Digital Equipment Corporation
Maynard, Massachusetts

digital

Maintenance Manual

TU20
TAPE TRANSPORT
MAINTENANCE MANUAL

DEC-00-I4AB-D

TU20
TAPE TRANSPORT
MAINTENANCE MANUAL

DIGITAL EQUIPMENT CORPORATION • MAYNARD, MASSACHUSETTS

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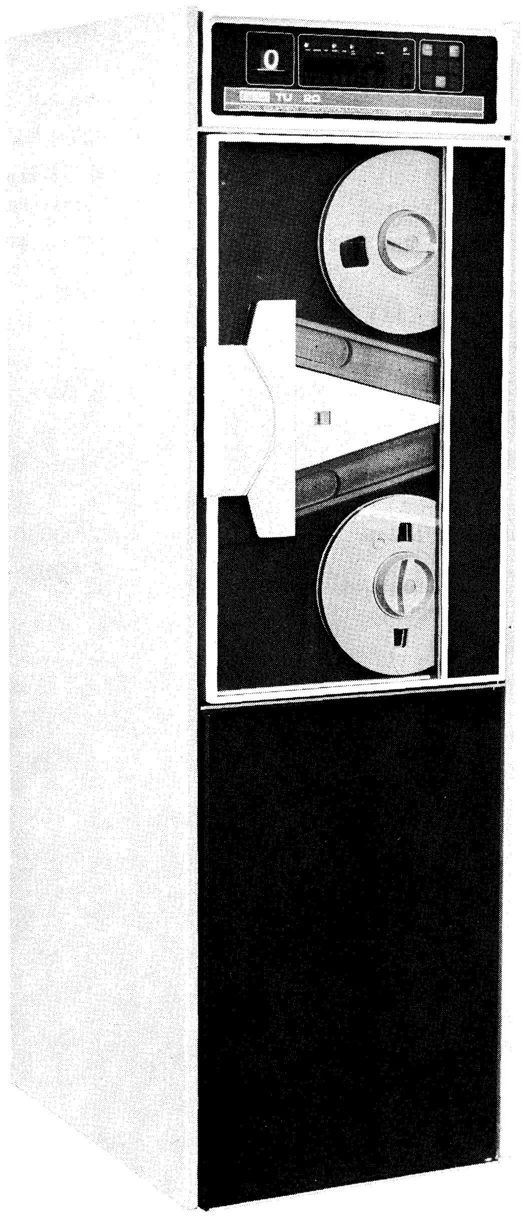
CONTENTS

CONTENTS (Cont)

ILLUSTRATIONS

ILLUSTRATIONS (Cont)

TABLES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CHAPTER 1
INTRODUCTION

This manual, together with referenced documents, provides operation and maintenance information for the TU20 Tape Transport used with the PDP-8, PDP-9, PDP-15, or PDP-10 computers. The levels of discussion assume that the reader has a familiarity with the applicable processor, as well as a working knowledge of similar magnetic tape systems.

1.1 GENERAL DESCRIPTION

The TU20 Tape Transport connects to the PDP-8 via the TC58 Tape Control Unit, to the PDP-9 and PDP-15 via the TC59 Tape Control Unit, and to the PDP-10 via the TM10 Tape Control Unit. The computer (PDP-8, PDP-9, PDP-15, or PDP-10) controls the operation of the tape transport by issuing IOT instructions to the tape control unit which decodes the instructions and specifies to the tape transport a specific operation. To write on tape, the tape control unit sends a motion-forward command and a write-enable command, and for each character to be recorded, it sends a record data pulse. For spacing and reading the tape, the tape control unit sends the required motion command. Regardless of the operation, the tape is always being read, and the data is sent back to the tape control unit. The tape control unit then uses the read information for detecting end-of-record to terminate operation.

The TU20 Tape Transport operates at 45 in./s and has three recording densities: 200, 556, and 800 bpi. The maximum transfer rate is 36,000 six-bit characters per second, and the standard 7-channel IBM-compatible tape format is used.

The TU20A is a different version of the TU20 and has essentially the same characteristics except that it records data in standard 9-channel IBM-compatible tape format.

Each TU20 consists of three basic sections: the tape transport, DEC logic, and the Control/Indicator Panel (see Figure 1-1). The tape transport, which consists of all the mechanical parts and related logic, is manufactured by DATAMEC, a division of Hewlett/Packard. The DEC logic allows the TU20 to be controlled by a TC58, TC59, or TM10 Tape Control Unit. The switches on the Control/Indicator Panel provide various functions, such as power to the transport, selection of local or remote mode operation, and control of the transport during local operation. All of the indicator lights denote the current status of the tape transport such as READY or in REWIND operation. The transport, DEC logic, and Control/Indicator Panel are all assembled into a standard DEC 19-inch cabinet.

1.2 EQUIPMENT SPECIFICATIONS

Tables 1-1 and 1-2 list the specifications for the TU20 and TU20A Tape Transports.

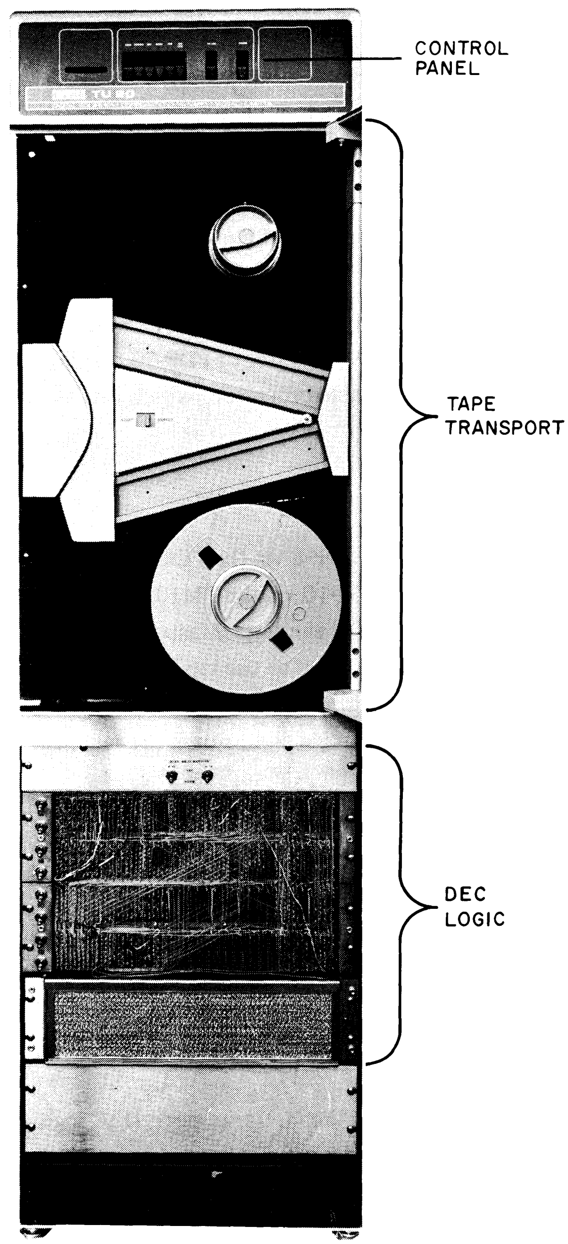


Figure 1-1 TU20 Tape Transport

Table 1-1
TU20 Specifications

Format

NRZI. Six data bits plus one parity bit. End and loadpoint sensing compatible with IBM 729 I–VI.

Tape

Width: 0.5 in.
Length: 2400 ft (1.5 mil).
Reels are 10.5 in., IBM-compatible, with file protect (write lock) ring.

Heads

Write-read gap of 0.300 in. Dynamic and static skew is less than 14 μs.

Tape Specifications

45 ips speed.
Rewind time is less than 3 minutes (2400 ft).
Start distance is 0.1 in. (±0.032 in.).
Stop time is less than 1.5 ms.
Stop distance is 0.045 in. (±0.015 in.).

Density

200, 556, and 800 bpi. Maximum transfer rate is 36 kHz.

Transport Mechanism

Pinch roller drive; vacuum column tension.

Controls

POWER, ON LINE, OFF LINE, FORWARD, REVERSE, REWIND, LOAD, RESET.

Physical Specifications

Width: 22-1/4 in.
Depth: 27-1/16 in.
Height: 69-1/8 in.
Weight: 600 lb.

Read (Read/Compare) Shutdown Delay

3.6 ms.

Write Shutdown Delay

Approximately 4.5 ms.

Table 1-2
TU20A Specifications

Format

NRZI. Eight data bits plus one parity bit. End and loadpoint sensing compatible with IBM.

Tape

Width: 0.5 in.
Length: 2400 ft (1.5 mil).
Reels are 10.5 in., IBM-compatible, with file protect (write lock) ring.

Heads

Write-read gap of 0.150 in. Dynamic and static skew is less than 14 μs.

Tape Specifications

45 ips speed.
Rewind time is less than 3 minutes (2400 ft).
Start distance is 0.080 in. (+0.035, -0.025 in.).
Stop time is less than 1.5 ms.
Stop distance is 0.045 in. (±0.015 in.).

Density

800 bpi. Maximum transfer rate is 36 kHz.

Transport Mechanism

Pinch roller drive; vacuum column tension.

Controls

POWER, ON LINE, OFF LINE, FORWARD, REVERSE, REWIND, LOAD, RESET.

Physical Specifications

Width: 22-1/4 in.
Depth: 27-1/16 in.
Height: 69-1/8 in.
Weight: 600 lb.

Read (Read/Compare) Shutdown Delay

3.6 ms.

Write Shutdown Delay

Approximately 4.5 ms.

1.3 REFERENCED DOCUMENTS

The information contained in the following documents is for use in conjunction with this manual.

Manual	Doc. No.
PDP-8 Computer Handbook	F-85
PDP-9 Computer Handbook	F-95
TC58 Tape Control Manual	DEC-08-I4AB-D
TC59 Tape Control Manual	DEC-9A-I3BB-D
TM10 Tape Control Manual	DEC-10-I4AA-D
DATAMEC D2020 Series Manual including Operating and Service Manual for Model 7975A Tape Transport	
DEC Logic Handbook	C-105

This material is available from the nearest DEC Field Office or from:

Digital Equipment Corporation
Direct Mail Department
146 Main Street
Maynard, Massachusetts 01754

CHAPTER 2
INSTALLATION

This chapter provides information that is necessary for the proper installation of the Type TU20 Magnetic Tape Transport unit for use with the PDP-8, PDP-9, PDP-15, or PDP-10 computers.

2.1 SITE PREPARATION

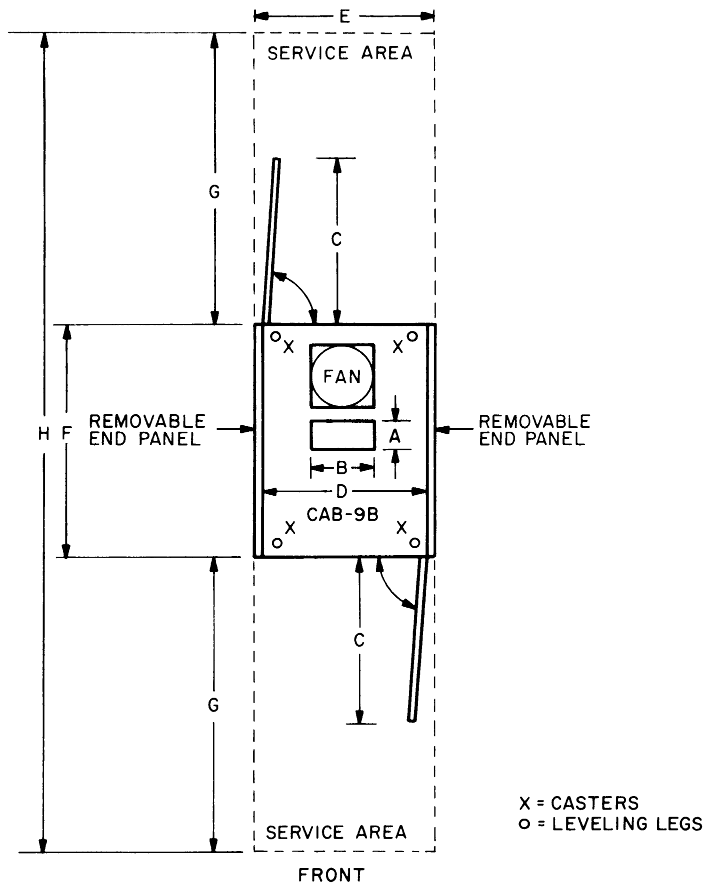
No special site preparation is required, except for the floor space dimensions outlines in Figure 2-1. As shown, adequate clearance for access must be provided in the bottom of the cabinet. Two wheels and two leveling devices on the bottom of the unit allow the cabinet to be easily positioned, with clearance for the cables. Normally, subflooring is required.

2.2 ENVIRONMENTAL CONDITIONS

The environmental conditions for the proper operation of the magnetic tape transport are limited by the tape transport. The in-cabinet air temperature must be maintained between +55 and +100°F, and the recommended relative humidity must fall between 40 and 60%. The installation site must also be as free as possible from excess dirt and dust, corrosive fumes and vapors, and strong magnetic fields.

2.3 CABLE INTERCONNECTIONS

For the cable interconnections between the TU20 and the TC58, TC59, or TM10 Magnetic Control Unit, refer to the applicable magnetic control unit manual.



DIMENSIONS	A	B	C	D	E	F	G	H
INCHES	3.5	7.0	19.3	20.3	22.0	29.0	36.0	100
METERS	0.09	0.18	0.49	0.52	0.54	0.72	0.90	2.50

10-0452

Figure 2-1 Installation Dimensions, Top View

CHAPTER 3
OPERATION AND PROGRAMMING

The programming of the TU20 Tape Transport is controlled via the TC58, TC59, or TM10 Tape Control Unit; therefore, the appropriate tape control manual should be consulted for programming information. This chapter describes the operational controls and indicators on the tape transport control panel.

3.1 CONTROLS

Figure 3-1 shows the tape transport control panel. Table 3-1 defines the functions of the control panel switches and Table 3-2 defines the function of the control panel indicators.

Figure 3-1 TU20 Control Panel

The tape transport can be operated locally by the control panel or remotely by the computer. The front panel OFF LINE control is depressed to put the tape transport into local operation when the control panel FORWARD, RESET, REVERSE, and REWIND switches are enabled. If either the FORWARD, REVERSE, or REWIND control is depressed, the tape moves in the specified direction until RESET is depressed, or the beginning of tape is detected for REWIND, or the end of tape is detected for FORWARD.

The ON-LINE control on the front panel is depressed to put the tape transport into remote operation. The tape transport must be selected by the tape control unit, however, before it can be operated remotely by the computer.

Table 3-1
Control Panel Switches

Switch	Function
POWER	Applies power to the entire TU20.
ON LINE	Selects programmed (remote) operation by the computer.
OFF LINE	Selects local operation by the control panel.
FWD	In local operation, spaces the tape in the forward direction.
REV	In local operation, spaces the tape in the reverse direction.
REWIND	In local operation, rewinds the tape at high speed.
RESET	In local operation, terminates the space forward, space reverse, or rewind operation.
LOAD	Enables the vacuum motor which draws the tape into the vacuum columns.
Unit Select Rotary Switch	Selects the tape transport unit by number (0–7). This number is used in the program to select the tape transport.

Table 3-2
Control Indicators

Indicator	Function
SELECT*	Indicates that the tape transport is selected by the tape control (or program).
READY*	Indicates that the tape transport is ready (vacuum on, and settle-down delay complete), no motion.
LOAD POINT*	Indicates that the tape is at load point.
END POINT*	Indicates that the tape is at end point (end of tape).
WRITE LOCK*	Indicates that the write lock-out ring is missing from the tape reel which prevents the write function.
WRITE STATUS*	Indicates that the program has enabled the write function in the tape transport.
9*	Indicates that this tape transport is a 9-track tape transport.
7*	Indicates that this transport is a 7-track tape transport.
REWIND*	Indicates that the tape transport is in the rewind operation.
LOAD	Indicates that the vacuum is on and the tape is loaded into the vacuum columns.
REV	Indicates that reverse operation is specified.
REWIND	Indicates that rewind operation is specified.

* This designation is visible through the translucent panel on the right side only when an associated indicator is illuminated behind the panel. (The photograph in Figure 3-1 was taken with all indicators illuminated; this condition will never occur during normal operation.)

(continued on next page)

Table 3-2 (Cont)
Control Indicators

Indicator	Function
RESET	Indicates that no motion (forward, reverse, or rewind) is specified.
FWD	Indicates that forward motion of the tape is specified.
OFF LINE	Indicates local operation by the control panel.
ON LINE	Indicates remote operation by the computer.
POWER	Indicates that power is applied to the tape transport.

3.2 TAPE LOADING

For information on installing and removing the file reel and threading the tape through the head section, refer to the Hewlett/Packard Operating and Service Manual for Model 7975A Tape Transport, Section III.

CHAPTER 4
PRINCIPLES OF OPERATION

This chapter describes in detail, the logic circuits of the TU20 Tape Transport. The TU20 operates under the control of the TC58, TC59, or TM10 control unit; therefore the reader should be familiar with the logic operation of the control unit.

4.1 GENERAL OPERATION

The operations performed by the tape transport under the control of the tape control unit are similar. The tape control sends the specified function, the tape transport responds by moving the tape in the specified direction until the tape control unit sends a stop signal. For example, consider the tape transport in remote status, selected by the tape control, and the tape transport ready. Upon receipt of computer instructions, the tape control unit initiates operation by sending a SET FUNCTION pulse. Simultaneously the particular tape function (forward, reverse, rewind, or write enable) is specified on the bus line. The SET FUNCTION pulse (Dwg. No. TU20-0-2, Sheet 2) generates the particular SET REVERSE, SET FORWARD, SET REWIND, or SET WRITE ENABLE pulse (or pulses) which set the appropriate flip-flop (Dwg. No. TU20-0-1, Sheet 2). The particular FORWARD, REVERSE, or REWIND signal is sent to the tape drive to move the tape in the specified direction (Dwg. No. TU20-0-2, Sheet 1).

The tape continues moving in the specified direction until the tape control signals it to stop; this is accomplished by the MOVE signal (Dwg. No. TU20-0-2, Sheet 1) from the tape control.

When the MOVE signal goes to zero, it generates the CLEAR FUNCTION pulse, which clears the function command flip-flops (FORWARD, REVERSE, etc.). Since the tape motion command is removed, the tape motion stops.

The integrating one-shot delay SETTLING DOWN is direct set until the motion flip-flop is cleared and 5 ms have elapsed. This provides a 5 ms delay to allow for settling down of the tape. During this time, the tape transport remains in a not-ready state to inhibit any tape functions until the settling-down period is over.

The vacuum columns allow the tape to be moved freely and reduce tape stretching. The staggered motion of the Take-Up Motor and the Supply Motor during forward or reverse motion is due to the vacuum switches (see Figure 4-1). When tape passes across these vacuum switches, they either enable or disable the motors. Vacuum switches VS 5, 7, and 8 are fail-safe switches which, if tape passes over them, will automatically shut off power to the transport, thereby preventing tape stretching or an excessive amount of tape in the vacuum columns.

