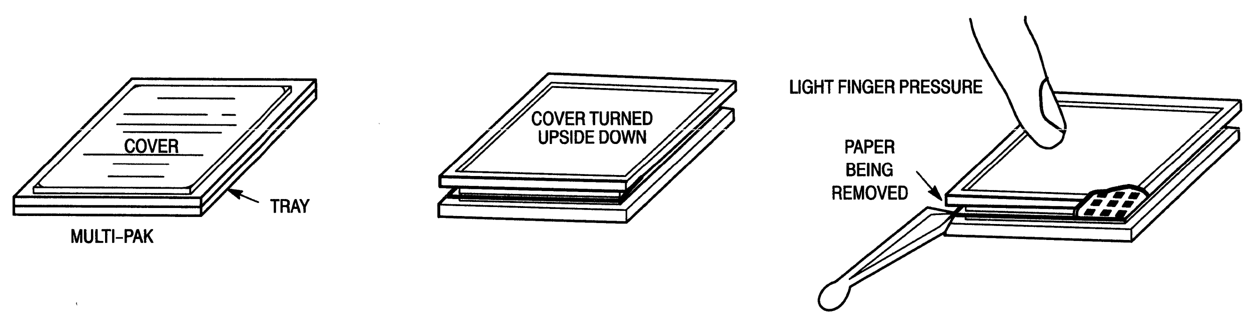


Figure 13. Care in removing the filter paper from the multi-pak will prevent loss of chips adhering to the paper.

Selector Guide

The following tables list the various Motorola DMO chips first by specific product categories and then in a logical fashion that permits rapid comparison of the more important design specifications.

Table 66. Transistors

Power, Bipolar — Listed in order of increasing Collector Current, I_C (continued)

Device Number		I_C Adc Max	$V_{CEO(sus)}$ Vdc Min	h_{FE} Min/Max	@ I_C Adc	t_{on}/t_{off} µs Max	t_r/t_f µs Max	@ I_C A	h_{fe} Min/Max	@ f MHz
NPN	PNP									
2C3767HV		4	80	40/60	0.5	0.25/2.5	—	0.5	1/8	10
	2C3741HV	4	80	30/120	0.25	0.4/1	—	1	25/250	0.001
2C5339HV	2C6193HV	5	100	60/240	2	—	0.1/0.2	2	3/15	10
2C3716HV	2C3792HV	10	80	30/120	3	—	1.3*	5	30/300	0.001
2C6059HV	2C6052HV	12	100	75/18k	6	2/10	—	5	1000/—	0.001

*t_f = 1.2 µs for 2C3716; 1.0 µs for 2C3792

Small-Signal — Listed in order of decreasing Breakdown Voltage, $V_{(BR)CEO}$

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	h_{FE} Min/Max	@ I_C mA	$V_{CE(sat)}$ Volts Max	@ I_C/I_B mA	t_{on}/t_{of} ns Max	@ I_C mA	h_{fe} Min/Max	@ f MHz
NPN										
2C3439HV	350	1000	40/60	20	0.5	50/4	1/10**	20	3/15	5
2C3501HV	150	300	100/300	150	0.4	150/15	115/1150	15	1.5/8	100
2C3019HV	80	1000	100/300	150	0.2	150/15	30/30	—	5/20	20
2C2484HV	60	50	200/500	0.01	0.3	1/0.1	—	—	2/7	30
2C2222AHV	50	800	100/300	150	1	500/50	35/300	150	2.5/—	100
2C2369AHV	40	200	40/120	10	0.2	10/1	16–Dec	10	5/10	100
2C918HV	15	50	20/200	3	0.4	10/1	—	—	6/18	100
PNP										
2C3251AHV	60	200	100/300	10	0.25	10/1	35/50*	10	3/9	0.1
2C2907AHV	60	50	100/300	150	0.4	150/15	45/300	—	2/—	100
2C2605HV	60	30	100/300	0.01	0.3	10/0.5	—	—	1/8	30
2C3468HV	50	1000	25/75	500	0.35	150/15	30/30*	500	150/500***	100

* = t_r/t_f ** = µs *** = f_T

RF, Power

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	P_{out} W Min/Max	@ P_{in} W	& f MHz	h_{FE} Min/Max	@ I_C mA	h_{fe} Min/Max	@ f MHz
NPN									
2C3553HV	40	1000	2.5/5.0	0.25	175	15/150	150	3.5/—	100
2C3866AHV	30	400	1.0/2.0	0.15	400	25/200	50	4/7.5	200

RF, Small-Signal

Device Type	$V_{(BR)CEO}$ Volts Min	I_C mA Max	G_{pe} dB Min/Max	@ f MHz	Noise Figure dB Max	@ f MHz	h_{FE} Min/Max	@ I_C mA	h_{fe} Min/Max	@ f MHz
NPN										
2C5109HV	20	400	11/—	200	3.5	200	40/150	50	5/10	200
2C2857HV	15	40	12.5/21	450	4.5	450	30/150	3	19–Oct	100

Table 67. Zener Diodes

Device Type Registered	Internal	V_Z Vdc ±5%
1C4370AHV	MZC2.4A5HV	2.4
	MZC2.5A5HV	2.5
1C4371AHV	MZC2.7A5HV	2.7
	MZC2.8A5HV	2.8
1C4372AHV	MZC3.0A5HV	3
1C746AHV	MZC3.3A5HV	3.3
1C747AHV	MZC36A5HV	3.6
1C748AHV	MZC3.9A5HV	3.9
1C749AHV	MZC4.3A5HV	4.3
1C750AHV	MZC4.7A5HV	4.7
1C751AHV	MZC5.1A5HCV	5.1
1C752AHV	MZC5.6A5HV	5.6
	MZC6.0A5HV	6
1C753AHV	MZC6.2A5HV	6.2
1C754AHV	MZC6.8A5HV	6.8
1C755AHV	MZC7.5A5HV	7.5
1C756AHV	MZC8.2A5HV	8.2
	MZC8.7AHV	8.7
1C757AHV	MZC9.1A5HV	9.1
1C758AHV	MZC10A5HV	10
1C962BHV	MZC11A5HV	11
1C759AHV	MZC12A5HV	12
1C964BHV	MZC13A5HV	13
	MZC14A5HV	14
1C965BHV	MZC15A5HV	15
1C966BHV	MZC16A5HV	16
	MZC17A5HV	17
1C967BHV	MZC18A5HV	18
	MZC19A5HV	19
1C968BHV	MZC20A5HV	20
1C969BHV	MZC22A5HV	22