4.2 MOTION DELAY

As explained in the tape control manual, the interrecord delay is implemented by a countdown counter which is set up in the tape transport. When the tape control unit is ready to receive the motion-delay number from the

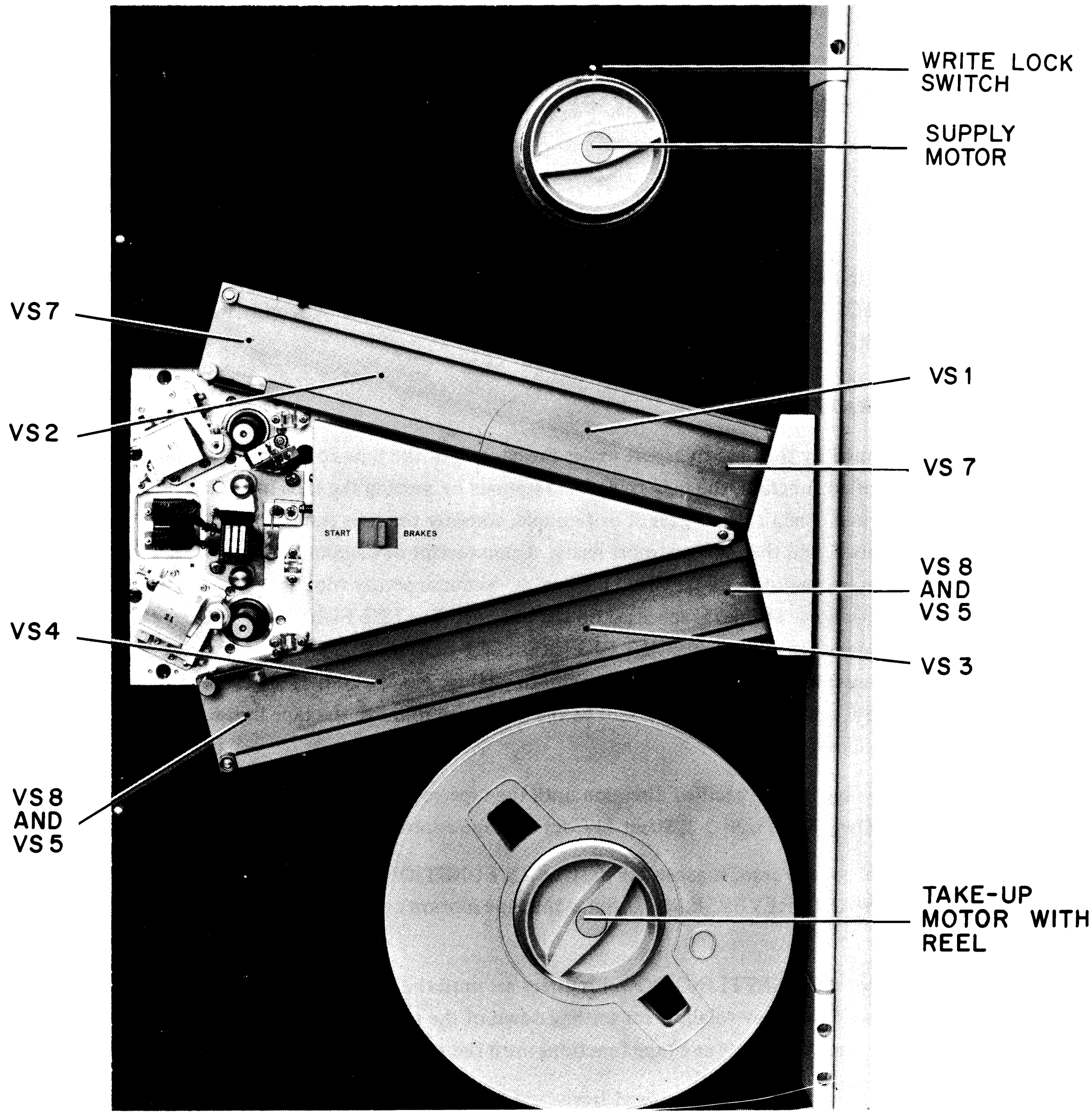


Figure 4-1 Tape Transport Unit

transport, it generates the EMD (enable motion delay) signal which applies the appropriate delay signal to the read bus (Dwg. No. TU20-0-1, Sheet 1). The motion delay signal sent to the tape control reflects the start/stop characteristics and the 45 ips operating speed of the TU20 Tape Transport.

4.3 WRITE OPERATION

As explained in Paragraph 4.1, the particular tape function is strobed into the appropriate command flip-flops. For writing on tape, the tape control unit sends the write and motion-forward commands to set the WRITE ENAB and FORWARD flip-flops. The motion-forward command moves the tape in the forward direction and after the interrecord delay, the tape control applies the character to be written on tape to the write buffer (Dwg. No. TU20-0-3). For each character, the tape control unit sends a RECORD DATA pulse, which complements the WRITE BUFFER flip-flop for each character to be recorded; for zeros, no action occurs.

After the record has been written (as determined by the tape control unit), the tape control sends the WRITE LPCC pulse to the tape transport to write the longitudinal parity character. At each bit-position, for every character that was recorded, the WRITE BUFFER flip-flop was complemented. Therefore, for an even number of ones written, the write buffer flip-flop should be in the reset state; if not, (since longitudinal parity is even) the LPCC pulse resets the flip-flop to record a one for that bit position. If no more records are to be written, the MOVE signal terminates operation as previously described.

4.4 READ OPERATION

For all tape functions (write, read, and spacing), except rewind, the read circuits in the tape transport are operating to detect the end-of-record to terminate operation. As the character bits are read from tape, for each one bit that is read, the READ BUFFER flip-flop is set (Dwg. No. TU20-0-3). The read buffers are sampled and the first read buffer bit set generates the SET SKEW GATE pulse (Dwg. No. TU20-0-1, Sheet 1) which strobes the appropriate skew delay for the selected tape density.

The skew delay compensates for most dynamic or static tape skew, by providing a delay in which all bits can be read for the particular character that is passing under the read heads. The SKEW DELAY OVER pulse is sent to the tape control unit to strobe the character in the read buffer into the tape control unit's data buffer. The SKEW DELAY OVER pulse also resets the read buffer. Operation continues until the tape control terminates operation by terminating the MOVE signal.

The WRITE ENAB (0) signal applied to the G084 module provides a higher slice level for reading. A lower slice level is provided on the readers during a write operation to reduce inductive channel pickup from adjacent channels.

4.5 SPACE OPERATION

For either space reverse or space forward, the tape control unit sends commands to the tape transport to execute these operations. The tape control terminates the space functions by removing the MOVE command. For the space-reverse operation, the tape transport stops if the beginning of tape (BOT) is detected.

4.6 LOCAL/REMOTE OPERATION

The local operation is effected when the front panel OFF LINE switch is depressed on the front panel (Dwg. No. TU20-0-2, Sheet 1). This resets the LOCAL/REMOTE flip-flop (Dwg. No. TU20-0-2, Sheet 2) to specify LOCAL operation. In local operation, the tape can be spaced forward, spaced reversed, or rewound by depressing the appropriate front panel control. Also, the rewind operation terminates when the beginning of tape is detected. The space forward operation terminates if the end-of-tape is detected.

For remote operation, the ON LINE control on the front panel is depressed. This sets the LOCAL/REMOTE flip-flop and specifies REMOTE operation. The control unit must select the tape transport before remote operation can be effected. This is accomplished by the select signals (Dwg. No. TU20-0-2) from the tape control unit complying with the unit number set into the tape transport UNIT SELECT switch. If these events occur, then the SELECT REMOTE signal enables control by the tape control unit.

4.7 TAPE TRANSPORT READY STATUS

The tape transport is ready to receive commands from the tape control when the tape transport vacuum is on, the settling down delay is over (Dwg. No. TU20-0-1, Sheet 2), and the tape transport is selected and in remote operation. If these events occur, the TUR (Dwg. No. TU20-0-1, Sheet 1) is sent to the tape control to signify tape transport ready.

4.8 CONTROL FLIP-FLOPS

4.8.1 END-POINT Flip-Flop

The END-POINT flip-flop (Dwg. No. TU20-0-1, Sheet 2) is set when the tape is moving forward and the reflective end-of-tape strip is detected. It is reset when any reverse motion rewinds the tape away from the reflective end-of-tape strip.

4.8.2 WRITE ENAB Flip-Flop

The WRITE ENAB (write enable) flip-flop is set by the SET WRITE ENABLE pulse when a write function is specified by the tape control unit. It can be set only if the WL (write lock out) is not specified. The WL is derived from the WL ring on the tape reel which, in its absence, prevents the WRITE ENAB flip-flop from being set and prevents writing on that tape reel.

The WRITE ENAB flip-flop is held in the cleared state during local operation to prevent writing on the tape. Any reverse motion (reverse or rewind) of the tape clears the WRITE ENAB flip-flop.

4.8.3 REWIND Flip-Flop

The REWIND flip-flop is set by the tape control command or front panel switches (via SET REWIND signal) if the forward and reverse flip-flops are in the cleared state and the tape is not at load point. REWIND is cleared when the BOT reflective strip is first encountered; however, the tape continues to move a short distance beyond this point. The BOT signal, enabled by REWIND (1), sets the FORWARD flip-flop to move the tape forward to load point at the end of the BOT reflective strip. BOT (1) resets the forward flip-flop to stop forward motion at this point. The CLEAR FUNCTION pulse also clears REWIND.

4.8.4 REVERSE Flip-Flop

The REVERSE flip-flop is set by the tape control command or front panel switches via the SET REVERSE signal provided that the REWIND and FORWARD flip-flops are cleared. REVERSE is cleared by the BOT (1) signal if encountered in remote operation. In local operation, the reverse mode completely rewinds the tape supply reel unless the RESET button is depressed. In remote operation the CLEAR FUNCTION pulse clears REVERSE.

4.8.5 FORWARD Flip-Flop

The FORWARD flip-flop is set by the tape control command or front panel switches via SET FORWARD signal if the REVERSE and REWIND flip-flops are cleared. FORWARD flip-flop is reset in local operation when the end of tape is detected or the RESET button is depressed, and in remote operation, it is reset by the CLEAR FUNCTION pulse.

CHAPTER 5
MAINTENANCE

This chapter contains maintenance information for the TU20 Magnetic Tape Transport. The information described in this chapter is supplemented by information supplied in the applicable manual on the tape control unit manual and the DATAMEC D2020 Series Manual.

5.1 MODULE LOCATIONS

Drawing No. D-MU-20-0-4 in Chapter 6 of this manual shows the location of the modules within the mounting panels, as viewed from the wiring side. The key functions or signals associated with each circuit on the module are listed within the module location and grouped according to the alpha pin designations.

5.2 PREVENTIVE MAINTENANCE

Preventive maintenance consists of tasks performed periodically, during operating time of the equipment, to assure satisfactory operation. Performance of such tasks forestalls failures induced by progressive deterioration or minor damage which, if not corrected, causes eventual downtime. Data obtained during the performance of each task is recorded in a log book. Analysis of this data indicates the rate of circuit operation deterioration and provides information to determine when components must be replaced to prevent failure of the system.

5.2.1 Magnetic Tape Transport

The preventive maintenance tasks required on the tape transport are outlined in the DATAMEC D2020 Series Manual. These mechanical checks must be performed at specified intervals by operating time and operating environment. In addition, the following procedures should be performed periodically.

1. Clean the exterior and the interior of the equipment cabinet with a vacuum cleaner or clean cloths moistened in nonflammable solvent.
2. Clean the air filters at the bottom of the cabinets. After removing the fan and housing (held in place by two knurled and slotted captive screws), remove each filter and wash in soapy water. Dry in an oven or by spraying with compressed air. Spray each filter with Filter-Kote (Research Products Corporation, Madison, Wisconsin).
3. Lubricate door hinges and casters with a light machine oil, wipe off excess oil.
4. Inspect all wiring and cables for cuts, breaks, fraying, wear, deterioration, kinks, strain, and mechanical security. Tape, solder, or replace any defective wiring or cable covering.
5. Inspect the following for mechanical security: switches, control knobs, lamp assemblies, jacks, connectors, transformers, fans, and capacitors. Tighten or replace as required.
6. Inspect all module mounting panels to assure that each module is securely seated in its connector.
7. Inspect power supply capacitors for leaks, bulges, or discoloration. Replace any capacitors showing signs of malfunction.

5.2.2 Power Supply Checks

The power supply output checks described in Table 5-1 are performed by using a multimeter for the output voltage measurements with the normal load connected. The oscilloscope is used to measure the peak-to-peak ripple content on all dc outputs of the supply. The +10V and -15V supplies are not adjustable. Therefore, if the output voltage or ripple content is not within specifications, the power supply is considered defective and troubleshooting procedures are required. Refer to the Dwg. No. RS-B-728 for the power supply schematic.

Table 5-1
Power Supply Output Checks

Measurement Terminals at Power Supply Output	Nominal Output (Vdc)	Acceptable Output Range (V)	Maximum Output Current (amp)	Maximum Peak-to-Peak Output Ripple (V)
Red (+) to Yellow (-)	+10	+ 9.5 to 11.5	7.5	0.7
Yellow (+) to Blue (-)	- 15	-14.5 to 16.5	8.5	0.4

5.3 CORRECTIVE MAINTENANCE

5.3.1 General

The simplicity of the system and the logic description provided in this manual should permit the use of standard troubleshooting techniques for isolating any trouble quickly and efficiently. For economical maintenance under most conditions, replace the inoperative module and return the defective module to DEC for repair or replacement.

Before commencing troubleshooting procedures, ensure that the processor and the unit power supply are operating properly. Refer to the appropriate PDP Maintenance Manual to determine the status of the processor. Also examine the maintenance log to determine whether the fault has occurred before and what steps were taken to correct the condition. Visually inspect the physical and electrical security of all cables, connectors, modules, and wiring.

DEC provides special test programs (MAINDEC), in addition to the one provided with the equipment, to exercise and check the operation of input/output equipment. These programs, which are designed to help in localizing the problem area, determine whether or not the peripheral is at fault.

5.3.2 TU20 Adjustment Procedures

5.3.2.1 Required Test Equipment – The following maintenance equipment is required for the TU20 adjustment procedures:

Dual Trace Oscilloscope With Two X10 Probes
Two X1 Oscilloscope Probes
IBM Master Skew Tape (800 bpi)
Vacuum Gauge
Magnetic Tape Tester (DEC)

5.3.2.2 Magnetic Tape Tester – This paragraph describes the operation of the Magnetic Tape Tester.

The Mag Tape Tester simulates ON-LINE commands to the TU20 which normally are supplied by the tape controller. Included in the tester are unit select switches, motion switches, data switches, read buffer indicators, status indicators, density select switch, record data pot and three pushbuttons. The CLEAR pushbutton clears any function; the SET pushbutton sends the command to the TU20; and the WRITE RESET pushbutton will allow one character, such as EOF, to be written on tape.

To connect the tester to the TU20, disconnect the five I/O cables going to the tape controller and connect them to the tester in accordance with Table 5-2. (Power must be shut off in the TU20.)

Table 5-2
I/O Cable Connections

Tester	TU20
AA01	C01
AA02	C02
AA03	C03
AA04	C04
AB01	C05

If more than one TU20 is connected on the same I/O line after the tester has been connected, keep the power on in the other transports but put all of them, except the transport to be checked out, in the OFF-LINE mode (Figure 5-1). This will ensure proper signal termination on the I/O cables and will allow only one TU20 to be controlled by the tester. The +10V, -15V, GND voltage wires must also be connected to the tester.

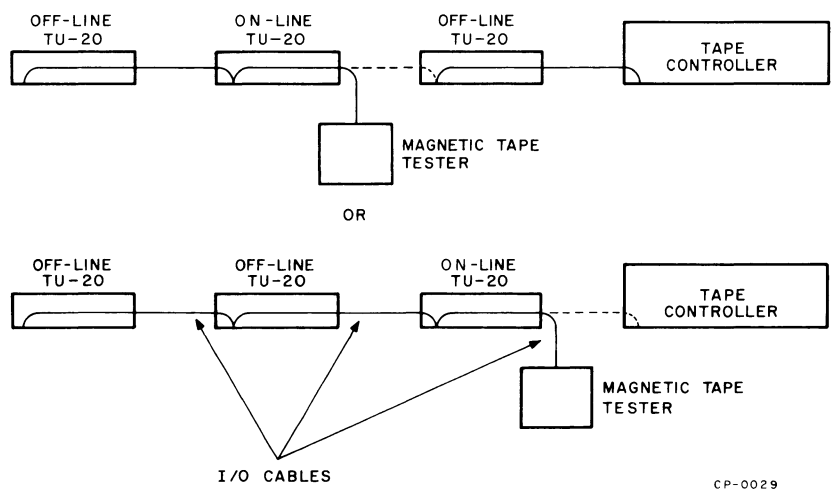


Figure 5-1 Mag Tape Tester Connections

To check out the magnetic tape tester, perform the following procedures:

Step	Procedure
1	With the tester connected to the TU20, return power. The OFF-LINE mode should be indicated on the TU20 Control/Indicator Panel when the POWER switch is pushed on.
2	Using the three unit-select toggle switches provided on the tester, select one of the possible eight octal select numbers. A switch in the up position is assumed to be a one (1). Rotate the transport select switch, on the Control/Indicator Panel, until the indicator marked SELECT is illuminated on the right side of the panel. The number on the transport select switch and the octal number on the tester should correspond.
3	To operate the tester, select the function via the toggle switches, press the CLEAR pushbutton, then press the SET pushbutton, which sends the command to the TU20. Any function, except a REWIND command, may be stopped by pressing the CLEAR pushbutton.
4	Check to see that the ON/OFF switch located on the rear side of the Transport Control Chassis (see Figure 5-14) is in the ON position. Push the LOAD switch, on the Control/Indicator Panel, which loads the tape into the vacuum columns.
5	Check all of the OFF-LINE motion functions using the switches on the Control/Indicator Panel.
6	Check all of the ON-LINE motion functions using the tester and with the TU20 in the ON-LINE mode.
7	A schematic of the tester is included in Chapter 6 of this manual.

5.3.2.3 Oscilloscope Setup – Unless a change is stated, all scope readings should be with the scope set up as follows:

Step	Procedure
1	Sync on channel 1.
2	Set the AC-GND-DC switches on DC.
3	Set the A SWEEP MODE switch on AUTO TRIG.
4	Set the A TRIGGERING COUPLING switch on AC COUPLING.

5.3.2.4 Load Point/End Point Voltages – For load point voltages:

Step	Procedure
1	Set the TU20 in the OFF-LINE mode.
2	Using the switches on the Control/Indicator Panel, move tape forward to LOAD POINT. Then move tape forward past the strip and then reverse back to LOAD POINT. The TU20 should respond correctly to the LOAD POINT strip. Check for agreement on the Control/Indicator Panel status lights.
3	While at LOAD POINT, check the photosense output (TP1) on the Photosense Amplifier module (see Figure 5-14). The correct photosense output voltage should be +2.5 Vdc or greater for ON LOAD POINT and +0.8 Vdc or less for OFF LOAD POINT.
4	If the voltages do not meet the above specifications, adjust R1 on the Photosense Amplifier module.

For End Point voltages:

Step	Procedure
1	Advance tape to end point using Forward in the OFF-LINE mode. Tape movement should stop at the END POINT strip. Check for agreement on the status indicators.
2	While at END POINT, check the photosense output (TP2) on the Photosense Amplifier module for the same voltages as above in LOAD POINT. Only REVERSE, REWIND, or POWER CLEAR should remove the END POINT status.
3	If the voltages do not meet the required levels, adjust R2 on the Photosense Amplifier module.

5.3.2.5 WRITE LOCK Switch – Figure 4-1 and 5-14 indicate the location of the WRITE LOCK switch. Check that the WRITE LOCK status is indicated on the Control/Indicator Panel when the TU20 is executing a REWIND command. The WRITE LOCK status should also be indicated if the File Protect Ring is taken out of the tape reel hub. (Upon removal of the File Protect Ring, vacuum must be removed from the chambers and be re-applied so as to release the write lock solenoid.)

5.3.2.6 Actuator – The two actuators are factory adjusted, but should be checked for the correct settings. First, set the TU20 to the OFF-LINE mode; then proceed as follows:

Step	Procedure
1	With tape loaded into the columns, insert a 0.002-in. gauge between the Coil Housing and Clapper (or Yoke) (see Figure 5-2).
2	Energize the actuator by moving tape forward, or reverse, using the switches on the Control/Indicator Panel. A slight amount of drag should be felt when moving the 0.002-in. gauge while the actuator is energized.
3	Normally this clearance does not need adjustment; but if it does, loosen the four hold-down screws so that the actuator assembly is capable of being moved, but yet will maintain its position after adjustment.
4	Loosen the nut that clamps the Position Adjusting Screw.
5	With tape still loaded, insert the 0.002-in. gauge between the Coil Housing and the Clapper and energize the actuator.
6	Adjust the Position Adjusting Screw so that the correct 0.002-in. clearance between the housing and the Clapper is obtained. Tighten the clamping nut and the hold-down screws.
7	With the tape loaded, check for the 0.002-in. clearance between the pinchroller–tape–capstan. It is best to place the gauge on the shiny surface (the top) of the mag tape so that the oxide on the other side will not be scratched (refer to Figure 5-3).
8	Adjust the Backstop Screw (see Figure 5-2) for the proper 0.002-in. clearance.
9	Remove both Head Guide Caps (see Figure 5-2) taking care not to drop the ceramic guide washers.
10	Move tape by using the switches on the Control/Indicator Panel.

(continued on page 5-7)

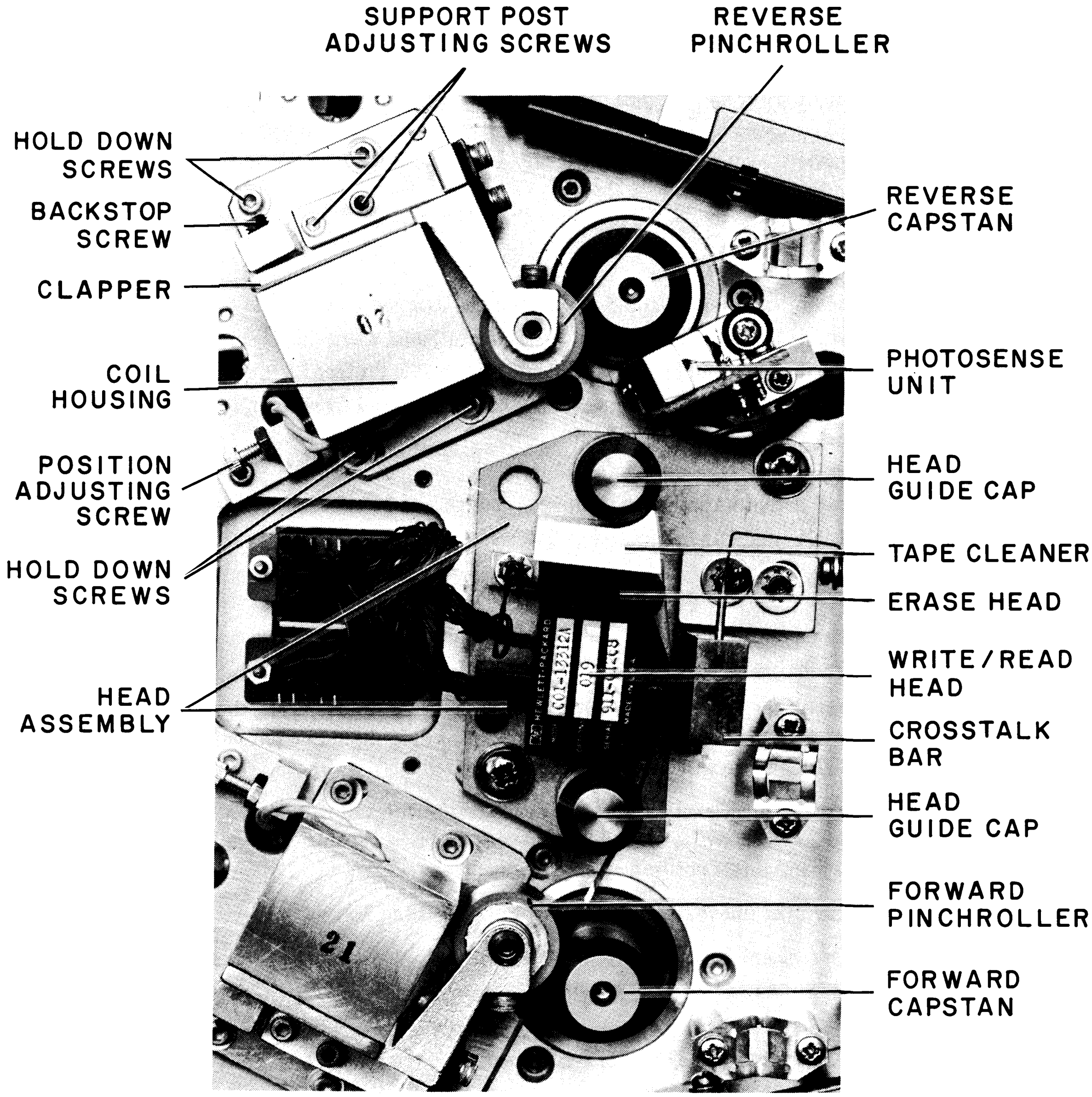


Figure 5-2 Transport Mechanism

Step	Procedure
11	Observe the edge of the tape as it traverses across the edges of the Head Guides alternately from a forward motion to reset and a reverse motion to a reset position. Carefully examine the tape for bounce and/or jitter produced by either pinchroller during any tape movement. The tape should not have any bounce or side movement across the guides; this will greatly increase skew as the tape passes across the WRITE/READ HEAD.
12	Adjust the Support Post Adjusting Screws on the related actuator (see Figure 5-2). There is a locking action between the two adjusting screws, so be sure that both are tightened.
	Replace the Head Guide Caps and HAND TIGHTEN ONLY.
13	Carefully examine the position of the tape between the pinchroller and capstan. The surfaces of the tape should not be touching either the capstan or the pinchroller. The tape should be situated exactly between the capstan and pinchroller.
14	If the tape is positioned correctly, the reverse pinchroller should not move while the tape is moving forward, and the forward pinchroller should not move when tape is moving in a reverse direction. Both pinchrollers should not move when tape is rewinding.
15	If adjustment is needed, loosen the hold-down screws of the Head Assembly (see Figure 5-2).
16	Position the Head Assembly so that the tape is situated exactly between the pinchroller and capstan and retighten the hold-down screws.
17	**CHECK ALL CLEARANCES AGAIN** if any adjustments have been made.

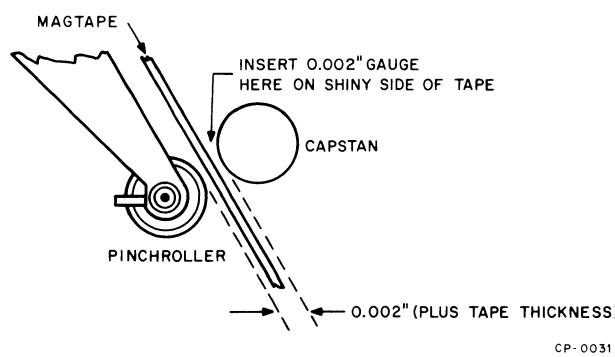


Figure 5-3 Pinchroller – Capstan Clearance

5.3.2.7 **Record Data Pulses** – Proceed as follows:

Step	Procedure
1	Scope calibrations should be set at 5 μs/cm @ 1V/cm.
2	Observe either C03D or D03D with scope probe 1 and synchronize on the positive slope.
3	Adjust the RECORD DATA pot on the tester so that the pulses occur every 40 μs.
4	Select the 556 density with the Density Switch on the tester.

5.3.2.8 **Clocks** – Proceed as follows:

Step	Procedure
1	Set scope calibrations at 5 μs/cm @ 1V/cm.
2	Examine the two crystal clocks (R405s) for frequency and double firing.
3	With scope probe 1, examine A12D (556 bpi). Check for a positive pulse occurring every 40 μs. Also check A13D (800 bpi) for a positive pulse occurring every 28 μs.

5.3.2.9 **Power Clear Pulses** – Proceed as follows:

Step	Procedure
1	Set scope calibrations at 0.5 μs/cm @ 1V/cm.
2	Place scope probe 1 on A15D. The pulses may be seen by shutting off the power by using the POWER switch on the Control/Indicator Panel.

5.3.2.10 **Clear Function Pulses** – Proceed as follows:

Step	Procedure
1	Set scope calibrations at 0.5 μs/cm @ 2V/cm.
2	Select FORWARD and S.S. (Start–Stop) on the tester and set the function.
3	Synchronize on the positive slope with scope probe 1 on A10M; the pulse will be difficult to see (see Figure 5-4).

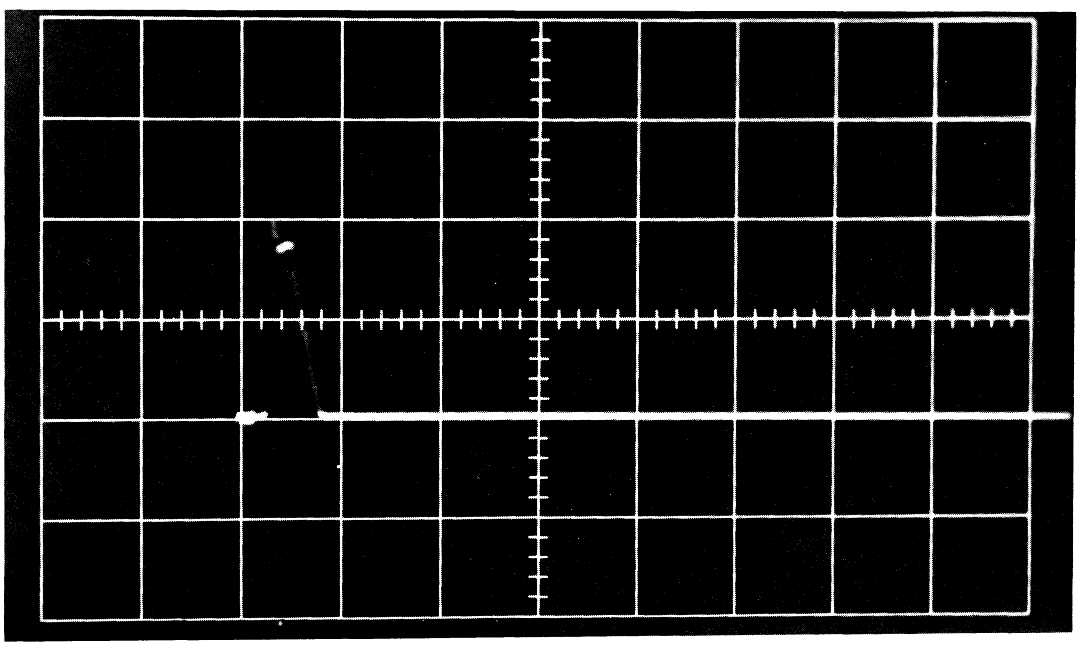


Figure 5-4 Clear Function Pulse

5.3.2.11 **Settling Down Delay** – Proceed as follows:

Step	Procedure
1	Set scope calibrations at 1 ms/cm @ 2V/cm.
2	Select FORWARD and S.S. on the tester.
3	Synchronize on the positive slope and observe that the delay time on pin A22S is of a 5-ms positive duration.
4	If the delay is not as specified above, adjust the R303 delay at A21 for 5 ms.

5.3.2.12 **Timing Buffer Delay Numbers** – There are no adjustments for the delay numbers. Proceed as follows:

Step	Procedure
1	On the tester, select E.M.D. (Enable Motion Delay), ALPHA (1), FORWARD, and READ. Set the function and observe the lights in the Read Buffer on the tester. This octal number is sent to the timing counter in the tape controller. The number represents the READ or SPACE up-to-speed delay and should be 000.
2	Leave the E.M.D. switch up, select ALPHA (0), FORWARD and READ on the tester. Set the function and observe the Reader Buffer indicators. The octal number represents the READ or SPACE shut-down delay and should be 100.
3	Leave the E.M.D. switch up, select WRITE, ALPHA (1) and FORWARD. Set the function and observe the READ Buffer. This octal number represents the WRITE up-to-speed delay and should be 140.
4	Leave the E.M.D. switch up, select READ, ALPHA (0) and REVERSE. Set the function and observe the Read Buffer. This octal number represents the SPACE REVERSE shut-down delay and should be 040.

5.3.2.13 **Write Drivers** – Proceed as follows:

Step	Procedure
1	Set scope calibrations at 20 μs/cm @ 5V/cm.
2	With the ALPHA and E.M.D. switches on the tester down, select FORWARD and WRITE. Do not change the density and Record Data Pot settings in section 5.3.2.7.
3	Set all the toggle switches in the DATA Register of the tester in the up (1) position.
4	Set the function which will cause all ones to be written in all channels on tape at 556 bpi.
5	The WRITE STATUS should be indicated on the Control/Indicator Panel.
6	Synchronize on the positive slope with probe 1 and observe the outputs of all the write drivers (G287s) on pins J, K, R, and S to ensure that data is being written in all channels. Varying the RECORD DATA pot will change the frequency of the outputs (see Figure 5-5).

(continued on next page)

Step	Procedure
7	With probe 1, synchronize on the negative slope and observe the setting of the Write Delays and Read Delays (R302s).
	The minimum delay setting is 0.9 μs. Each delay should not have any negative overshoot (see Figure 5-6). Section 5.3.2.21 and 5.3.2.22 should be referred to when WRITE or READ delays are replaced.

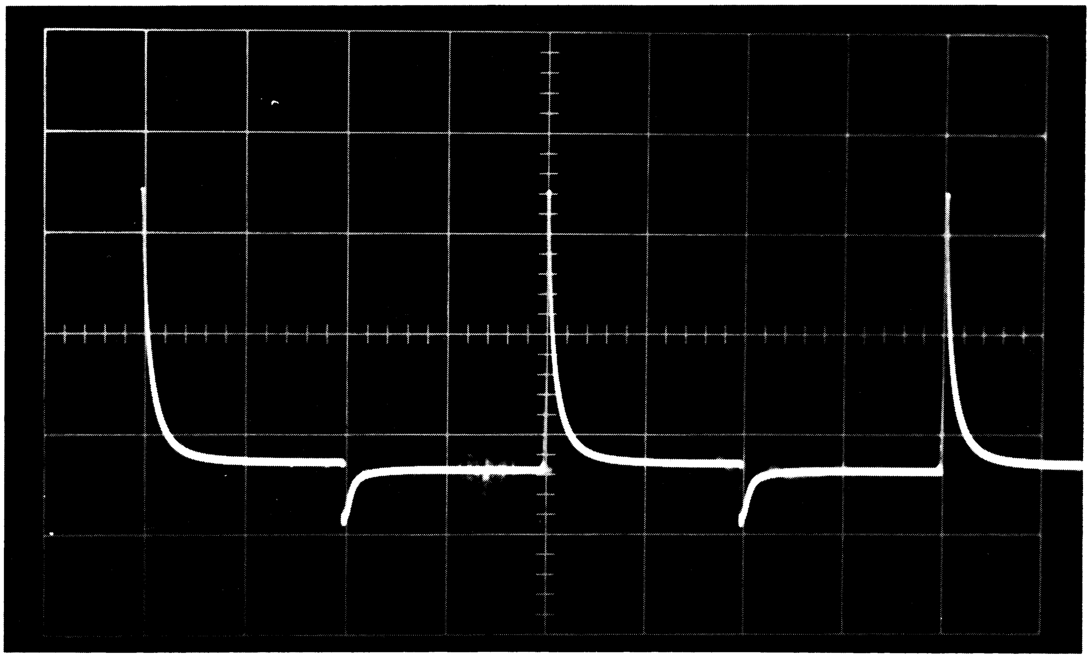


Figure 5-5 Write Driver Output

5.3.2.14 Static State Crosstalk – Proceed as follows:

Step	Procedure
1	Set up the scope so that probes 1 and 2 are added by turning the Mode switch on the scope to the Add setting. Also pull out, or enable, probe 2 to be inverted.
2	Two (XI) scope probes with ground connectors must be used. Scope calibrations should be 0.1 ms/cm @ 5 mV/cm.
3	Rewind the tape to LOAD POINT.
4	Select WRITE with all the data switches on the tester in the up (1) position. Do not select any motion function.
5	Set the function.
6	Using the XI probes, observe pin E with probe 1 and pin F with probe 2 on all the Read Amplifiers (G084s).

(continued on next page)

Step	Procedure
7	This is the static state crosstalk across the WRITE/READ HEAD and should not be greater than 2 mV pk–pk (see Figure 5-7).
8	Adjust the Crosstalk Bar (see Figure 5-2) to reduce some of the excess crosstalk if it is over 2 mV pk–pk.

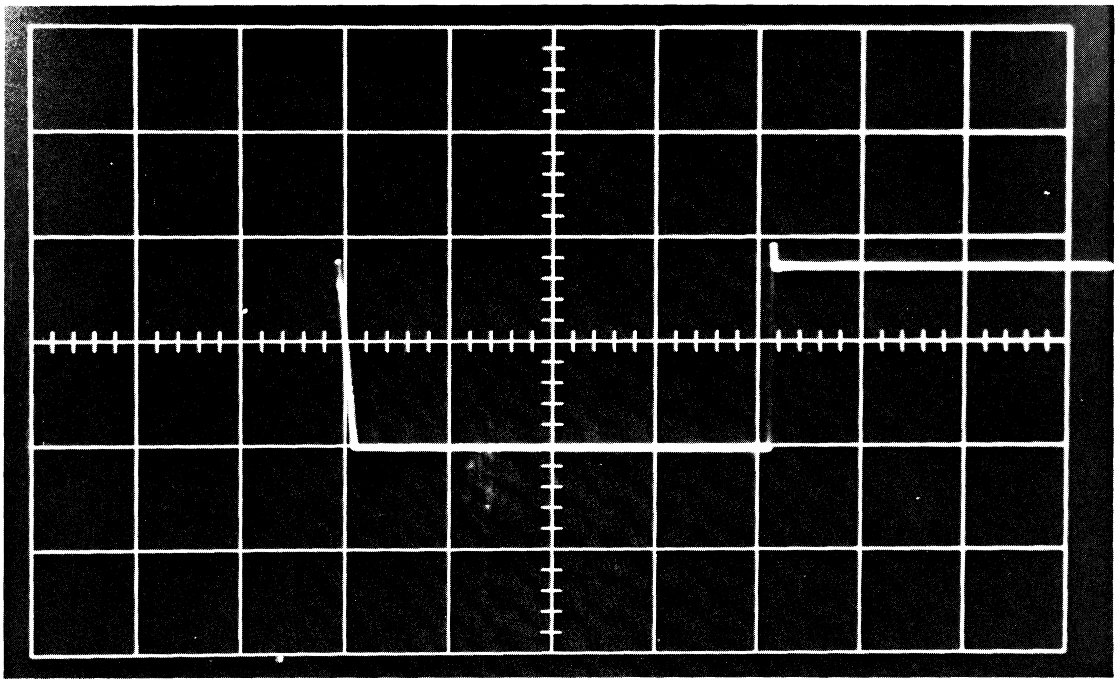


Figure 5-6 Read (or Write) Delay

5.3.2.15 **Dynamic Crosstalk** – Proceed as follows:

Step	Procedure
1	Use the same scope setup as used in 5.3.2.14 with the calibrations at 0.1 ms/cm @ 5 mV/cm.
2	Rewind the tape to LOAD POINT.
3	Select WRITE with all the data switches in the up (1) condition and FORWARD and set the function.
4	Using the X1 probes, observe pin E with probe 1 and pin F with probe 2 on all the Read Amplifiers (G084s).
5	This is the dynamic crosstalk and should be between 15 mV–27 mV pk–pk. By varying the RECORD DATA pot on the tester, the frequency should change, but the amplitude should not be affected (see Figure 5-8).
6	Return the scope to the normal setup.
7	Adjustment is the same as in 5.3.2.14.