Device Type Registered	Internal	V_Z Vdc ±5%
1C970BHV	MZC24A5HV	24
	MZC25A5HV	25
1C971BHV	MZC27A5HV	27
	MZC28A5HV	28
1C972BHV	MZC30A5HV	30
1C973BHV	MZC33A5HV	33
1C974BHV	MZC36A5HV	36
1C975BHV	MZC39A5HV	39
1C976BHV	MZC43A5HV	43
1C977BHV	MZC47A5HV	47
1C978BHV	MZC51A5HV	51
1C979BHV	MZC56A5HV	56
	MZC60A5HV	60
1C980BHV	MZC62A5HV	62
1C981BHV	MZC68A5HV	68
1C982BHV	MZC75A5H	75
1C983BHV	MZC82A5HV	82
	MZC87A5HV	87
1C984BHV	MZC91A5HV	91
1C985BHV	MZCl00A5HV	100
1C986BHV	MZC110A5HV	110
1C987BHV	MZC120A5HV	120
1C988BHV	MZC130A5HV	130
	MZC140A5HV	140
1C989BHV	MZC150A5HB	150
1C990BHV	MZC160A5HV	160
	MZC170A5HV	170
1C991BHV	MZC180A5HV	180
	MZC190A5HV	190
1C992BHV	MZC200A5HV	200

Product Literature and Technical Training

In Brief . . .

With the pace of new semiconductor product introductions, the task of providing an effective and up-to-date perspective of available components is beyond the means of any single document. Hence, a comprehensive Motorola Literature System has been put in place to keep semiconductor users totally informed of all aspects of the Motorola product lines — from new product introductions, to applications, to major changes in directions.

The Motorola technical literature library and associated services consist of the following:

- *An extensive library of Data Books, each containing a complete selection of data sheets associated with a particular product line.*
- *A series of User's Manuals and Design Manuals dealing with the application of highly complex products.*
- *A wide range of Application Notes and Article Reprints detailing the utilization of new and significant products.*
- *Instructor-led Training for: Digital Signal Processing (DSP) Family; M68000 Family; Embedded Controllers (EC); Fuzzy Logic; MC68360 QUIC; PowerPC; Microcontroller (MCU); RISC Family; plus the MC68302, MC68332, MC68340 and the MC68HC16.*
- *Audio Cassette Course programs covering the M68000 Family, the DSP56000/1, and the MC88100/200 RISC.*

These products and services are described on the following pages. However, because of different conditions and standards, some of these may not be available outside the USA.

7

Technical Data Services

Motorola Semiconductor Master Selection Guide

For the identification and preliminary selection of components for circuit and system designs

For the design engineer, the Motorola Master Selection Guide is perhaps the most important single document for the identification and preliminary selection of components for circuit and system designs. Within its pages is a complete listing and description of Motorola semiconductor devices currently in general use, and those recommended for new designs. It serves two purposes:

1. It lists all standard products in the vast Motorola semiconductor inventory for rapid identification.
2. It divides this total product offering into a variety of major product categories, with sufficient technical information to permit an intelligent first-order evaluation as to the most suitable devices for a specific application.

Semiconductor Data Update Magazine

Innovative new developments from Motorola's Semiconductor Products Sector

This highly informative periodical is available to all semiconductor users on a free subscription basis. The magazine provides information on new semiconductor products and developments and provides a quick-scan insight into new-product offerings. Concise, informative articles discuss significant new product capabilities as well as newly introduced services and literature. In short, it represents an overview of the latest and most important events at Motorola that influence the efficient implementation and most cost-effective use of semiconductor devices.

We recently introduced an International edition of the periodical, which is now available throughout the European community. In addition to the informative news you've come to expect about Motorola's leading-edge products, this new broader coverage will enable us to highlight manufacturing, awards, special events, and trade shows from an international perspective.

For your free Update Magazine subscription in the USA, please contact the Literature Distribution Center. The subscription service may not be available outside the USA.

Design-NET — Motorola Data On-Line

Information about Motorola Semiconductors is now available from an on-line service(*) via your desk-top computer. Also, this information is continually being updated on a regular basis.

The resource is an engineering/purchasing tool which speeds device selection, gives you access to applications data, and many other product and service related items. The system is available 24 hours a day, seven days a week with local access phone numbers in thousands of locations throughout the U.S. and many other countries.

The device selection feature contains up to the minute data on over 10,000 devices recommended for new applications with over 32,000 cross-references to these devices. The devices are organized into over 110 categories for easy access. Once a device has been located, its current OEM price and ordering data are available or a data sheet can be Faxed from the system.

Some of the features currently available on Design-NET include:

- "Specs-In-Secs" device data
- Press releases
- Literature catalog
- Training information and schedules
- Technical Forum
- Motorola news
- Application Note abstracts
- Trade show schedules
- Product Bulletins and notices
- E-Mail to and from Motorola
- Data Sheet and Application Note faxing
- Consultants database
- On-Line Q&A
- OEM Price Book

The system runs on General Electric Information Systems (GEIS) worldwide Network with 24x7 local access throughout the U.S. and many other countries in Europe, Asia, North & South America and Australia.

The system operates over direct phone lines and PBX equipment. An 800 number is provided by GEIS for access problems and other connection related issues.

Motorola has a full time staff dedicated to supporting the service.

Minimum user system requirements:

- IBM compatible with 640k; HD with 3 meg available; DOS 3.3, CGA or Macintosh Plus or better with 1 meg; HD; system 6.0.5 Modem and access to a phone line.

Order BR1307/D for more information and a sign-up form.

*Subscription fees currently waved for qualified customers.

Motorola Data and Application Literature

Complete technical data for the world's most comprehensive inventory of semiconductor components

To complement the industry's broadest line of semiconductor products, Motorola offers a complete library of Data books which detail the electrical characteristics of its products. These documents are supplemented by User's Manuals describing the capabilities of the products in circuit and system design.

Motorola attempts to fill the need for applications information concerning today's highly complex electronic components. Each year dozens of authors from colleges and universities, and from the industry, add their individual contributions to the collective literature. From these, Motorola has selected a number of texts which add substantially to the comprehension and applications of some of the more complex products. By buying these in large quantities and providing them to customers at lower than retail cost, Motorola hopes to foster a more comprehensive acquaintance with these products at greatly reduced prices.

For complete summaries and prices, in the USA order BR101/D from the Literature Distribution Center and in Europe order BR464/D from the Literature Distribution Centre.

Discrete Literature

Data Books & Handbooks

DL110/D, Vol. 1 & 2, RF Device Data
DL111/D, Bipolar Power Transistor Data
DL118/D, Optoelectronics Device Data
DL126/D, Small-Signal Transistors/FETs/Diodes
DL135/D, Power MOSFET Transistor Data
DL137/D, Thyristor Device Data
DL148/D, Discrete Military Operations Data
DL150/D, TVS/Zener Device Data
DL200/D, Pressure Sensor Device Data
HB213/D, Discrete Military Operations

Brochures and Selector Guides

SG46/D, RF Products
SG79/D, Switchmode
SG131/D, Power Semiconductors for Isolated Package Applications

Textbooks

TB321/D, Practical Switching Power Supply Design
TB326/D, Practical Radio Frequency Transistor Applications

IC Literature

Databooks & Handbooks

DL121/D, FAST and LS TTL Data
DL122/D, MECL Device Data
DL128/D, Linear and Interface ICs Data
DL129/D, High-Speed CMOS Logic Data
DL130/D, CMOS Application-Specific Standard ICs
DL131/D, CMOS Logic Data
DL136/D, Telecommunications Device Data
DL138/D, FACT Data
DL140/D, ECLinPS Device Data
DL144/D, Commercial Plus and Mil/Aero Applications Memory Data
DL145/D, Military MECL Family Data
DL152/D, MDA15 CMOS Standard Cell Data
DL154/D, MDA08 CMOS Standard Cell Data
DL155/D, Dynamic RAM Data
DL156/D, Fast Static RAM BiCMOS, CMOS and Module Data
HB205/D, MECL System Design Handbook
M68000FR/AD, M68000 Family Reference

Brochures and Selector Guides

BR1100/D, MOS Memory Products Division Reliability and Quarterly Report, 4th Quarter
SG96/D, Linear and Interface Integrated Circuits
SG99/D, MOS Application-Specific Digital-Analog ICs
SG138/D, Military IC and Discrete
SG146/D, DSP Quarterly Update
SG165/D, CSIC Microcontroller Quarterly Update
SG166/D, Advanced Microcontroller Quarterly Update
SG167/D, High End MPU Quarterly Update
SG169/D, MOS Digital-Analog IC Quarterly Update
SG171/D, Fast Static RAM Quarterly Update
SG172/D, Dynamic RAM Quarterly Update
SG368/D, Video Capture Chip Set Selector Guide

General Literature

BR128/D, Semiconductor Data Update
BR135/D, Applications Literature Catalog
BR518/D, Reliability and Quality Handbook
BR1202/D, Motorola Quality System Review Guidelines
BR1307/D, Design-Net Bulletin Board Application
DK101/D, Motorola Data Disk (IBM)
DK105/D, Scattering Parameter Library (IBM)
DK106/D, Scattering Parameter Plotting Utility (IBM)
DK107/D, Impedance Matching Program (IBM)
SG73/D, Master Selection Guide
SG127/D, Surface Mount Products Selector Guide
Dr. BuB, DSP Electronic Bulletin Board
Freeware Line, Microcontroller Electronic Bulletin Board

Motorola Data and Application Literature: IC Literature (continued)

Microprocessor Manuals

BR729/D
The 68K Source — Third Party Vendor Catalog

DSP56000UM/AD
DSP56000/56001 Digital Signal Processor

DSP56116UM/AD
DSP56116 User's Manual

DSP96002UM/AD
DSP96002 IEEE Floating-Point Dual-Port

M6809PM/AD
MC6809-MC6809E Microprocessor Programming Manual

M68000PM/AD
Programmer's Reference to M68000 AND CPU32

M68000UM/AD
MC68000/68008/68010/58HC000 8-/16-32-Bit

MC68020UM/AD
MC68020 32-Bit

MC68030UM/AD
MC68030 Enhanced 32-Bit

MC68EC030UM/AD
EC030 32-Bit Embedded Controller's User's Manual

MC68040DH/AD
MC68040 Designer's Handbook, Preliminary Version

MC68040UM/AD
M68040, 32-Bit

MC68302UM/AD
MC68302 Integrated Multi-Protocol Processor

MC68330UM/AD
Integrated CPU32 Processor User's Manual

MC68331UM/AD
M68300 Family MC68331 User's Manual

MC68332UM/AD
Modular Microcontroller Family MC68332 User's Manual

MC68340UM/AD
MC68340 Integrated Processor

MC68488UM/AD
MC68488 General Purpose Interface Adapter User's Manual

MC68605UM/AD
MC68605 X.25 Protocol Controller

MC68606UM/AD
MC68606 Multi-Link LAPD Protocol Controller

MC68824UM/AD
MC68824 Token Bus Controller

MC68836UM/AD
MC68836 FDDI Clock Generator User's Manual

MC68837UM/AD
MC68837 FDDI Elasticity Buffer and Link Management User's Manual

MC68838UM/AD
MC68838 FDDI Media Access Controller User's Manual

MC68851UM/AD
MC68851 Paged Memory Management Unit

MC68881UM/AD
MC68881/68882 Floating-Point Coprocessor

MC88100UM/AD
MC88100 RISC Microprocessor

MC88110UM/AD
MC88110 Second Generation RISC Microprocessor User's Manual

MC88200UM/AD
MC88200 Cache/Memory Management Unit

MC88410UM/AD
MC88410 Secondary Cache Controller User's Manual

Microcontroller Manuals

ADCRM/AD
Modular Microcontroller Family Analog-to-Digital (ADC) Reference Manual

CPU16RM/AD
M68HC16CPU16 Central Processor Unit Reference Manual

CPU32RM/AD
CPU32 Central Processor Unit

GPTRM/AD
CPU32 Modular Microcontroller Family General Purpose Timer Reference Manual