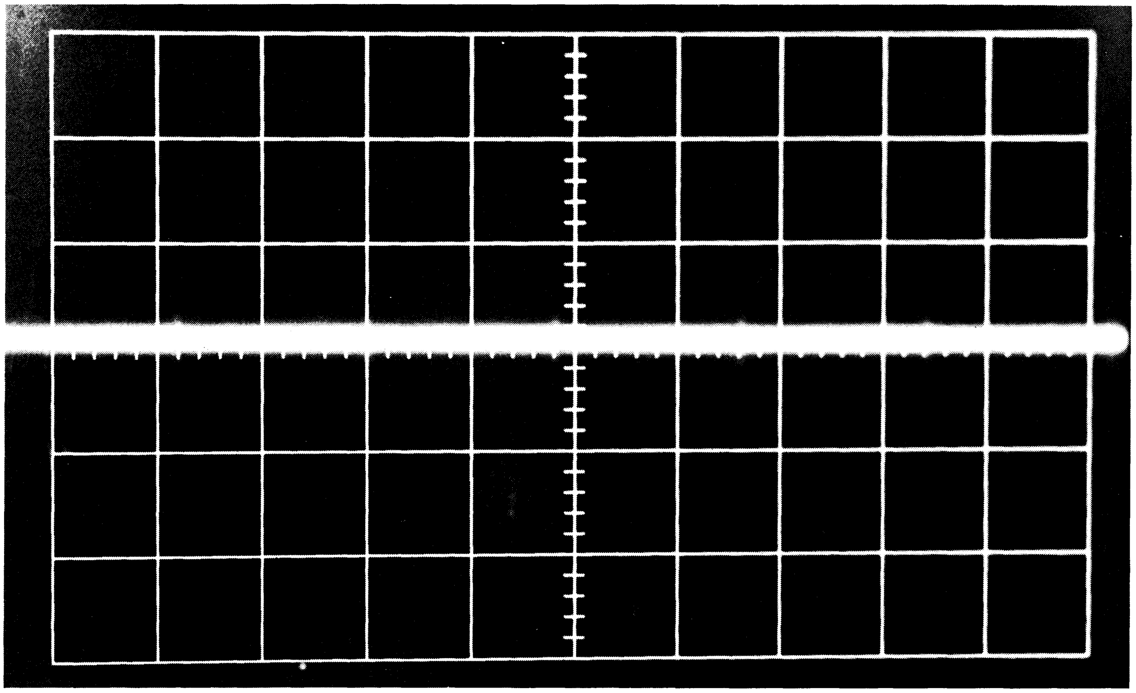


Figure 5-7 Static State Crosstalk

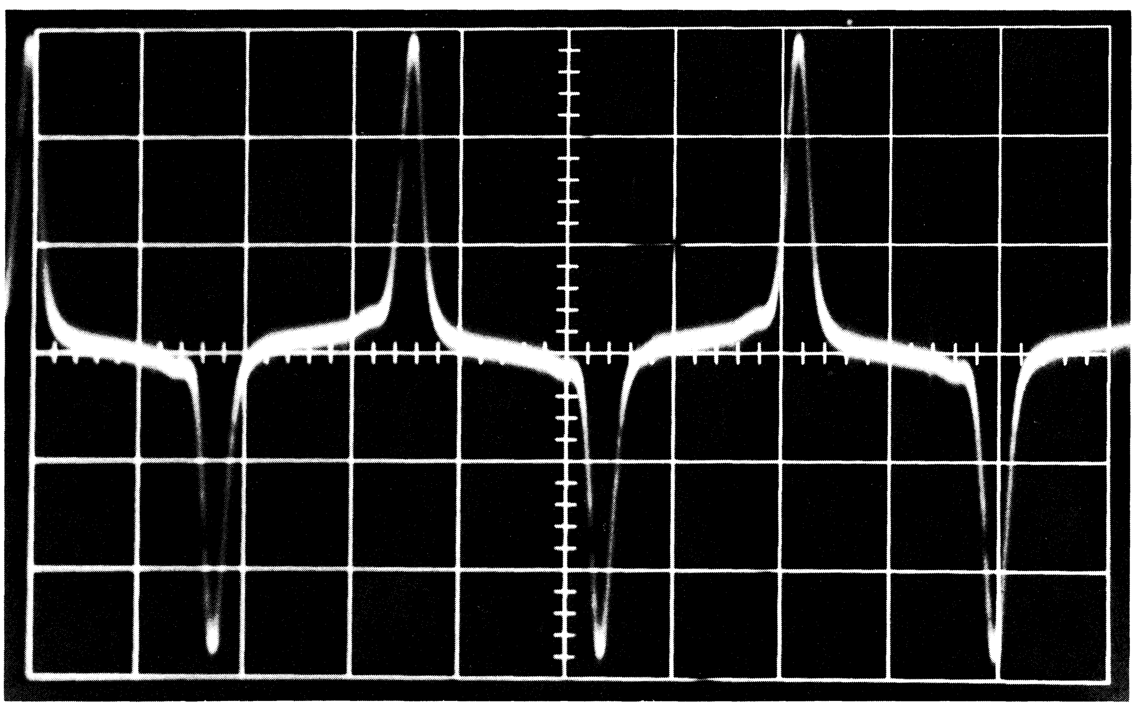


Figure 5-8 Dynamic Crosstalk

5.3.2.16 **Erase Head Voltage** – Proceed as follows:

Step	Procedure
1	Rewind the tape to LOAD POINT.
2	Select FORWARD and WRITE and set the function.
3	With either the scope or a voltmeter, check A6S for approximately -11 Vdc and A6T for approximately -10 Vdc. The Erase Head must have a 1 Vdc drop across it with A6T being the more negative.

5.3.2.17 **Read Amplifiers** – Proceed as follows:

Step	Procedure
1	Set scope calibration at 5 μs/cm @ 1V/cm and synchronize on the positive slope.
2	Rewind the tape to LOAD POINT.
3	With probe 1, examine C03D and adjust the RECORD DATA pot on the tester so that the pulses occur every 40 μs.
4	Select the 556 bpi density on the tester along with WRITE with all the data switches in the up (1) position and FORWARD.
5	Set the function which will cause all ones in all channels to be written on the tape at 556 bpi.
6	Change the scope setup so that the AC-GND-DC switch for probe 1 is on ac with calibrations set at 0.2 ms/cm @ 1V/cm.
7	With scope probe 1, observe pin S on all the READ amplifiers (G084s).
8	The output on pin S should be 1.8 Vac pk–pk (see Figure 5-9).
9	If the output does not meet the 1.8 Vac pk–pk requirement, adjust the pots on the G084 modules.

NOTE

The READ Amplifier outputs should be checked and re-adjusted, if needed, when the TU20 is under program control (ON-LINE). Write an all ones data pattern at 556 bpi using the Data Reliability Diagnostic and observe the output on pin S. Adjust the pots to 1.8 Vac pk–pk. Also, the amplitude will be affected somewhat when using different qualities of tape.

5.3.2.18 **Forward Start/Stop Times** – Proceed as follows:

Step	Procedure
1	Set up scope with the AC-GND-DC switch on probe 1 set to dc and the AC-GND-DC switch on probe 2 on ac. Calibrations should be set at 1 ms/cm @ 1V/cm.
2	Use the tape with all 1s originated from the procedure in 5.3.2.17.
3	Rewind the tape back to LOAD POINT.
4	Select SS (Start-stop). FORWARD and READ on the tester and set the function.

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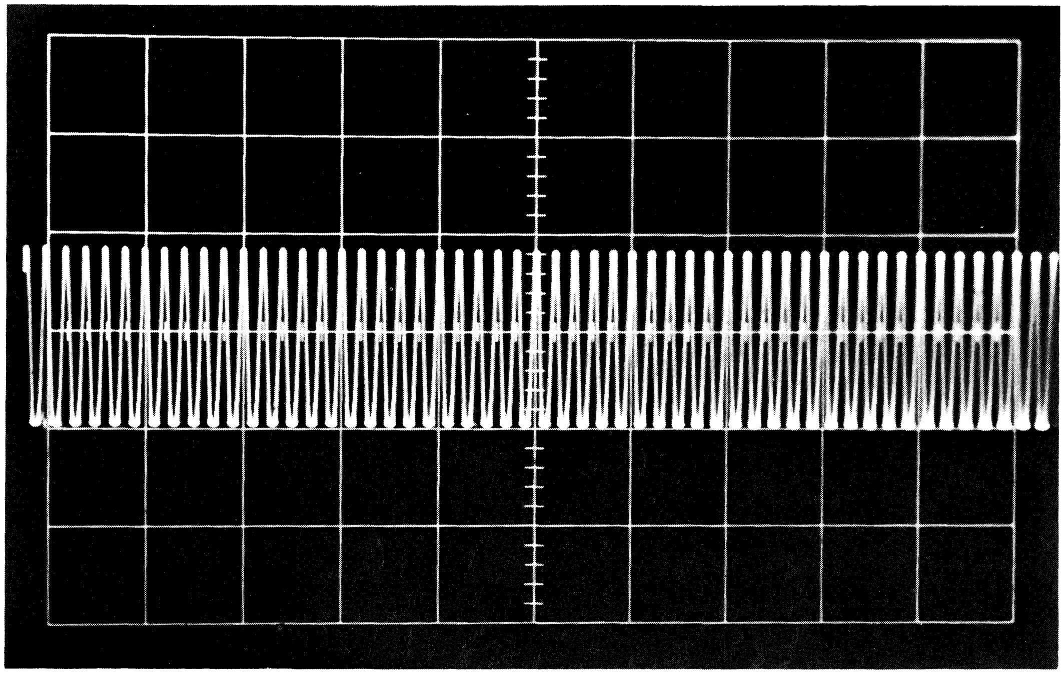


Figure 5-9 Read Amplifier Output

Step	Procedure
5	Synchronize on the positive slope with probe 1 on A18H and observe the waveform with probe 2 on A30S.
6	This is the time between the setting of the Forward flip-flop in the TU20 and the actual reading of data. The Forward Start time should be between 3.0 ms and 3.5 ms (see Figure 5-10).
7	If the above time is incorrect, adjust the gap between the forward pinchroller and the capstan (refer to 5.3.2.6, 2).

For Forward Stop, proceed as follows:

Step	Procedure
1	Examine the Forward Stop time by changing the probe 1 synchronization from the positive slope to the negative slope.
2	This is the time between the clearing of the Forward flip-flop in the TU20 and the last data being read by the Read Amplifiers. The time must be between 0.5 ms and 1.3 ms (see Figure 5-11).
3	If the above time inincorrect, adjust the gap between the forward pinchroller and capstan (refer to 5.3.2.6, 2).

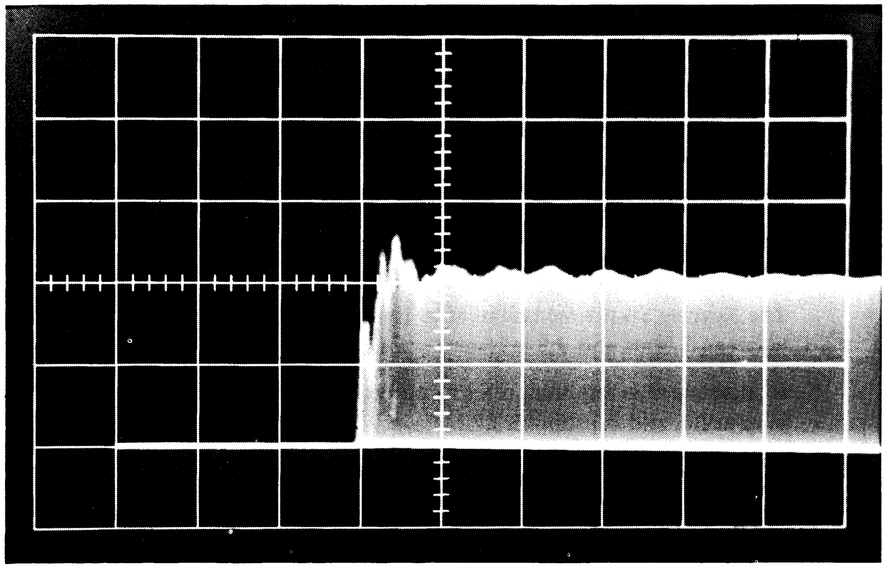


Figure 5-10 Forward (or Reverse) Start Time

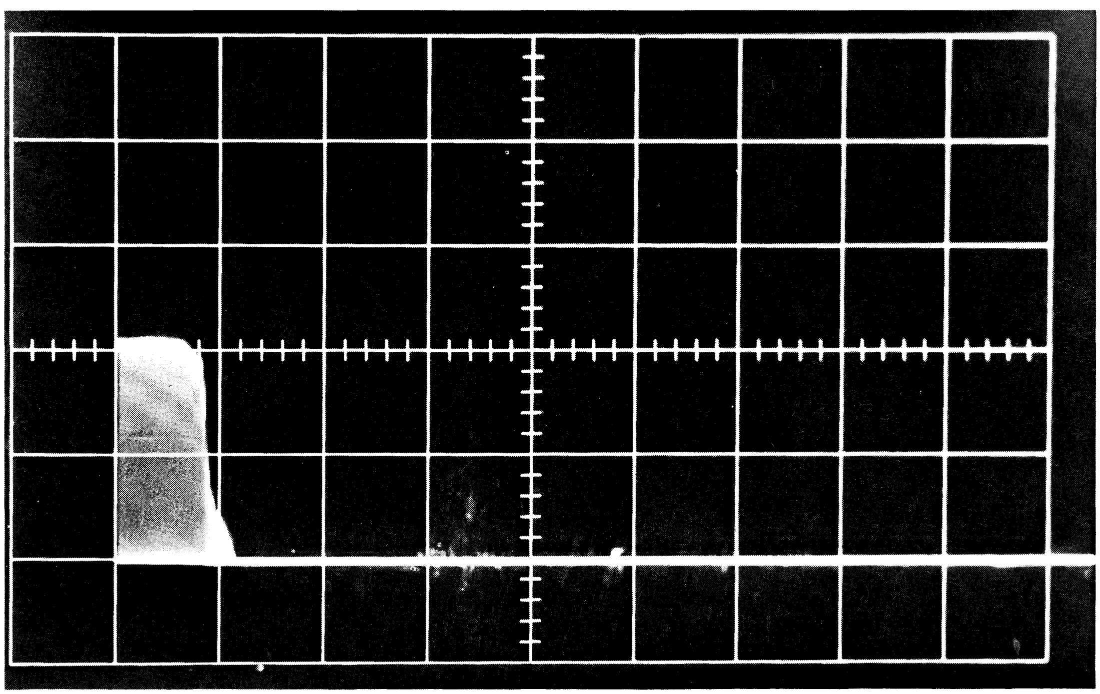


Figure 5-11 Forward (or Reverse) Stop Time

5.3.2.19 **Reverse Start/Stop Times** – For Reverse Start proceed as follows:

Step	Procedure
1	Scope calibrations and setup are the same as shown in 5.3.2.18, 1.
2	Move tape well beyond LOAD POINT.
3	Select REVERSE, READ and S.S. on the tester and set the function.
4	Synchronize on the positive slope with probe 1 on A18S and observe the waveform with probe 2 on A30S.
5	The Reverse Start time is similar to that of the Forward Start time and should be between 3.0 ms and 3.5 ms (see Figure 5-10).
6	If adjustment is required, refer to procedures for the gap between the Reverse pinchroller and capstan (5.3.2.6, 2).

For Reverse Stop, proceed as follows:

Step	Procedure
1	By changing the probe 1 synchronization to the negative slope the Reverse Stop time can be examined.
2	The Reverse Stop time is similar to the Forward Stop time and should be between 0.5 ms and 1.3 ms (see Figure 5-11).
	Adjustment is the same as shown in 5.3.2.6, 2.

5.3.2.20 **Skew Delays** – The following skew delay procedures apply to TU20 systems using R303 delay modules. Check the system to see if the R303 modules are contained in slots C23, C24, and C25.

For 200 bpi, proceed as follows:

Step	Procedure
1	Set up scope with the AC-GND-DC switches for probes 1 and 2 on dc. Calibrations should be set at 20 μs/cm @ 1V/cm.
2	Rewind the tape to LOAD POINT.
3	With probe 1, observe the Record Data pulses at C03D and adjust the RECORD DATA pot on the tester so that the pulses occur every 112 μs.
4	Select WRITE, with only one data switch in the up position, FORWARD and also the 200 bpi density on the tester.
5	Set the function.
6	Change the scope calibrations to 10 μs/cm @ 1V/cm.
7	With probe 1, examine C23F and synchronize on the negative slope. This is the 200 bpi Skew Delay and should be set at 50 μs.
8	Adjust the R303 (C23) for a delay of 50 μs if required.

For 556 bpi, proceed as follows:

Step	Procedure
1	Change the scope calibrations to 5 μs/cm @ 1V/cm.
2	Rewind the tape to LOAD POINT.
3	Observe the Record Data pulses at C03D with probe 1 and adjust the RECORD DATA pot on the tester so that the pulses occur every 40 μs.
4	Select WRITE, in only one channel, FORWARD, and the 556 bpi density on the tester.
5	Set the function.
6	Synchronize on the negative slope with probe 1 at C24F. This is the 556 bpi Skew Delay and should be set at 20 μs.
7	Adjustment of the R303 (C24) pot provides a delay of 20 μs.

For 800 bpi, proceed as follows:

Step	Procedure
1	Keep the scope calibrations at 5 μs/cm @ 1V/cm.
2	Rewind the tape to LOAD POINT.
3	Observe the Record Data pulses at C03D with probe 1 and adjust the RECORD DATA pot so that the pulses occur every 28 μs.
4	Select WRITE, in only one channel, FORWARD and the 800 bpi density on the tester.
5	Set the function.
6	Change the scope calibrations to 2 μs/cm @ 1V/cm.
7	Synchronize on the negative slope with probe 1 at C25F. This is the 800 bpi Skew Delay and should be set at 14 μs. To obtain the 14-μs delay, adjust the R303 (C25).

5.3.2.21 **Read Skew and Read Deskew** – For Read Skew, proceed as follows:

Step	Procedure
1	To check read skew, remove the scratch tape from the transport and turn off power.
2	Remove the WRITE HEAD CABLE in AB1 in the TU20 logic.
3	Return power to the transport.
4	Load an I.B.M. Master Skew Tape (800 bpi).

NOTE
Do not rewind Master Skew Tape.

Step	Procedure
5	Scope calibrations should be set at 1 μs/cm @ 2V/cm.
6	On the tester, select FORWARD and READ, then set the function. The RECORD DATA POT should still be the same as shown in Section 5.3.2.20, 3, and the density switch should be set at 800.