LONUG/AD
LonBuilder User's Guide

M6805UM/AD3
M6805 HMOS, M146805 CMOS Family User's Manual

M68HC11EVB/AD1
M68HC11EVBU Universal Evaluation Board User's Manual

MC68HC11K4RG/AD
MC68HC11K4 and MC68HC711K4 Programming Reference Guide

MC68HC11KA4RG/AD
MC68HC11KA4 and MC68HC711KA4 Programming Reference Guide

MC68HC11L6RG/AD
MC68HCL6 and MC68HC711L6 Programming Reference Guide

MC68HC16Z1UM/AD
Modular Microcontroller Family MC68HC16Z1 User's Manual

Motorola Data and Application Literature: IC Literature (continued)

Microcontroller Manuals (continued)

MCCIRM/AD
Modular Microcontroller Family Multichannel Communication Interface (MCCI) Ref. Manual

NEURONCPG/AD
NEUTRON C Programmer's Guide

SIMRM/AD
Modular Microcontroller Family System Integration Module (SIM) Reference Manual

M68HC11RM/AD
M68HC11 Reference Manual

M68PCBUG11/D2
M68HC11 PCbug11 User's Manual

MC6801RM/AD2
MC6801/6803/68701 8-Bit Single-Chip

MC68332UM/AD
MC68332 System Integration Manual

MC68488UM/AD
MC68488 General Purpose Interface Adapter

MC68HC05CXRG/AD
MC68HC05CX HCMOS Programming Guide

MC68HC11A8RG/AD
MC68HC11A8 Programming Reference Guide

MC68HC11D3RG/AD
MC68HC11D3, 711D3 Programming Guide

MC68HC11E9RG/AD
MC68HC11E9 Programming Reference Guide

MC68HC11F1RG/AD
MC68HC11F1 Programming Reference Guide

MC68HC811E2RG/D
MC68HC311E2 Programming Reference Guide

QSMRM/AD
Queued Serial Module Reference Manual

TPURM/AD
M68300 Family Time Processor Reference Manual

ASIC Design Manuals

BR165/D
MCA800/MCA2500ECL Macrocell Arrays

BR916/D
Packaging Manual for ASIC Arrays

BR1400/D
OACS System Brochure

HCA62A00DM/D
HCA62A00 Series HCMOS Macrocell Array

H4CDM/D
H4C Series Design Reference Guide

HDCDM/D
HDC Series CMOS Arrays

MCA3ECL/D
MCA3 Series ECL Array

MCA3ETLDM/D
MCA3 ETL Series Arrays

SG367/D
ASIC Overview Guide

Textbooks

TB301/D
Basic Microprocessor and 6800

TB303/D
Using Microprocessors and Microcomputers: The 68000 Family

TB304/D
Pascal Programming Structures for Motorola Microprocessors

TB309/D
Programming the 6809

TB312/D
Introduction to Integrated Circuit Layout

TB313/D
Efficient C

TB316/D
Single and Multi-Chip MCU Interfacing

TB316LM/D
Lab Manual to TB316

TB317/D
6800, 68010, 68020 Primer

TB318/D
Microprocessor Systems Design: 68000 Hardware, Software and Interfacing

TB319/D
MC68000 Assembly Language and Systems Programming

TB320/D
The 68000 Family, Volume 1: Architecture, Addressing Modes and Instruction Set

TB323/D
The 68000 Book

TB324/D
Real Time Digital Signal Processing Applications with Motorola's DSP56000 Family

TB325/D
The Motorola MC68332 Microcontroller

TB325LM/D
Lab Manual to TB325

TB327/D
Using Small Microcontrollers

Motorola Application Literature

Semiconductors in theory and practice

Application Notes, Engineering Bulletins and Article Reprints are part of a total information system to define the characteristics and applications of semiconductor devices. Motorola's library consists of more than 300 such documents dealing with the applications of all types of semiconductors from discrete power transistors to the most complex microprocessors. All are described in an Application Note Catalog available from our Literature Distribution Center.

Individual application notes, application reports, engineering bulletins and article reprints can also be ordered from our Literature Distribution Center.

Contact the Literature Distribution Center for prices and ordering information. In addition, there may be an alternative document available in some countries, contact your local Motorola Sales Office.

For complete summaries and prices: in the U.S.A. order BR135/D from the Literature Distribution Center.

In Europe order SG410/D from the Literature Distribution Centre. An Application Manual Series is also available which includes the following:

DL408/D	8-bit MCU Applications Manual	DL412/D	Industrial Control Applications Manual
DL409/D	16/32-bit Applications Manual	DL413/D	Radio, RF and Video Applications Manual
DL411/D	Communications Applications Manual	DL414/D	FET Applications Manual

Technical Training 1993

Course Offerings on Instructor-led, Audio Cassette and Video Training

MC68EC/000 Microprocessor
This is a 3-day course in which the student learns to design with the MC68000 and MC68EC000 microprocessors. Labs are a major part of the learning process; lecture and exercises are also part of the course.

MC68EC/000 Family Programming
This is a 3-day course in which the student learns software design with the MC68000 and M68EC000 family of microprocessors. Labs are a major part of the learning process; lecture and exercises are also part of the course.

MC68EC/020A Microprocessor
This is a 2-day course in which the student (with MC68000 experience) learns to design with the MC68020 and MC68EC020 CPU including instruction cache. Labs are a major part of the learning process; lecture and exercises are also part of the course.

MC68EC/020B Microprocessor
This is a 4-day course in which the student (with no MC68000 experience) learns to design with the MC68020 and MC68EC020 CPU including instruction cache. Labs are a major part of the learning process; lecture and exercises are also part of the course.

MC68EC/030A Microprocessor
This is a 2-day course in which the student (with M68000 family experience) learns to design with the MC68030 and MC68EC030 CPU including instruction and data caches and memory management unit. Labs are a major part of the learning process; lecture and exercises are also part of the course.

MC68EC/030B Microprocessor
This is a 4-day course in which the student (with no M68000 family experience) learns to design with the MC68030 and MC68EC030 CPU including instruction and data caches and memory management unit. Labs are a major part of the learning process; lecture and exercises are also part of the course.

MC68EC/040A Microprocessor
This is a 2-day course in which the student (with M68000 family experience) learns to design with the MC68040 and MC68EC040 CPU including instruction and data caches and memory management unit. The course consists of lecture and exercises.

MC68EC/040B Microprocessor
This is a 4-day course in which the student (with no M68000 family experience) learns to design with the MC68040 and MC68EC040 CPU including instruction and data caches and memory management unit. The course consists of lecture and exercises.

MC68EC/020/030 Hardware
This is a 1-day course in which the student (with microprocessor experience) learns to design with the hardware of the MC68EC/020 and MC68EC/030 microprocessors. The course consists of lecture and exercises.

MC68302A Communications Controller
This is a 3-day course in which the student (with MC68000 experience) learns to design with the Systems Integration Block and Communications Processor of the MC68302. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

MC68302B Communications Controller
This is a 4-day course in which the student (with MC68000 experience) learns to design with the Systems Integration Block and Communications Processor of the MC68302. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

MC68331/332A Embedded Controller
This is a 3-day course in which a student (with MC68000 experience) learns to design with the CPU32, Queued Serial Module, System Integration Module and Timer Processor Unit (no microcoding) of the MC68332 or General Purpose Timer of the MC68331. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

MC68331/332B Embedded Controller
This is a 4-day course in which a student (with no MC68000 experience) learns to design with the CPU32, Queued Serial Module, System Integration Module and Timer Processor Unit (no microcoding) of the MC68332 or General Purpose Timer of the MC68331. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

MC68340A Integrated Processor
This is a 2-day course in which the student (with M68000 family experience) learns to design with the CPU32, DMA Channels, Timers, Serial I/O Module, and System Integration Module. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

MC68340B Integrated Processor
This is a 3-day course in which the student (with M68000 family experience) learns to design with the CPU32, DMA Channels, Timers, Serial I/O Module, and System Integration Module. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

Ask about our optional pre-requiste days and advanced lab days on some courses.

Technical Training 1993 (continued)

MC88100/200 RISC Microprocessor

This is a 3-day course in which the student learns to design with the MC88100 RISC and MC88200 CMMU. The course consists of lecture and exercises.

MC68HC05 Microcontroller

This is a 3-day course in which the student (with micro- processor experience) learns to design with the MC68HC05 including the on-chip subsystems. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

MC68HC11 Microcontroller

This is a 3-day course in which the student (with microprocessor experience) learns to design with the MC68HC11 including the on-chip subsystems. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

MC68HC16 Microcontroller

This is a 3-day course in which the student (with microprocessor experience) learns to design with the CPU16, Queued Serial Module, System Integration Module, Analog-to-Digital Converter, and General Purpose Timer of the MC68HC16. Labs are a major part of the learning process; lecture and exercises are also a part of the course.

DSP56100 Family

This is a 3-day course in which the student (with digital signal processing design experience) learns to design with the DSP56156 digital signal processor. The course consists of lecture and exercises.

DSP56000/1 Digital Signal Processor

This is a 4-day course in which the student (with digital signal processing design experience) learns to design with the DSP56000/1 digital signal processor. The course consists of lecture, labs, and exercises.

DSP96000 Digital Signal Processor

This is a 4-day course in which the student (with digital signal processing design experience) learns to design with the DSP96000 digital signal processor. The course consists of lecture and exercises.

TPU Microcode

The TPU Microcode course is a 3-day lab-intensive course in which the student learns how to write microcode functions for the TPU. The course is approximately 50% lecture and exercises and 50% lab time.

Fuzzy Logic

This course teaches the student how to develop embedded systems using fuzzy logic methodologies. The 3-day course consists of a mixture of lecture which covers fuzzy logic concepts, system development considerations and specific operation of the development environment, and lab where the student proceeds through the steps to develop a simple fuzzy logic-based application. Motorola's Fuzzy Inference Development Environment (FIDE) software will be used in the lab portions of the course. Although fuzzy logic can be used with different MCUs, the MC68HC11 8-bit MCU is used in all of the lab portions of the course as the specific application processor.

MC68360 QUIC

This course covers the features and subsystems of the MC68360. An in-depth overview of all the subsystems of the MC68360 as well as a brief review of the MC68000 family architecture is provided. This course will address the design issues encountered while using the subsystems (CPU32+, Timers, serial channels, IDMA channels, chip selects, memory controller, PIP and the SPI) of the MC68360 in a typical application.

PowerPC

The PowerPC course provides a background for the entire PowerPC family. The course is built around the PowerPC Architecture specification, the guideline from which each PowerPC implementation (i.e. each processor) is built. Details of all publicly announced implementations are discussed.

Ask about our optional pre-requiste days and advanced lab days on some courses.

Technical Training 1993 (continued)

Not all courses described are scheduled in 1993. If you or your company has a special need for one of these courses, call us at (602) 897-3665 and we will make special arrangements. If you are outside the USA, contact your local Motorola Sales Office or Technical Training Center listed in this section.

Call 1-800-521-6274 for the latest copy of our Technical Training Catalog and class schedule. If you are outside of the USA, call your local Technical Training Center or Sales Office and ask for BR348AD/D Rev 9.

Technical Training Centers

Regional Training Centers

Detroit
41700 Six Mile Road
Nothville, MI 48167
(313) 347-6800

Phoenix
2100 E. Elliot Road EL524
Tempe, AZ 85284
(602) 897-4172
(800) 521-6274

Worldwide Training Centers

Munich, Germany
Phone: (89) 92103-571

Kwai Chung, N.Y. Hong Kong
Phone: 0-223111

Madrid, Spain
Phone: 457 82 04

Solna, Sweden
Phone (8) 7348800

Vanves Cedex, France
Phone: (1) 40955900

Ramat, Israel
Phone: 972-3-7538222

Aylesbury, United Kingdom
Phone: (0296) 393312

Assago Milano, Italy
Phone: (39) 282201

Audio Cassette Courses

MC68000 Microprocessor/MTTA1/CC

Course description:

This course is an introduction to the MC68000. It covers the major features of the MC68000: pins and bus operation, programming model, addressing modes, instruction set and exception processing (including interrupts). Software and hardware examples are included.

Who should take this course:

The student should be familiar with memory concepts, binary numbers, hexadecimal number notation, binary arithmetic and standard logic operations. Experience with an 8-bit microprocessor, a 16-bit minicomputer, or a mainframe would be beneficial. After completion of this course, the student will have a working, technical knowledge of the MC68000.