(continued on next page)

Step	Procedure
7	Synchronize on the positive slope with probe 1 at B26R (Set Skew Gate) and with probe 2, observe the "one" side output of all the Read Buffer flip-flops.
8	Each Read Buffer flip-flop must be in the "one" state within 1 μs after Set Skew Gate B26R (see Figure 5-12).
9	If any of the Read Buffer flip-flops are out of this 1 μs skew tolerance, follow the Read Deskew procedure that follows. If no adjustments are needed, proceed with the Write Skew check (Section 5.3.2.22).

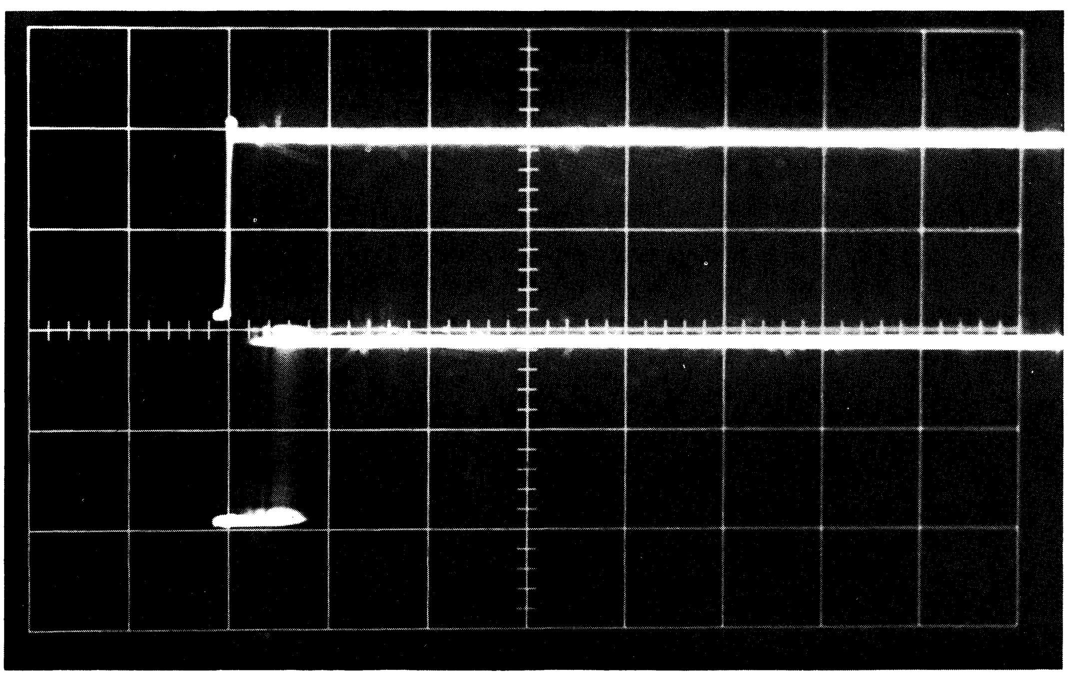


Figure 5-12 Read Skew

For Read Deskew, proceed as follows:

Step	Procedure
1	Reverse the Master Skew Tape to LOAD POINT.
2	Select READ and FORWARD on the tester and set the function.
3	With probe 1, synchronize on the negative slope and look at the outputs of each Read Delay.
4	Adjust all delays for 4.5 μs.
5	After all delays have been adjusted to 4.5 μs, synchronize on the positive slope with probe 1 at B26R. With probe 2, examine the "one" side of each of the Read Buffer flip-flops.
6	Adjust each Read Delay so that its corresponding Read Buffer flip-flop is in the "one" state within the 1-μs skew tolerance.
7	Synchronize on the negative slope with probe 1 and examine the outputs of all the Read Delays. The minimum delay setting is 0.9 μs.

5.3.2.22 **Write Skew and Write Deskew** – For Write Skew, proceed as follows:

Step	Procedure
1	Set scope calibrations at 1 μs/cm @ 1V/cm.
2	Remove the I.B.M. Master Skew Tape from the transport and turn off power.
3	Connect the WRITE HEAD CABLE in AB1, return power and load a scratch tape.
4	On the tester, select WRITE, with all the data switches in the up (1) position, and FORWARD.
5	The Record Data pulses at C03D should still be at intervals of 28 μs, and the 800 bpi density on the tester should still be selected.
6	Set the function which will cause all ones in all channels to be written on tape at 800 bpi.
7	With probe 1, synchronize on the positive slope at B26R, and with probe 2, observe the "one" side output of each Read Buffer flip-flop.
8	Each flip-flop should be in the "one" state within the 1-μs skew tolerance after Set Skew Gate (B26R) (see Figure 5-12).
9	If any of these flip-flops is out of the 1-μs skew tolerance, follow the Write Deskew Procedure below.
10	If all checks and adjustments have been performed, the TU20 is ready to be checked out ON-LINE using the computer and various checkout programs.

For Write Deskew, proceed as follows:

Step	Procedure
1	Set scope calibrations at 1 μs/cm @ 1V/cm.
2	Rewind the tape to LOAD POINT.
3	On the tester, select WRITE, all ones in all channels and FORWARD.

(continued on next page)

Step	Procedure
4	The Record Data pulses should be set at intervals of 28 μs (C03D), and the 800 bpi density on the tester should be selected.
5	Set the function.
6	Synchronize on the negative slope with probe 1 and look at the output of each WRITE DELAY.
7	Adjust each delay to 4.5 μs.
8	Synchronize on the positive slope with probe 1 at B26R, and observe with probe 2, the "one" side output of each Read Buffer flip-flop.
9	Adjust each Write Delay so that its corresponding Read Buffer flip-flop is in the "one" state within the 1-μs skew tolerance.
10	After all adjustments have been made, synchronize on the negative slope with probe 1, and check the output of each WRITE DELAY. The minimum delay setting is 0.9 μs.

5.3.3.23 **Basic Problems and Solutions** – Basic problems/symptoms and solutions are shown in Table 5-3.

Table 5-3
Symptoms and Solutions

Symptom	Solution
Picking up or dropping a bit	Corresponding read amplifier in the TU20 may need adjusting.
Parity errors, Record Length Incorrect error, picking up or dropping bits	Check all READ and WRITE delays for any negative overshoot.
Jitter or bounce noticed while checking skew	May be caused by incorrect mechanical adjustments. Refer to Section 5.3.2.6 for mechanical adjustment instructions. Jitter may also cause random errors.
Reverse skew	If forward skew, all mechanical adjustments, all delays, and all read amplifiers are correct, and errors still exist, the reverse skew should be checked. If reverse skew is not correct, then errors will occur especially when writing a record, or file, backspacing, and then reading the same record or file. To check reverse skew: **Step** / **Procedure** 1 Write all ones at 800 bpi in the forward direction. 2 Stop the tape. With probe 1, synchronize on the positive slope and examine B26R. 3 Set the READ and REVERSE command in the TU20. With probe 2, observe the "one" side output of each READ BUFFER flip-flop. The maximum amount of reverse skew is 8 μs. If the reverse skew is over 8 μs, the reverse pinch-roller may need adjustment.
–	Check that all ECOs pertaining to the TU20 and the tape controller have been implemented.

5.3.3 DATAMEC Logic Checkout and Adjustments

The DATAMEC logic for the TU20 is primarily concentrated on two logic boards: the REEL SERVO BOARD and the ASSY C BOARD (see Figure 5-13). The power supply and relays are located on the CONTROL CHASSIS next to the logic boards.

NOTE
All other logic is inside the CONTROL CHASSIS.

There are two schematics at the end of this manual that include all the DATAMEC logic. The pin numbers labeled on the schematic TAPE TRANSPORT (page 1 of 2) represent the test points or connecting pins on both the REEL SERVO and ASSY C BOARDS.

NOTE
On the schematic TAPE TRANSPORT (page 1 of 2), all pin numbers not on the dotted lines which enclose the ASSY C BOARD circuitry are on the REEL SERVO BOARD.

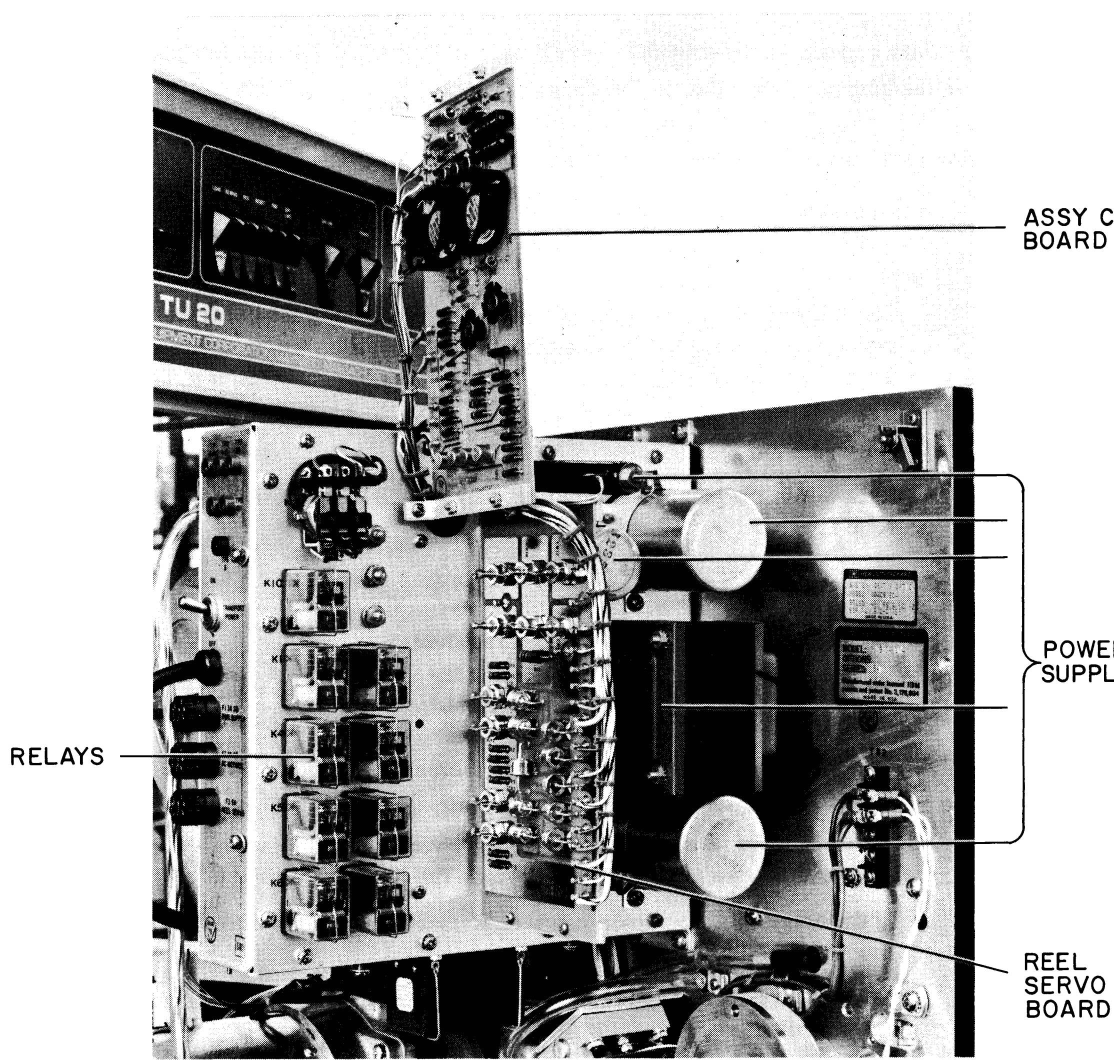


Figure 5-13 REEL SERVO BOARD and ASSY C BOARD

If a problem occurs in the DATAMEC logic, check the voltages on each pin on both boards. See Tables 5-4 and 5-5 for test point voltages.

On the back of the CONTROL CHASSIS, there are six test points for voltages which supply the DATAMEC logic (see Figure 5-14). On new TU20s an additional test point is supplied for Jog time.

Test Point	Voltage
TP1	6 Vac
TP2	+10 Vdc
TP3	- 28 Vdc
TP4	- 28 Vdc STATIC STATE
	0 Vdc FORWARD MOTION
	- 6 Vdc REVERSE MOTION
TP5	- 28 Vdc STATIC STATE
	- 6 Vdc FORWARD MOTION
	0 Vdc REVERSE MOTION

The symbol ≺↔≻ which appears on the schematic Tape Transport (page 1 of 2) refers to a jumper located inside the Jumper box on the bottom of the Control Chassis (see Figure 5-14).

5.3.4 Tape Motion Problems and Solutions (refer to Figure 5-14)

5.3.4.1 Brakes – To test brakes, proceed as follows:

Step	Procedure
1	Check both brakes for proper clearance. To do this, release the brakes, using the switch near the Write/Read Head located between the vacuum columns on the front of the TU20.
2	Rotate the reels and check for any drag or high spots which would indicate the brakes are too tight.
3	If, however, the brakes are too loose, they will be noisy during forward and/or reverse tape motion.

To adjust the brakes, proceed as follows:

Step	Procedure
1	Remove the DRAG BRAKE RETAINING SPRINGS if the TAKE-UP BRAKE is to be adjusted.
2	Loosen the set screw on the brake and loosen the BRAKE ADJUSTMENT NUT approximately 30 degrees.
3	Tighten the set screw and test to see if the reel turns freely when the brakes are released. Be sure to rotate the reel over a full 360 degrees.
4	If the brake continues to drag, repeat Steps 2 and 3. If the brake turns freely, proceed with the following steps.
5	Loosen the set screw and tighten the BRAKE ADJUSTMENT NUT until the brake starts to drag.
6	When the brake begins to drag, back off the BRAKE ADJUSTMENT NUT approximately 30 degrees and retighten the set screw.

(continued on next page)

Step	Procedure
7	Recheck the brake to ensure that the reel rotates freely a full 360 degrees. If the brake is too tight, repeat Steps 2 through 6. Move tape forward and reverse by using the switches on the Control/Indicator Panel. If the brake is too loose, excessive noise will be heard, and Steps 5 and 6 should be repeated.

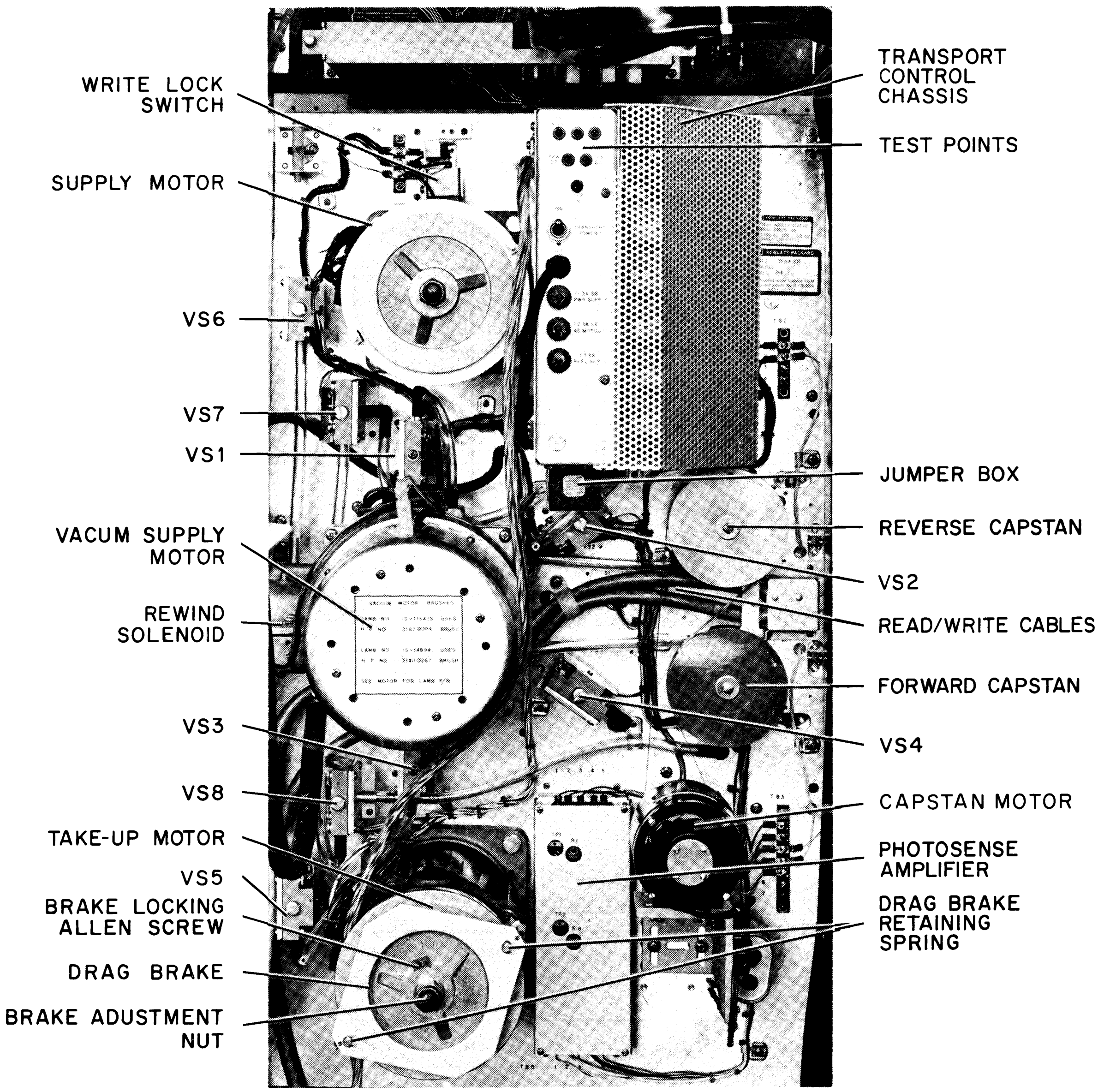


Figure 5-14 Tape Transport Unit

Table 5-4
ASSY C BOARDS

	Static State	Forward	Reverse	Rewind
PIN 1	0V	0V	-8 Vdc	0V
PIN 2	0V	-8 Vdc	0V	0V
PIN 3	0V	0V	0V	0V
PIN 4	-28 Vdc	-26 Vdc with 2 Vac pk–pk	same as forward	same as forward
PIN 5	+10 Vdc	+10 Vdc	+10 Vdc	+10 Vdc
PIN 6	-28 Vdc	0V	-6.5 Vdc with 1 Vac pk–pk	-26 Vdc with 1 Vac pk–pk
PIN 7	-28 Vdc	-6.5 Vdc with 1 Vac pk–pk	0V	-26 Vdc with 1 Vac pk–pk
PIN 8	0V	0V	0V	-13 Vdc
PIN 9	-28 Vdc	-26 Vdc with 2 Vac pk–pk	same as forward	0V
PIN 10	-28 Vdc	-26 Vdc with 2 Vac pk–pk	same as forward	same as forward
PIN 11	+10 Vdc	+10 Vdc	+10 Vdc	see note 1
PIN 12	+0.8 Vdc	+0.8 Vdc	+0.8 Vdc	see note 2
PIN 13	+10 Vdc	+10 Vdc	+10 Vdc	-28 Vdc
PIN 14	+10 Vdc	+10 Vdc	+10 Vdc	+10 Vdc
PIN 15	+0.8 Vdc	+0.8 Vdc	+0.8 Vdc	-26 Vdc with 1 Vac pk–pk

NOTES: 1. Rewind -28 Vdc until tape is out of columns, then goes to 0V.

2. Rewind jogs between +0.8V and -28 Vdc during jog time; after rewind is over, extremely slow rise time to +0.8V.

Table 5-5
REEL SERVO BOARD

PIN 1	160 Vac pk–pk; 60 Hz/or 50 Hz if 50 Hz line voltage is used.
PIN 2	Same as PIN 1.
PIN 3	80 Vac pk–pk; 120 Hz/or 100 Hz if 50 Hz line voltage is used (see Figure 5-15).
PIN 4	Same as PIN 3 except waveform is inverted.
PIN 5	STATIC STATE – 80 Vac Standard wave, same as PIN 3. FORWARD TAPE MOTION – Standard 80 Vac wave is affected (see Figure 5-16) when tape passes across vacuum switch 2 (VS2).

(continued on next page)

Table 5-5 (Cont)

REEL SERVO BOARD

PIN 5 (cont)	REVERSE TAPE MOTION – Standard 80 Vac wave is inverted when tape passes across VS1. REWIND – 80 VAC standard wave will alternately invert a few times during JOG TIME (while tape is jogging out of the columns), but will stay inverted when tape is fully out of the columns and rewinding.
PIN 6	Same as PIN 5.
PIN 7	STATIC STATE – Standard 80 Vac wave, same as PIN 3. FORWARD TAPE MOTION – 80 Vac waveform is inverted when tape passes across VS2. REVERSE TAPE MOTION – 80 Vac wave is inverted when tape passes across VS1. REWIND – 80 Vac wave alternately inverts during JOG TIME, but stays inverted when tape is out of the columns and rewinding.
PIN 8	STATIC STATE – Standard 80 Vac wave. FORWARD TAPE MOTION – Standard 80 Vac wave is affected when tape passes across VS2. REVERSE TAPE MOTION – 80 Vac waveform is affected (see Figure 3-3) when tape passes across VS1. REWIND – During JOG TIME, 80 Vac standard wave bounces. When tape is out of the columns and rewinding, waveform (Figure 5-16) bounces.
PIN 9	Same as PIN 8.
PIN 10	STATIC STATE – Standard 80 Vac wave. FORWARD TAPE MOTION – Standard 80 Vac wave is affected (Figure 5-16) when tape passes across VS3. REVERSE TAPE MOTION – 80 Vac waveform is inverted when tape passes across VS4. REWIND – During JOG TIME, standard 80 Vac wave bounces, but becomes the standard 80 Vac wave while tape is out of the columns and rewinding.
PIN 11	Same as PIN 10.
PIN 12	STATIC STATE – 60 Vac wave pk–pk; similar to the standard 80 Vac waveform. FORWARD TAPE MOTION – Wave fluctuates between 50 Vac and 80 Vac because of the brakes being enabled and disabled. REVERSE TAPE MOTION – Same as Forward. REWIND – 30 Vac pk–pk waveform bounces during JOG TIME. When tape is out of the columns and rewinding, 40 Vac pk–pk wave increases to a maximum of 60 Vac pk–pk.
PIN 13	STATIC STATE – Standard 80 Vac wave. FORWARD TAPE MOTION – 80 Vac waveform inverts when tape passes across VS3.

(continued on next page)

Table 5-5 (Cont)
REEL SERVO BOARD

PIN 13 (cont)	REVERSE TAPE MOTION – 80 Vac waveform inverts when tape passes across VS4. REWIND – 80 Vac wave inverts a few times during JOG TIME, but stays inverted when tape is out of the columns and rewinding.
PIN 14	STATIC STATE – Standard 80 Vac wave. FORWARD TAPE MOTION – Standard 80 Vac wave inverts when tape passes across VS3. REVERSE TAPE MOTION – 80 Vac wave is affected (Figure 5-16) when tape passes across VS4. REWIND – 80 Vac waveform inverts a few times during JOG TIME but becomes the standard 80 Vac wave while tape is out of the columns and rewinding.
PIN 15	Same as PIN 14.
PIN 16	Same as PIN 3.

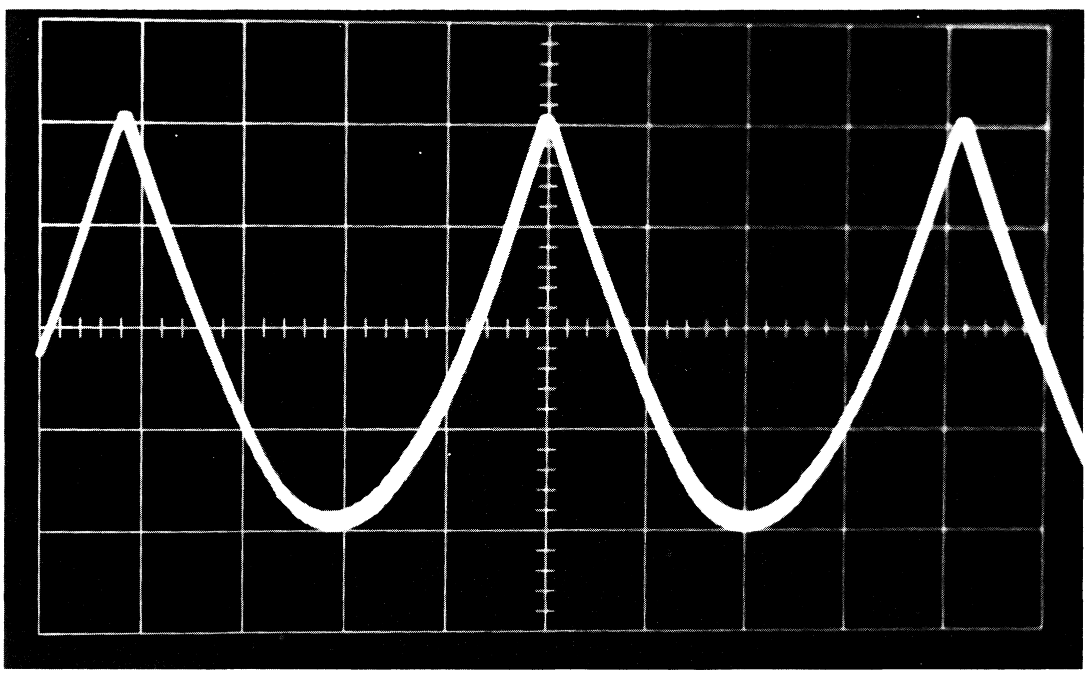


Figure 5-15 REEL SERVO BOARD, Standard 80 Vac Waveform

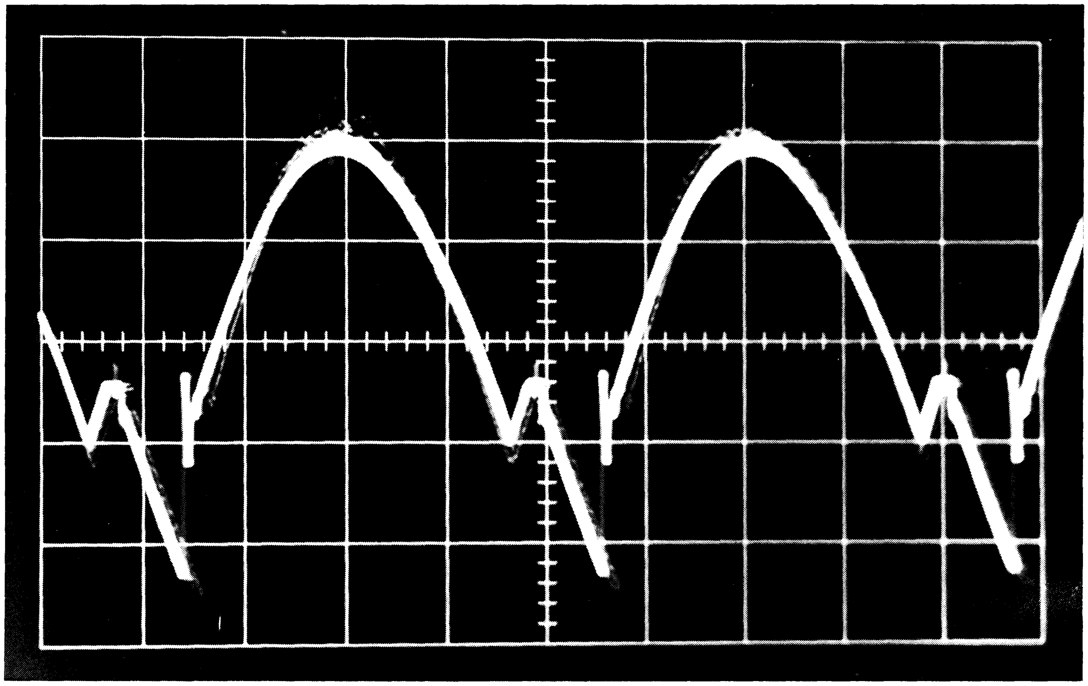


Figure 5-16 REEL SERVO BOARD, Non-Standard 80 Vac Waveform

5.3.4.2 **Vacuum Switches** – The test equipment required is:

a. Vacuum gauge with a range of up to 30 in. of water

b. Two lengths of 1/4-in. inside diameter rubber or plastic tubing

c. 1/4-in. "T" fitting. If the fitting is not available, the one used for the hose connections for VS5 and VS8 in the transport may be used (see Figure 5-14).

To adjust the vacuum switches, proceed as follows:

Step	Procedure
1	Turn off the power in the transport.
2	It may be convenient for the operator to remove the entire vacuum switch from the base plate in some cases.
3	Remove the phenolic cover from the back side of the vacuum switch, revealing the contacts.
4	Remove the vacuum hose from the switch fitting by using a flat-head screwdriver and prying the hose away from the switch.

NOTE
Do not PULL the hose off the fitting.

(continued on next page)

Step	Procedure
5	Connect an ohmmeter across the vacuum switch terminals using a low-resistance scale. Switches VS1 and VS3 are normally closed while all other switches are normally open.
6	Connect the hoses and "T" fitting as shown in Figure 5-17. Always connect the test vacuum to the fitting that protrudes from the plastic portion of the switch. VS7 and VS8 have back fittings attached to the switch mounting bracket. When testing these switches, remove the hose on the back fitting so that the back fitting is exposed to the atmosphere.
7	By slowly increasing the vacuum, notice when the ohmmeter changes, indicating a change of state in the vacuum switch. Also notice the reading of the vacuum gauge when the ohmmeter changes. There should be a definite change of state for all vacuum switches when a vacuum of between 3 to 8 in. of water is applied. A slight turn of the screw, located near the vacuum switch contacts, should be sufficient for the vacuum switch to respond within the limits.
8	The vacuum switch should be checked for leakage. Apply a vacuum of approximately 25 to 30 in. of water, then tightly clamp the vacuum source hose. The vacuum gauge should slowly fall to 0 in approximately 2 to 3s. If a sharp decrease in vacuum is noticed, tighten all the screws that hold the switch to the mounting plate and check again.

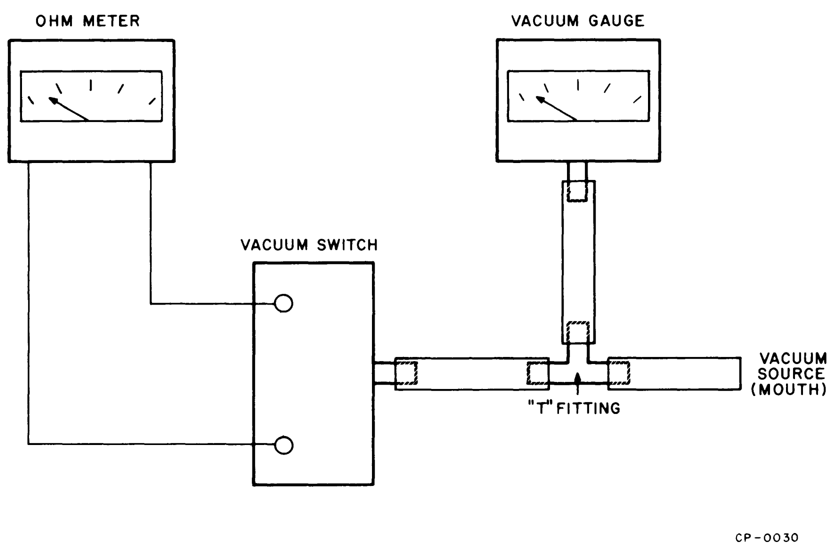


Figure 5-17 Vacuum Switch Adjustment Setup

5.3.4.3 Running Vacuum – Test equipment required is:

a. Vacuum gauge

b. Piece of 1/4-in. inside diameter tubing.

To check a running vacuum, proceed as follows:

Step	Procedure
1	Turn off power. Remove one of the Tape Cleaner Guide hoses from the fitting located at the base of the VACUUM SUPPLY MOTOR (see Figure 5-14) with a flat-head screwdriver.
2	Connect the vacuum gauge to the fitting at the base of the Vacuum Supply Motor.
3	Return power and load tape into the columns. With no tape motion, the vacuum gauge should be reading approximately 15 in. of water.
4	To adjust the running vacuum, locate the adjustable slide situated on the right side of the Vacuum Supply Motor base. Loosen the screws which hold the slide in position and adjust the slide so that the vacuum gauge reads 15 ± 1 in. of water. Tighten the screws and check again for the proper vacuum.

5.3.4.4 Rewind Vacuum – To check the rewind vacuum, proceed as follows:

Step	Procedure
1	Repeat Steps 1 and 2 in Section 5.3.4.3.
2	Move tape forward so that the TAKE-UP REEL is half full.
3	Rewind the tape and notice the vacuum gauge. The gauge should read approximately 10 to 12 in. of water during JOG TIME and should not read less than 9 in. of water while tape is rewinding.
4	The REWIND VACUUM should be adjusted while the transport is executing a rewind command. A second person would be helpful, but is not required, when making this adjustment.

NOTE
If adjustment is done by one person, begin rewind operation and proceed with Step c.

a. One person should hold both reels while the other person initiates the REWIND command. Hold both reels firmly even though the tape is attempting to jog out of the vacuum columns.

b. Slowly rotate both reels in a clockwise direction until tape is out of the columns. Continue to hold both reels firmly. Jogging action should stop when tape is out of the vacuum columns.

c. Loosen the two screws which secure the REWIND SOLENOID (see Figure 5-14). Slide the solenoid body in or out to obtain the necessary 10 in. of water. Be sure the solenoid is energized when making this adjustment.

d. When the proper reading is obtained, tighten the solenoid mounting screws.

e. Press the RESET switch on the Control/Indicator Panel. Tape should stop rewinding. The REWIND Solenoid should release and the RUNNING VACUUM should be present. If the solenoid does not release or is not functioning properly, position the solenoid body so that the shaft will not bind or become cocked.

NOTE
The REWIND SOLENOID must function freely and maintain the proper RUNNING and REWIND vacuums.

The following is a list of vacuum leak symptoms:

a. REWIND SOLENOID not functioning properly.

b. Vacuum column glass covers not seated properly.

c. VACUUM SUPPLY MOTOR loose.

d. VACUUM SUPPLY MOTOR may need new brushes (refer to the DATAMEC manual for the brush changing procedure).

e. A hole in a vacuum hose or a removed hose from a fitting.

5.3.4.5 Tape Motions – Forward and reverse tape movement and associated circuitry and rewind operations are described in detail in the DATAMEC manual.

Check the following:

a. Rewind operation – the unit must perform a complete rewind of a 2400-ft reel of tape in approximately 3 min. If the rewinding is too fast, tape will stretch. To correct, adjust both DRAG BRAKE RETAINING SPRINGS the same amount (see Figure 5-14).

b. Jog Time Checkout and Adjustments

NOTE

On newer TU20s, a jog time testpoint is available on the back of the transport control chassis. When this testpoint is provided, proceed directly to Step 4 below.

Step	Procedure
1	If a jog time testpoint is not available, remove relay K5 on the TRANSPORT CONTROL CHASSIS (see Figure 5-13).
2	Insert a wire (approximately 24 WG) through pin 5 of relay K5.
3	Replace relay K5. Wire should protrude from the base of the relay.
4	Attach scope probe 1 to wire or to the testpoint.
5	Scope setup should be 10 ms/cm @ 1V/cm and with the AC-GND-DC switch in the AC position.
6	Jog time characteristics should be as in Figure 5-18. The relay must be on for 50 ms and off for 50 ms.
7	Adjust R46 and R47 (the two pots on ASSY C) for the correct ON/OFF times.
8	Remove the wire from relay K5.

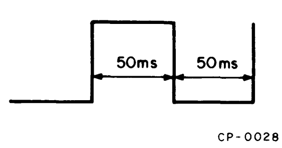


Figure 5-18 Jog Time Characteristics

CHAPTER 6
ENGINEERING DRAWINGS

This chapter contains reduced copies of the block schematics, circuit schematics, and other engineering drawings necessary for understanding and maintaining this equipment. Only those drawings which are essential and are not available in the referenced documents are included. Refer to the table of contents for a list of these drawings.

A complete set of engineering drawings is supplied with the equipment. Should any discrepancy exist between the drawings in this chapter and those supplied, assume that the latter drawings are correct.

6.1 DRAWING NUMBERS

6.1.1 General

Engineering drawing numbers contain five pieces of information, separated by hyphens. This information consists of a 2-letter code specifying the type of drawing; a 1-letter code specifying the size of the drawing; and variable-length codes specifying the type number of the equipment, the manufacturing series of the equipment, and a serial number for the drawing. The drawing type codes are:

BS, block schematic or logic diagram
CD, cable diagram
CS, circuit schematic
FD, flow diagram
ID, interconnection drawing
PW, power wiring
RS, replacement schematic
SD, system diagram
TD, timing diagram
TFD, timing and flow diagram
UML, utilization module list
WD, wiring diagram

6.1.2 Drawing List

Following is a list of engineering drawings contained in this chapter.

(continued on next page)

*This drawing used by permission of DATAMEC Division of Hewlett-Packard Company, Mountain View, California.

6.2 CIRCUIT SYMBOLS

The block schematics of DEC equipment are multipurpose drawings that combine signal flow, logical function, circuit type and location, wiring, and other pertinent information. Individual circuits are shown in block or semi-block form, using special symbols that define the circuit operation. These symbols are similar to those in the Digital System Modules Catalog but are often simplified. Figure 6-1 illustrates most of the symbols used in DEC engineering drawings.

6.3 LOGIC SIGNAL SYMBOLS

A Digital logic signal symbol is shown at the input of almost all circuit symbols to specify the assertive conditions required to produce a desired output.

All logic signals are either standard Digital logic levels or standard Digital pulses. A standard Digital logic level is either a ground (0 to -0.3V) or -3V (-2.5 to -3.5V). Logic signals are generally given mnemonic names which indicate the condition represented by assertion of the signal. An open diamond (—◇) indicates that the signal is a level and that ground represents assertion; a solid diamond (—◆) indicates that the signal is a level and that -3V represents assertion.

The standard Digital negative pulse is indicated by a solid triangle (—▶) and goes from ground to -2.5 or -3V (-2.3 to -3.5V tolerances). The standard Digital positive pulse, indicated by an open triangle (—▷), goes either from -3V to ground or from ground to +2.5V (+2.3 to +3.0V). The width of the standard pulses used in this equipment is either 1.0, 0.4, or 0.07 μs, depending on the module and application.

Occasionally, the transition of a level is used at an input where a standard pulse is otherwise expected and a composite symbol (◆▷) is drawn to indicate this fact. The triangle is drawn open or solid depending respectively on whether the positive (-3V to ground) or the negative (ground to -3V) transition triggers circuit action. The shading of the diamond either is the same as that of the triangle to indicate triggering on the leading edge of a level, or is opposite that of the triangle to indicate triggering on the trailing edge. Any other signal is nonstandard and is indicated by an arrowhead (—►) pointing in the direction of signal flow.