Course content:

The course is composed of three audio cassette tapes containing approximately four and one-half hours of material. Course notes for the tapes and an MC68000 User's Manual are supplied to aid the student. A set of application notes and other helpful technical materials are also included. Each topic begins with clearly set objectives and continues with a comprehensive study of the subject, including self-evaluation exercises (answers are provided).

MC68020 Microprocessor/MTTA2/CC

Course description:

This course is an introduction to the MC68020. It covers the major features of the MC68020: internal architecture, programming model, pins and bus operations, addressing modes, instruction set and exception processing.

Who should take this course:

The student should be familiar with MC68020. After completion of this course, the student will have a working, technical knowledge of the MC68020.

Course content:

The course is composed of three audio cassette tapes containing approximately four and one-half hours of material. Course notes for the tapes and an MC68020 User's Manual are supplied to aid the student. A set of application notes and other helpful technical materials are also included. Each topic begins with clearly stated objectives, continues with a comprehensive study of the subject and concludes with a set of self-evaluation exercises (answers are provided).

MC68030 Microprocessor/MTTA3/CC

Course description:

This course is an introduction to the MC68030. It covers the major features of the MC68030: data cache, burst mode, synchronous bus and the internal Memory Management Unit.

Who should take this course:

This course assumes knowledge of the MC68000 and the MC68020. After completion of this course, the student will have a working, technical knowledge of the MC68030.

Course content:

The course is composed of three audio cassette tapes containing approximately three and one-half hours of material. Course notes for the tapes and an MC68030 User's Manual are supplied to aid the student. Each topic begins with clearly stated objectives and continues with a comprehensive study of the subject, including self-evaluation exercises (answers are provided).

DSP56000/1 Microprocessor/MTTA5/CC

Course description:

This course contains a brief overview of general Digital Signal Processing concepts. The main course content covers specifics of the DSP56000 and DSP5601 including the following: internal architecture and programming model, pins and buses, general addressing modes, general instruction set, exception processing, on-chip I/O, plus the DSP instructions and addressing modes.

Who should take this course:

The student should be familiar with memory concepts, binary numbers, hexadecimal number notation, binary arithmetic, standard logic operations and analog signal processing. After completion of this course, the student will have a working, technical knowledge of the DSP56000/1.

Course content:

The course is composed of three audio cassette tapes containing approximately four and one-half hours of material. Each topic has stated objectives and self-evaluation exercises with answers.

Cassettes are available through Literature Distribution Center – call (602) 994-6561 or 1-800-441-2447

Audio Cassette Courses (continued)

MC88100/MC88200/MTTA6/CC

Course description:
This course is an introduction to the MC88100/MC88020. This course covers: pins and registers, exception processing (including interrupts), addressing modes, instruction set, cache and Memory Management Unit.

Who should take this course:

Experience with a 16/32-bit microprocessor or mainframe is required. After completing the course, the student will have a working, technical knowledge of the MC88100/MC88200.

Course content:
The course is composed of three audio cassette tapes containing approximately four and one-half hours of material. Course notes for the tapes are supplied to aid the student. Each topic begins with clearly stated objectives and continues with a comprehensive study of the subject including self-evaluation exercises (answers are provided).

Video Training

Basic Semiconductor Videos

This brand new video training program “Motorola and the Semiconductor Universe” is a four part video program covering basic electronics and semiconductors for non-technical people. It is designed for Motorolans who are in support, administrative, and sales roles who are not EEs, but are involved in the daily business of serving SPS customers. It will also be ideal for our authorized distributors and direct customer buyers who would like to know more about the products they are purchasing. The series was produced by the Sales and Marketing Training Department.

The program is designed to answer the following questions:
- Why are we in business – what is the benefit to the customer?
- What do we make, and how do we make it?
- How do our products work?
- How are our products used by the customer, and where do they use them?
- What do our products do to provide specific customer solutions in their products?

The program uses many “real-life” examples and analogies. It graphically shows, through video animation and live footage, how electrons and the products we build to control them affect our everyday lives. The program includes supportive written material and is designed in a four part series:
- Part 1 - “The Fundamentals”
- Part 2 - “Discretes”
- Part 3 - “Integrated Circuits”
- Part 4 - “Microprocessors and Microcontrollers”, including Memories.

The order number for this training program is SEMIVID/D and it can be ordered from the Literature Distribution Center for $100.

Cassettes and videos are available through Literature Distribution Center – call (602) 994-6561 or 1-800-441-2447

Device Index and Subject Index

In Brief . . .

Device Index

The following index lists the device numbers of the products contained in this selector guide and references the page number where each device is described in greater detail.(1) The listing is in a numeric sequence organized in a "computer sort." This means that all the devices listed herein follow a 39 character alphabet. This "new" alphabet starts with a Period, a Dash and a Slash (. – /), followed by the 26 letter alphabet (A thru Z), which is then followed by 10 numbers (0 thru 9).

The ranking or hierarchy of this 39 character alphabet is as follows:

. – / A B C D E F G H I J K L M N O P Q R S T U V W X Y Z 0 1 2 3 4 5 6 7 8 9

Therefore, if you are looking for a device starting with a letter of the alphabet like an MC1741CP, it would appear before a device starting with a number, such as 2N1132.

To find a device in this index, start with the first character of the device and find that section of the index; next move to the second character in the device number, and move to that character within the same portion of the listing; and so on until the device number is found. In other words, it is used just like a dictionary, character by character.

For example, to find the 2N6837, go to that section of the listing that begins with the number "2" (Notice that the section follows all devices that begin with a letter of the alphabet or "1"). Next, find that portion of the listing that begins with "2N" (Notice it follows those devices that begin with "2K"). Next, find that portion of the listing that begins with "2N6" (Notice it follows those devices that begin with "2N5"). Continue looking for those portions that begin with the next consecutive character until you have found the entire number.

Because of the way "Computer Sort" works it is not necessary to be concerned with the absolute value or number of characters in a part number, just move across the device part number, left to right, one character at a time until you find the number.

Subject Index

This listing is intended to simplify the identification of products where specific device numbers are not known.

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(1) The device numbers contained in this index are for reference only and do not necessarily represent the complete device number necessary to order the device. Contact your local Sales Office or Authorized Distributor for complete ordering information.

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Sales Offices and Distributors

In Brief . . .