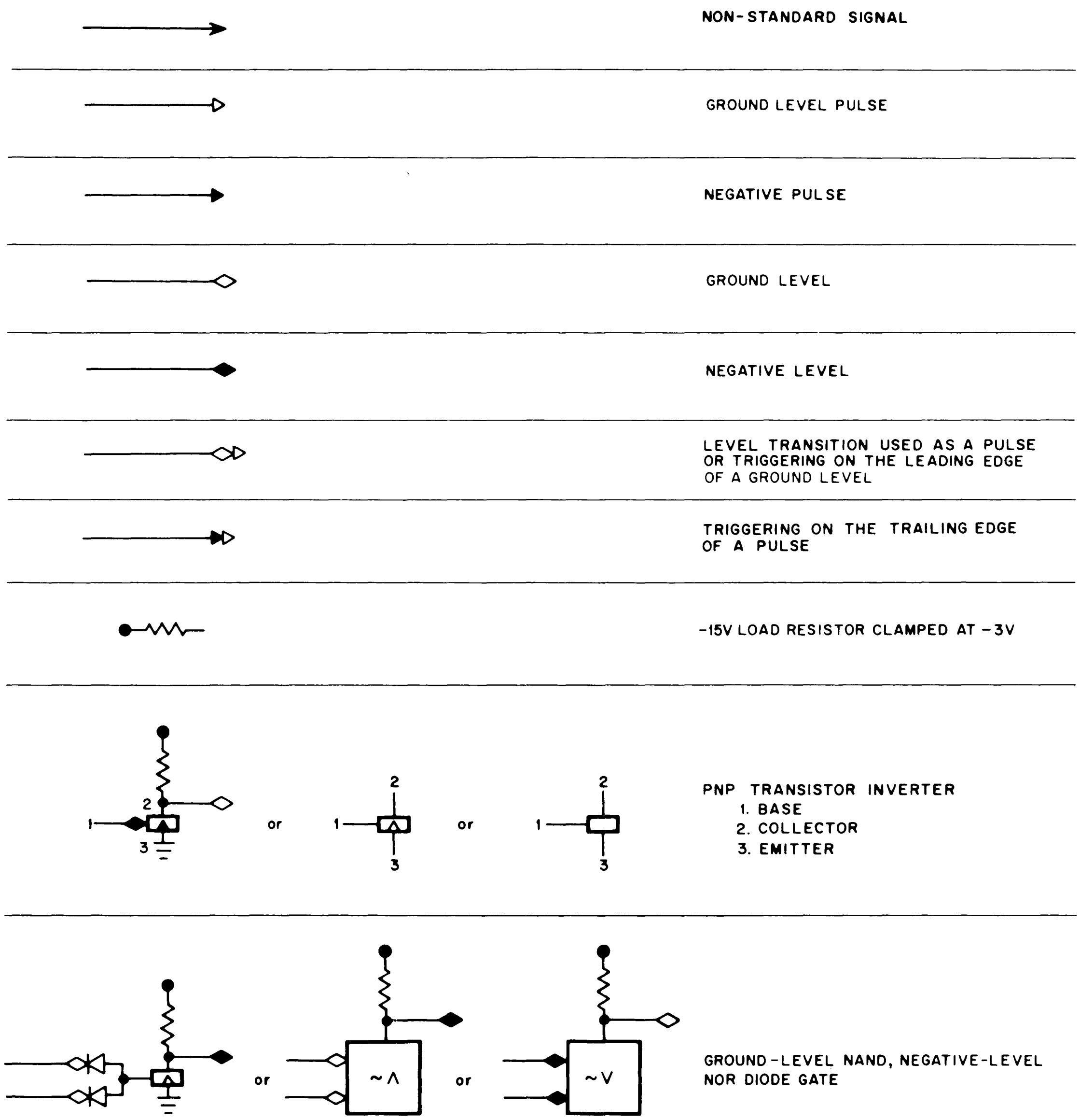
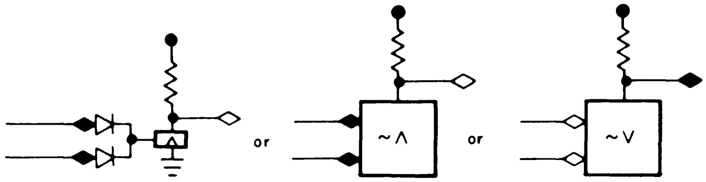


Figure 6-1 DEC Logic Symbols (Part 1)



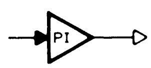
GROUND-LEVEL NOR, NEGATIVE-LEVEL NAND DIODE GATE

DIODE-CAPACITOR-DIODE GATE

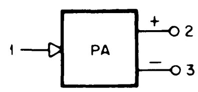
CAPACITOR–DIODE GATE

CAPACITOR-DIODE GATE, POSITIVE OR NEGATIVE INDICATED BY POLARITY OF THE INPUTS.

1. PULSE INPUT
2. CONDITIONING LEVEL INPUT
3. PULSE OUTPUT



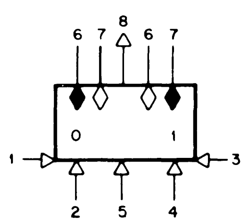
PULSE INVERTER



PULSE AMPLIFIER

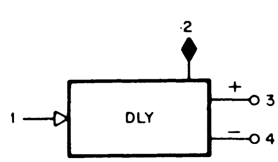
1. PULSE INPUT, POLARITY INDICATED BY INPUT SIGNAL

2,3. TRANSFORMER-COUPLED PULSE OUTPUT. EITHER TERMINAL MAY BE GROUNDED



FLIP-FLOP (MOST FLIP-FLOPS HAVE ONLY SOME OF THE FOLLOWING):

1. DIRECT-CLEAR INPUT
2. GATED-CLEAR INPUT
3. DIRECT-SET INPUT
4. GATED-SET INPUT
5. COMPLEMENT INPUT
6. OUTPUT LEVEL, -3 V IF 0, 0 V IF 1
7. OUTPUT LEVEL, 0 V IF 0, -3 V IF 1
8. CARRY PULSE OUTPUT, UPON BEING CLEARED

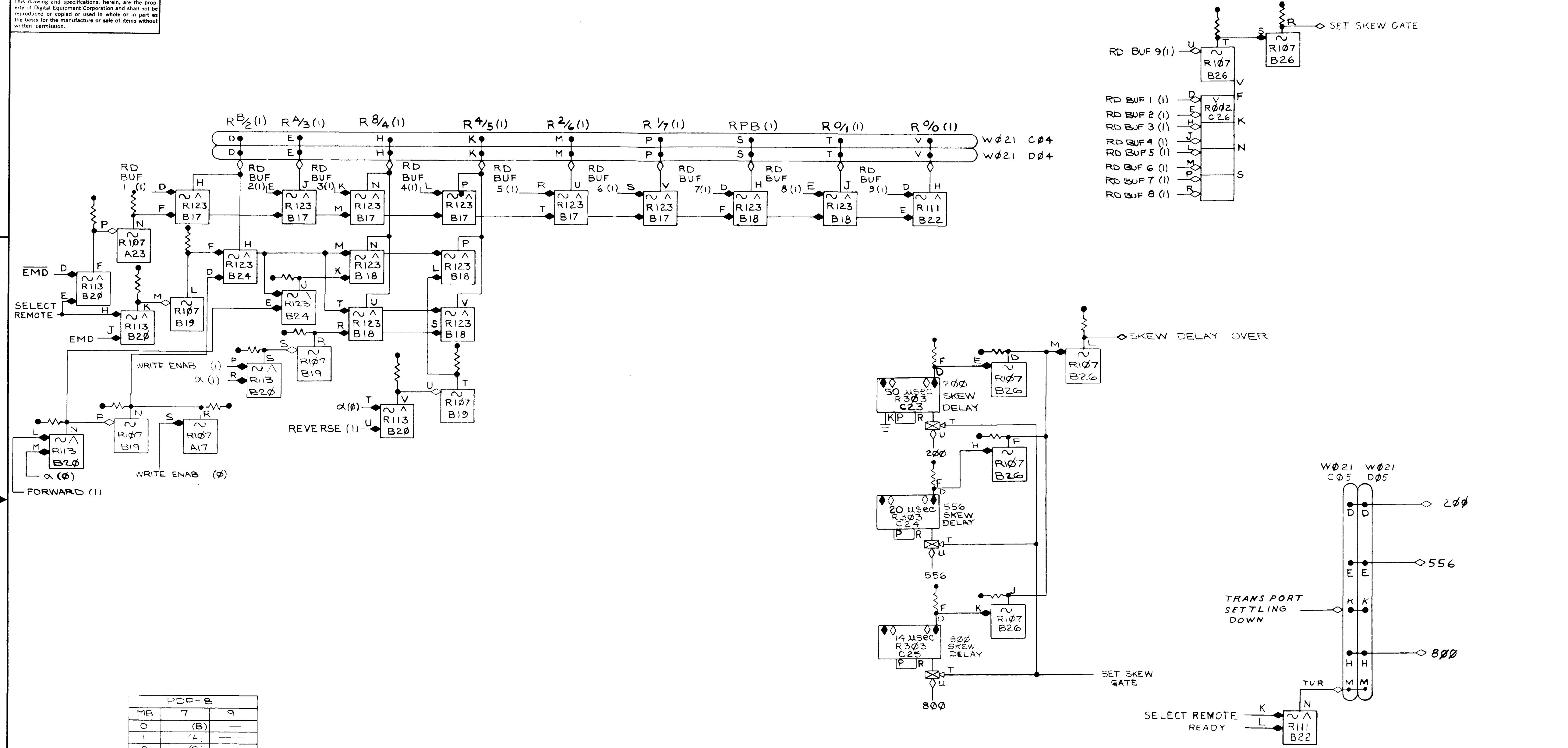


DELAY (ONE-SHOT MULTIVIBRATOR)

1. INPUT PULSE
2. OUTPUT LEVEL, -3V DURING DELAY

3,4. TRANSFORMER-COUPLED PULSE OUTPUT. EITHER TERMINAL MAY BE GROUNDED

Figure 6-1 DEC Logic Symbols (Part 2)



PDP-8		
MB	7	9
0	(B)	—
1	(A)	—
2	(B)	—
3	(4)	PARITY
4	(2)	0
5	( )	1
6	(B)	2
7	(A)	3
8	(8)	4
9	(4)	5
0	(2)	6
	( )	7

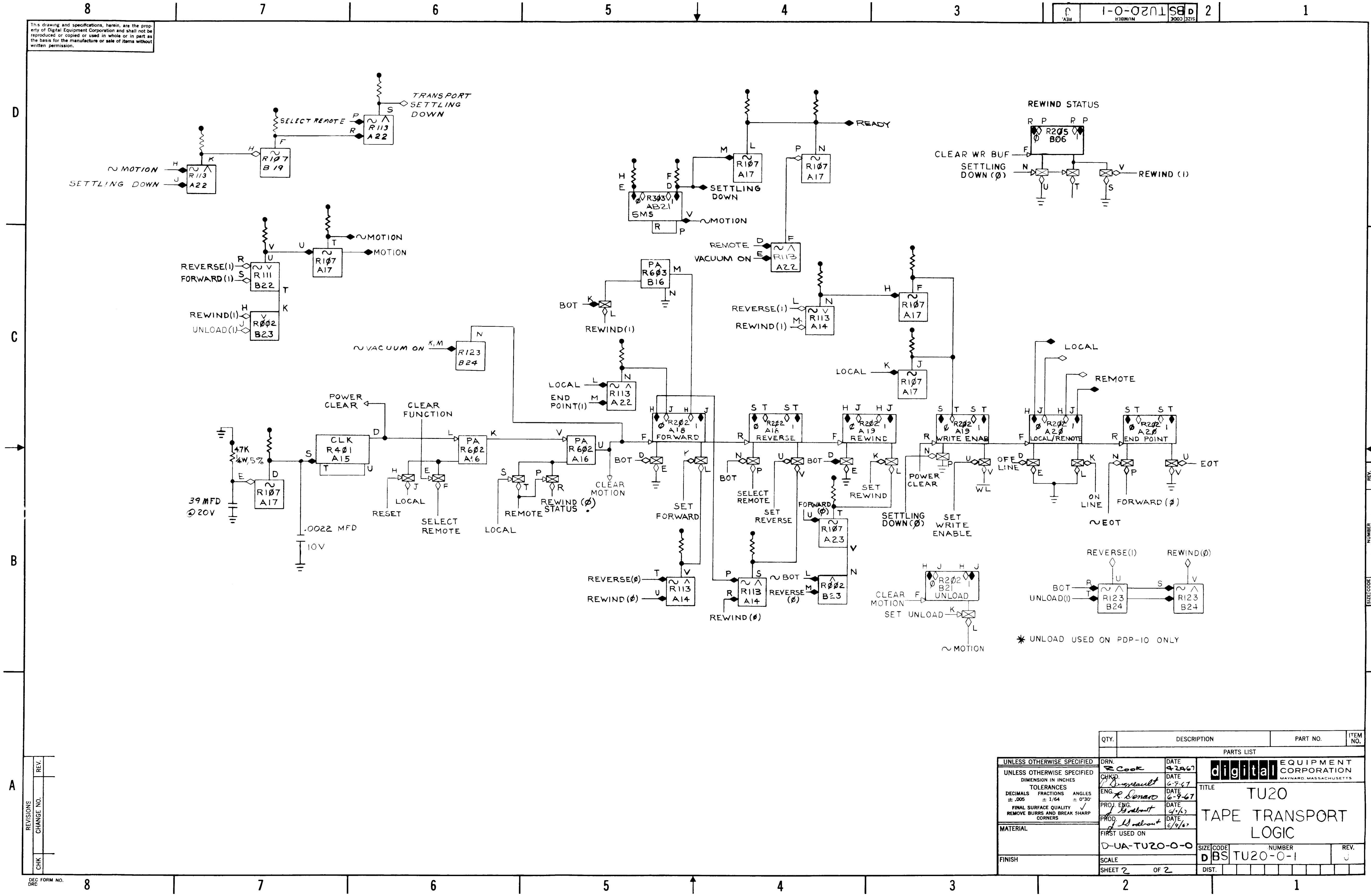
UNLESS OTHERWISE SPECIFIED
DIMENSION IN INCHES
TOLERANCES
DECIMALS ±.005 FRACTIONS ± 1/64 ANGLES ± 0°30'
FINAL SURFACE QUALITY √
REMOVE BURRS AND BREAK SHARP CORNERS
MATERIAL
FINISH

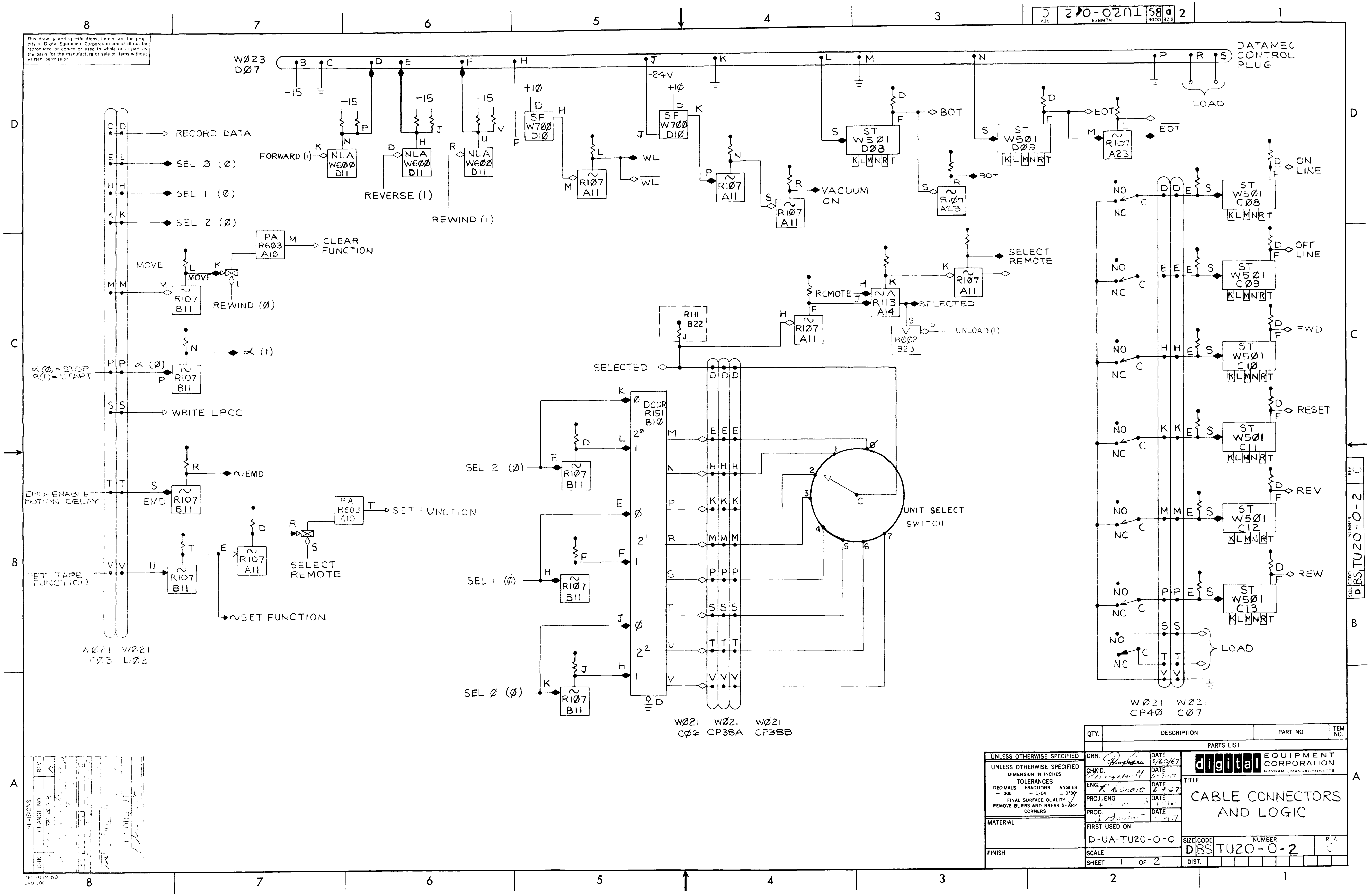
DRN. R Cook
CHKD. Marquault DATE 6-7-67
ENG. R Denaro DATE 6-9-67
PROJ. ENG. J Goodhart
PROD. J Goodhart
FIRST USED ON D-UA-TU20-0-0