Motorola's vast network of sales offices and distributors, augmented by manufacturing centers throughout the world, not only ensures easy communications, cost-effective pricing and rapid service, but guarantees a continuing stream of state-of-the-art products based on worldwide experience and demand.

This section identifies for you the Motorola North American Distributors, European Distributors, and Worldwide Sales Offices and their phone numbers.

The information contained in this section is accurate to the date of publication.

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6/1/93

MOTOROLA DISTRIBUTOR AND WORLDWIDE SALES OFFICES

AUTHORIZED NORTH AMERICAN DISTRIBUTORS

UNITED STATES

ALABAMA

Huntsville
- Arrow/Schweber Electronics (205)837-6955
- Future Electronics (205)830-2322
- Hall-Mark Electronics (205)837-8700
- Hall-Mark Electronics (205)837-8700
- Newark (205)837-9091
- Time Electronics (205)721-1133

Arizona

Chandler
- Hamilton/Avnet Electronics (602)961-0836

Phoenix
- Future Electronics (602)968-7140
- Hall-Mark Electronics (602)437-1200
- Newark Electronics (602)864-9905
- Wyle Laboratories (602)437-2088

Tempe
- Arrow/Schweber Electronics (602)431-0030
- Time Electronics (602)967-2000

CALIFORNIA

Agoura Hills
- Time Electronics Corporate (818)707-2890

Belmont
- Richardson Electronics (415)592-9225

Calabassas
- Arrow/Schweber Electronics (818)880-9686
- Wyle Laboratories (818)880-9000

Chatsworth
- Future Electronics (818)772-6240
- Hall-Mark Electronics (818)773-4500
- Time Electronics (818)998-7200

Costa Mesa
- Hamilton/Avnet Electronics (714)754-6092

Culver City
- Hamilton/Avnet Corporate (213)558-2000

Gardena
- Hamilton/Avnet Electronics (213)516-6498

Irvine
- Arrow/Schweber Electronics (714)587-0404
- Future Electronics (714)250-4141
- Hall-Mark Electronics (714)727-6000
- Wyle Laboratories Corporate (714)753-9953
- Wyle Laboratories (714)863-9953

Mountain View
- Richardson Electronics (415)960-6900

Orange
- Newark (714)634-8224

Rocklin
- Hall-Mark Electronics (916)624-9781

Sacramento
- Hamilton/Avnet Electronics (916)925-2216
- Newark (916)721-1633
- Wyle Laboratories (916)638-5282

San Diego
- Arrow/Schweber Electronics (619)565-4800
- Future Electronics (619)278-5020
- Hall-Mark Electronics (619)268-1201
- Hamilton/Avnet Electronics (619)571-8730
- Newark (619)569-9877
- Wyle Laboratories (619)565-9171

San Francisco
- Newark (415)571-5300

San Jose
- Arrow/Schweber Electronics (408)441-9700
- Arrow/Schweber Electronics (408)428-6400
- Future Electronics (408)434-1122
- Hall-Mark Electronics (408)432-4000

Santa Clara
- Wyle Laboratories (408)727-2500

Sunnyvale
- Hamilton/Avnet Electronics (408)743-3300
- Time Electronics (408)734-9888

Torrance
- Time Electronics (310)320-0880

Tustin
- Time Electronics (714)669-0100

West Hills
- Newark (818)888-3718

Woodland Hills
- Hamilton/Avnet Electronics (818)594-0404
- Richardson Electronics (615)594-5600

COLORADO

Broomfield
- Future Electronics (303)421-0123

Colorado Springs
- Newark (719)592-9494

Denver
- Newark (303)757-3351

Englewood
- Arrow/Schweber Electronics (303)799-0258
- Hall-Mark Electronics (303)790-1662
- Hamilton/Avnet Electronics (303)740-1000
- Time Electronics (303)721-8882

Thornton
- Wyle Laboratories (303)457-9953

CONNECTICUT

Bethel
- Future Electronics (203)743-9594

Cheshire
- Hall-Mark Electronics (203)271-2844

Danbury
- Hamilton/Avnet Electronics (203)743-6077

Southbury
- Time Electronics (203)271-3200

Wallingfort
- Arrow/Schweber Electronics (203)265-7741

Windsor
- Newark (203)683-8860

FLORIDA

Altamonte Springs
- Future Electronics (407)767-8414

Casselberry
- Hall-Mark Electronics (407)830-5855

Clearwater
- Future Electronics (813)530-1222
- Hall-Mark Electronics (813)541-7440

Deerfield Beach
- Arrow/Schweber Electronics (305)429-8200

Ft. Lauderdale
- Hamilton/Avnet Electronics (305)767-6377
- Time Electronics (305)484-1778

Lake Mary
- Arrow/Schweber Electronics (407)333-9300

Orlando
- Hamilton/Avnet Electronics (407)628-3888
- Newark (407)896-8350
- Time Electronics (407)841-6565

Plantation
- Newark (305)424-4400

Pompano Beach
- Hall-Mark Electronics (305)971-9280

Tampa/St. Petersburg
- Hamilton/Avnet Electronics (813)573-3930
- Newark (813)287-1578
- Time Electronics (407)841-6565

Winter Park
- Richardson Electronics (407)644-1453

GEORGIA

Atlanta
- Time Electronics (404)351-3545

Duluth
- Arrow/Schweber Electronics (404)497-1300
- Hall-Mark Electronics (404)623-4400
- Hamilton/Avnet Electronics (404)446-0611

Norcross
- Future Electronics (404)441-7676
- Newark (404)448-1300
- Time Electronics (404)368-0969

ILLINOIS

Bensenville
- Hamilton/Avnet Electronics (708)860-7700

Chicago
- Newark Electronics Corp. (312)784-5100

Hoffman Estates
- Future Electronics (708)882-1255

Itasca
- Arrow/Schweber Electronics (708)250-0500

LaFox
- Richardson Electronics (708)208-2401

Schaumburg
- Newark (708)310-8980
- Time Electronics (708)303-3000

Wooddale
- Hall-Mark Electronics (708)860-3800

INDIANA

Indianapolis
- Arrow/Schweber Electronics (317)299-2071
- Hall-Mark Electronics (317)872-8875
- Hamilton/Avnet Electronics (317)844-9333
- Newark (317)259-0085
- Time Electronics (708)303-3000

Ft. Wayne
- Newark (219)484-0766

IOWA

Cedar Rapids
- Hamilton/Avnet Electronics (319)362-4757
- Newark (319)393-3800
- Time Electronics (314)391-6444

KANSAS

Lenexa
- Arrow/Schweber Electronics (913)541-9542
- Hall-Mark Electronics (913)888-4747

Overland Park
- Hamilton/Avnet Electronics (913)888-8900
- Newark (913)677-0727
- Time Electronics (314)391-6444

MARYLAND

Beltsville
- Newark (301)604-1700

Columbia
- Arrow/Schweber Electronics (301)596-7800
- Future Electronics (301)290-0600
- Hall-Mark Electronics (301)988-9800
- Hamilton/Avnet Electronics (301)995-3500
- Time Electronics (301)964-3090

MASSACHUSETTS

Billerica
- Hall-Mark Electronics (508)667-0902

Boston
- Arrow/Schweber Electronics (508)658-0900
- Hamilton/Avnet Electronics (508)531-7430

Bolton
- Future Corporate (508)779-3000

Burlington
- Wyle Laboratories (617)272-7300

Methuen
- Newark (508)683-0913

Norwell
- Richardson Electronics (617)871-5162

Peabody
- Time Electronics (508)532-9900

AUTHORIZED DISTRIBUTORS – continued

UNITED STATES – continued

MICHIGAN

Detroit
- Newark (313)967-0600

Grand Rapids
- Hamilton/Avnet Electronics (616)243-8805

Livonia
- Arrow/Schweber Electronics (313)462-2290
- Future Electronics (313)261-5270
- Hall-Mark Electronics (313)462-1205
- Hamilton/Avnet Electronics (313)347-4270
- Time Electronics (614)794-3301

MINNESOTA

Eden Prairie
- Arrow/Schweber Electronics (612)941-5280
- Future Electronics (612)944-2200
- Hall-Mark Electronics (612)881-2600
- Time Electronics (612)943-2433

Minneapolis
- Hamilton/Avnet Electronics (612)932-0600
- Newark (612)331-6350

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Earth City
- Hall-Mark Electronics (314)291-5350
- Hamilton/Avnet Electronics (314)537-1600

St. Louis
- Arrow/Schweber Electronics (314)567-6888
- Future Electronics (314)469-6805
- Newark (314)298-2505
- Time Electronics (314)391-6444

NEW HAMPSHIRE

Manchester
- Hamilton/Avnet Electronics (603)624-9400

NEW JERSEY

Cherry Hill
- Hamilton/Avnet Electronics (609)424-0100

Fairfield
- Future Electronics (201)299-0400
- Newark (201)882-0300

Marlton
- Arrow/Schweber Electronics (609)596-8000
- Future Electronics (609)778-7600

Mount Laurel
- Hall-Mark Electronics (609)235-1900

Pinebrook
- Arrow/Schweber Electronics (201)227-7880

Parsippany
- Hall-Mark Electronics (201)515-3000
- Hamilton/Avnet Electronics (201)575-3390

Wayne
- Time Electronics (201)785-8250

NEW MEXICO

Albuquerque
- Alliance Electronics (505)292-3360
- Hamilton/Avnet Electronics (505)345-0001
- Newark (505)828-1878

NEW YORK

Commack
- Newark (516)499-1216

Fairport
- Hall-Mark Electronics (716)425-3300

Hauppauge
- Arrow/Schweber Electronics (516)231-1000
- Future Electronics (516)234-4000
- Hall-Mark Electronics (516)737-0600
- Hamilton/Avnet Electronics (516)231-9800

Liverpool
- Future Electronics (315)451-2371

Pittsford
- Newark (716)381-4244

Rochester
- Arrow/Schweber Electronics (716)427-0300
- Future Electronics (716)272-1120
- Hall-Mark Electronics (716)425-3300
- Hamilton/Avnet Electronics (716)292-0730
- Richardson Electronics (716)264-1100
- Time Electronics (315)432-0355

Rockville Centre
- Richardson Electronics (516)872-4400

Syracuse
- Hamilton/Avnet Electronics (315)437-2641
- Time Electronics (315)432-0355

NORTH CAROLINA

Charlotte
- Future Electronics (704)455-9030
- Richardson Electronics (704)548-9042

Greensboro
- Newark (919)292-7240

Raleigh
- Arrow/Schweber Electronics (919)876-3132
- Future Electronics (919)790-7111
- Hall-Mark Electronics (919)872-0712
- Hamilton/Avnet Electronics (919)878-0810
- Time Electronics (919)693-5166

OHIO

Centerville
- Arrow/Schweber Electronics (513)435-5563

Cleveland
- Hall-Mark Electronics (216)349-4632
- Hamilton/Avnet Electronics (216)349-5100
- Newark (216)391-9330
- Time Electronics (614)794-3301

Columbus
- Hamilton/Avnet Electronics (614)882-7004
- Newark (614)431-0809
- Time Electronics (614)794-3301

Dayton
- Hamilton/Avnet Electronics (513)439-6700
- Newark (513)294-8980
- Time Electronics (614)794-3301

Mayfield Heights
- Future Electronics (216)449-6996

Solon
- Arrow/Schweber Electronics (216)248-3990

Toledo
- Hamilton/Avnet Electronics (419)242-6610

Worthington
- Hall-Mark Electronics (614)888-3313

OKLAHOMA

Tulsa
- Hall-Mark Electronics (918)254-6110
- Hamilton/Avnet Electronics (918)252-7297
- Newark (918)252-5070

OREGON

Beaverton
- Arrow/Almac Electronics Corp. (503)629-8090
- Future Electronics (503)645-9454
- Wyle Laboratories (503)643-7900

Portland
- Hamilton/Avnet Electronics (503)627-0201
- Newark (503)297-1984
- Time Electronics (503)626-2979

PENNSYLVANIA

Erie
- Hamilton/Avnet Electronics (814)455-6767

King of Prussia
- Newark (215)265-0933

Montgomeryville
- Richardson Electronics (215)628-0805

Philadelphia
- Hall-Mark Electronics (215)355-7300
- Time Electronics (609)596-6700

Pittsburgh
- Arrow/Schweber Electronics (412)963-6807
- Hamilton/Avnet Electronics (412)281-4150
- Newark (412)788-4790
- Time Electronics (614)794-3301

TENNESSEE

Franklin
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