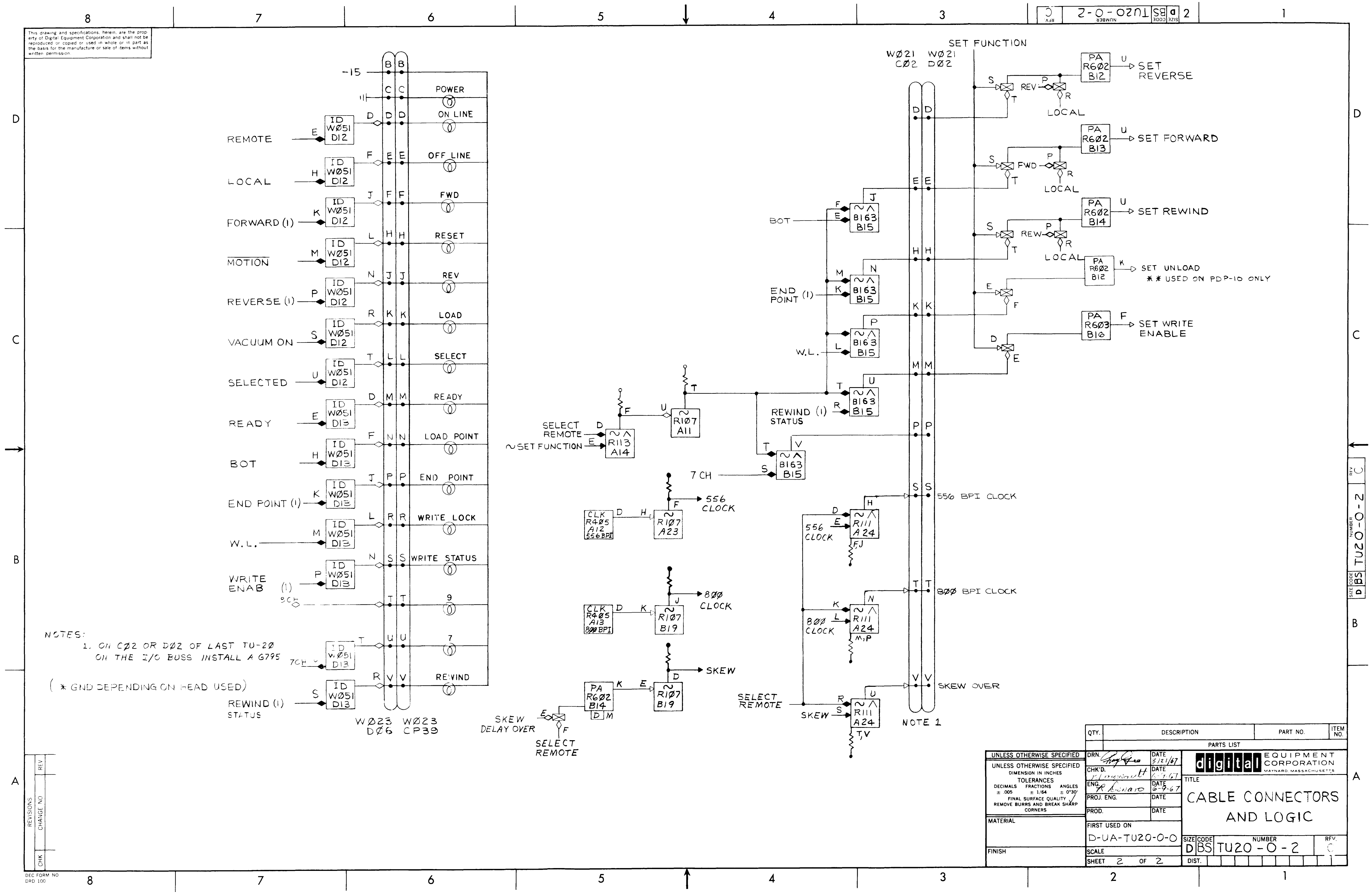
digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS

TITLE TU20 TAPE TRANSPORT LOGIC

SIZE D CODE BS NUMBER TU20-0-1 REV.
SHEET 1 OF 2


This drawing and specifications, herein, are the property of Digital Equipment Corporation and shall not be reproduced or copied or used in whole or in part as the basis for the manufacture or sale of items without written permission.
TRANSPORT SETTLING DOWN
SELECT REMOTE
~MOTION
SETTLING DOWN
READY
REWIND STATUS
CLEAR WR BUF
SETTLING DOWN (Ø)
REWIND (1)
SETTLING DOWN
~MOTION
REMOTE
VACUUM ON
REVERSE(1)
FORWARD(1)
REWIND(1)
UNLOAD(1)
~MOTION
MOTION
BOT
REWIND(1)
~VACUUM ON
LOCAL
END POINT(1)
LOCAL
REMOTE
POWER CLEAR
CLEAR FUNCTION
CLK R4Ø1 A15
47K 1/4W, 5%
39 MFD @20V
.0022 MFD
10V
RESET
LOCAL
SELECT REMOTE
REMOTE
LOCAL
REWIND (Ø) STATUS
CLEAR MOTION
FORWARD
REVERSE
REWIND
WRITE ENAB
LOCAL/REMOTE
END POINT
SET FORWARD
SELECT REMOTE
SET REVERSE
SET REWIND
POWER CLEAR
SETTLING DOWN (Ø)
SET WRITE ENABLE
OFF LINE
ON LINE
FORWARD (Ø)
~EOT
EOT
WL
REVERSE(Ø)
REWIND (Ø)
REWIND (Ø)
~BOT
REVERSE (Ø)
CLEAR MOTION
SET UNLOAD
UNLOAD
~MOTION
REVERSE(1)
REWIND(Ø)
BOT
UNLOAD(1)
✱ UNLOAD USED ON PDP-10 ONLY
QTY. DESCRIPTION PART NO. ITEM NO.
PARTS LIST
UNLESS OTHERWISE SPECIFIED
DIMENSION IN INCHES
TOLERANCES
DECIMALS ±.005 FRACTIONS ±1/64 ANGLES ±0°30'
FINAL SURFACE QUALITY
REMOVE BURRS AND BREAK SHARP CORNERS
MATERIAL
FINISH
DRN. R. Cook
CHKD.
ENG.
PROJ. ENG.
PROD.
FIRST USED ON D-UA-TU20-0-0
digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS
TITLE TU20 TAPE TRANSPORT LOGIC
SIZE D CODE BS NUMBER TU20-0-1 REV. J
SCALE
SHEET 2 OF 2
DIST.
REVISIONS
REV.
CHANGE NO.
CHK
DEC FORM NO. DRC


DATAMEC CONTROL PLUG
LOAD
RECORD DATA
SEL Ø (Ø)
SEL 1 (Ø)
SEL 2 (Ø)
CLEAR FUNCTION
MOVE
REWIND (Ø)
α (1)
α(Ø)=STOP
α(1)=START
WRITE LPCC
~EMD
EMD-ENABLE MOTION DELAY
SET FUNCTION
SELECT REMOTE
SET TAPE FUNCTION
~SET FUNCTION
FORWARD (1)
REVERSE (1)
REWIND (1)
WL
VACUUM ON
BOT
EOT
SELECTED
UNLOAD (1)
UNIT SELECT SWITCH
ON LINE
OFF LINE
FWD
RESET
REV
REW
CABLE CONNECTORS AND LOGIC
D-UA-TU20-0-0
D BS TU20-0-2
SHEET 1 OF 2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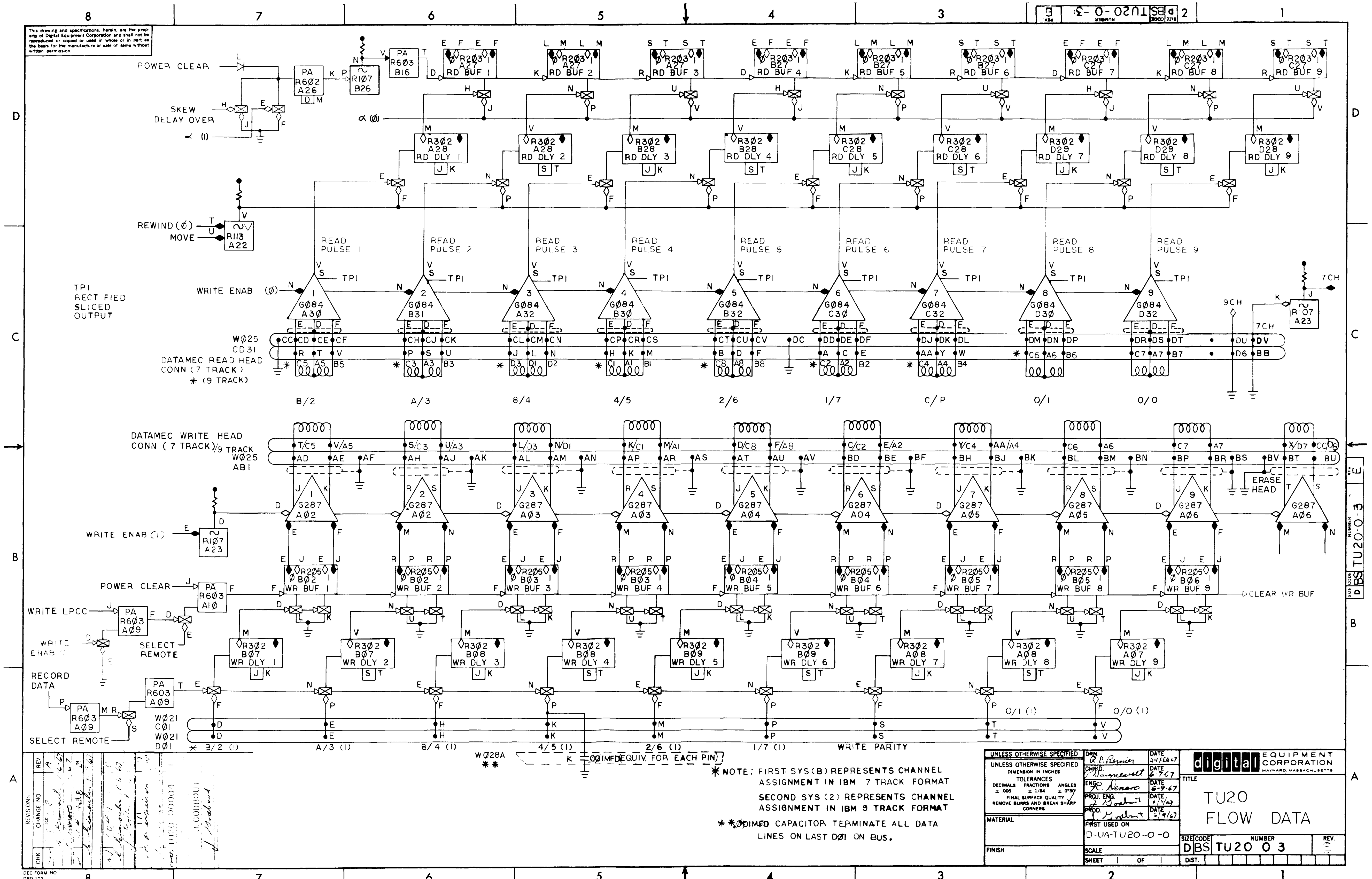
SET FUNCTION
WØ21 CØ2
WØ21 DØ2
SET REVERSE
SET FORWARD
SET REWIND
SET UNLOAD
** USED ON PDP-10 ONLY
SET WRITE ENABLE
LOCAL
REMOTE
FORWARD (1)
MOTION
REVERSE (1)
VACUUM ON
SELECTED
READY
BOT
END POINT (1)
W.L.
WRITE ENAB (1)
REWIND (1) STATUS
POWER
ON LINE
OFF LINE
FWD
RESET
REV
LOAD
SELECT
READY
LOAD POINT
END POINT
WRITE LOCK
WRITE STATUS
9
7
REWIND
WØ23 DØ6
WØ23 CP39
NOTES:
1. ON CØ2 OR DØ2 OF LAST TU-2Ø ON THE I/O BUSS INSTALL A G795
(* GND DEPENDING ON HEAD USED)
SELECT REMOTE
~SET FUNCTION
7 CH
556 CLOCK
8ØØ CLOCK
SKEW
SKEW DELAY OVER
556 BPI CLOCK
8ØØ BPI CLOCK
SKEW OVER
REWIND (1) STATUS
END POINT (1)
NOTE 1
UNLESS OTHERWISE SPECIFIED DIMENSION IN INCHES TOLERANCES
DECIMALS ± .005 FRACTIONS ± 1/64 ANGLES ± 0°30'
FINAL SURFACE QUALITY REMOVE BURRS AND BREAK SHARP CORNERS
PARTS LIST
digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS
TITLE CABLE CONNECTORS AND LOGIC
FIRST USED ON D-UA-TU20-0-0
SIZE D CODE BS NUMBER TU20-0-2 REV C
SHEET 2 OF 2
DEC FORM NO DRD 100


TU20 FLOW DATA
digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS
D BS TU20 0 3
D-UA-TU20-0-0
POWER CLEAR
SKEW DELAY OVER
REWIND (Ø)
MOVE
TPI RECTIFIED SLICED OUTPUT
WRITE ENAB (Ø)
READ PULSE 1
READ PULSE 2
READ PULSE 3
READ PULSE 4
READ PULSE 5
READ PULSE 6
READ PULSE 7
READ PULSE 8
READ PULSE 9
WØ25 CD31 DATAMEC READ HEAD CONN (7 TRACK) * (9 TRACK)
B/2 A/3 8/4 4/5 2/6 1/7 C/P 0/1 0/0
DATAMEC WRITE HEAD CONN (7 TRACK)/9 TRACK WØ25 AB1
WRITE ENAB (1)
ERASE HEAD
POWER CLEAR
WRITE LPCC
SELECT REMOTE
RECORD DATA
SELECT REMOTE
CLEAR WR BUF
WØ21 CØ1 WØ21 DØ1
* 3/2 (1) A/3 (1) 8/4 (1) 4/5 (1) 2/6 (1) 1/7 (1) WRITE PARITY 0/1 (1) 0/0 (1)
WØ28A ** K .Ø01MFD (EQUIV FOR EACH PIN)
* NOTE: FIRST SYS (B) REPRESENTS CHANNEL ASSIGNMENT IN IBM 7 TRACK FORMAT
SECOND SYS (2) REPRESENTS CHANNEL ASSIGNMENT IN IBM 9 TRACK FORMAT
** .Ø01MFD CAPACITOR TERMINATE ALL DATA LINES ON LAST DØ1 ON BUS.

D MU TU20-0-4 J

Slot	A module	A functions	B module	B functions	C module	C functions	D module	D functions
1	W025	WRITE CABLE			W021	WRITE DATA	W028*	WRITE DATA
2	G287	WRITE DRIVER #1; WRITE DRIVER #2	R205	WR BUF #1; WR BUF #2	W021	STATUS	G795*	STATUS
3	G287	WRITE DRIVER #3; WRITE DRIVER #4	R205	WR BUF #3; WR BUF #4	W021	COMMAND	W021	COMMAND
4	G287	WRITE DRIVER #5; WRITE DRIVER #6	R205	WR BUF #5; WR BUF #6	W021	READ DATA	W021	READ DATA
5	G287	WRITE DRIVER #7; WRITE DRIVER #8	R205	WR BUF #7; WR BUF #8	W021	DENSITY	W021	DENSITY
6	G287	WRITE DRIVER #9; ERASE HEAD	R205	WR BUF #9; REWIND STATUS	W021	SELECT SWITCH	W023	CONTROL PANEL INDICATORS
7	R302	WR DLY #9	R302	WR DLY #1; WR DLY #2	W021	CONTROL PANEL OPERATION	W023	DATAMEC CONN
8	R302	WR DLY #7; WR DLY #8	R302	WR DLY #3; WR DLY #4	W501	ON LINE	W105	BOT
9	R603	WRITE LPCC; RECORD DATA; STROBE WRITE DELAYS	R302	WR DLY #5; WR DLY #6	W501	OFF LINE	W105	EOT
10	R603	40 WRITE BUFFER; CLEAR FUNCT.; SET FUNCT.	R151	SELECT UNIT	W501	FWD	W700	WRITE LOCK; -24V
11	R107	SET FUNCT.; SELECT; SELECT REMOTE; W.L.; VACUUM ON; ENABLE STATUS	R107	SEL 0; SEL 1; SEL 2; GO; ∝(1); EMD; SET FUNCT.	W501	RESET	W600	REVERSE (1); FWD (1); REWIND (1)
12	R405	556 CLOCK	R602	SET UNLOAD; SET REVERSE	W501	REV	W051	REMOTE IND; LOCAL IND; FWD IND; MOTION IND; REVERSE IND; VACUUM IND; SELECT IND
13	R405	800 CLOCK	R602	SET FORWARD	W501	REW	W051	READY IND; BOT IND; END POINT IND; W.L. IND; WRITE ENB IND; REWIND IND; 7 CH IND
14	R113	ENABLE STATUS; SELECT REMOTE; WRITE ENABLE (0); ENABLE REVERSE; ENABLE FORWARD	R602	SKEW; SET REWIND				
15	R401	POWER CLEAR	B163	BOT; END POINT; W.L.; REWIND; 7 CHANNEL				
16	R602	CLEAR FLIP-FLOPS; CLEAR FLIP-FLOPS	R603	SET WRITE ENABLE; FORWARD (1); CLEAR RD BUF				
17	R107	POWER CLEAR; WRITE ENABLE; ENABLE (0); READY; FORWARD STOP DELAY; MOTION	R123	RB/2 (1); RA/3 (1); R8/4 (1); R4/5 (1); R2/6 (1); R1/7 (1)				
18	R202	FORWARD; REVERSE	R123	RPB (1); R0/1 (1); R8/4 (1); R4/5 (1); R8/4 (1); R4/5 (1)				
19	R202	REWIND; WRITE ENABLE	R107	SKEW; B19F; CLOCK 800; ENABLE; SHUT DOWN FORWARD; WRITE START; REVERSE STOP				
20	R202	LOCAL/REMOTE; END POINT	R113	EMD; EMD; FWD STOP; WRITE START; REV STOP				
21	R303	SETTLING DOWN DELAY	R202*	UNLOAD				
22	R113	READY; TRANSPORT SETTLING DOWN; FORWARD (0); TRANSPORT SETTLING DOWN; READ ENABLE	R111	R0/0; SEL REM & READY; MOTION				
23	R107	WR ENAB; 556; 7 CH; EOT; ENABLE READ BUFFER; BOT; ENABLE REWIND	R002	MOTION; ENABLE REWIND; SELECT	R303	200 SKEW DELAY		
24	R111	556 BPI CLOCK; 800 BPI CLOCK; SKEW OVER	R123	RB/2 (1); R8/4 (1); CLEAR MOTION; REWIND; REVERSE	R303	556 SKEW DELAY		
25					R303	800 SKEW DELAY		
26	R602	READ BUFFER	R107	SKEW DELAY; SKEW DELAY; SKEW DELAY; SKEW DELAY OVER; CLEAR RD BUF; SET SKEW GATE; TOTAL SKEW	R002	RD BUF 1(1); RD BUF 2(1); RD BUF 3(1); RD BUF 4(1); RD BUF 5(1); RD BUF 6(1); RD BUF 7(1); RD BUF 8(1)		
27	R203	RD BUF #1; RD BUF #2; RD BUF #3	R203	RD BUF #4; RD BUF #5; RD BUF #6	R203	RD BUF #7; RD BUF #8; RD BUF #9		
28	R302	RD DLY #1; RD DLY #2	R302	RD DLY #3; RD DLY #4	R302	RD DLY #5; RD DLY #6	R302	RD DLY #9
29							R302	RD DLY #7; RD DLY #8
30	G084	READ CKT #1	G084	READ CKT #4	G084	READ CKT #6	G084Δ	READ CKT #8
31			G084	READ CKT #2		READ HEAD CABLE		
32	G084	READ CKT #3	G084	READ CKT #5	G084	READ CKT #7	G084Δ	READ CKT #9
33–44								

* USED ONLY ON LAST TU-20 ON I/O BUSS.

Δ FOR TU20-A-A/B

** USED ON PDP-10 ONLY

REVISIONS: REV | CHANGE NO | CHK
TU20-00004 J GODBOUT
VONADA
00006 J. GODBOUT
TU20-00015 J. SWANSON 12/31/6

UNLESS OTHERWISE SPECIFIED
DIMENSION IN INCHES
TOLERANCES
DECIMALS ± .005 FRACTIONS ± 1/64 ANGLES ± 0°30'
FINAL SURFACE QUALITY ✓
REMOVE BURRS AND BREAK SHARP CORNERS
MATERIAL
FINISH

DRN. R.E. Bernier DATE 14FEB67
CHK'D. DATE
ENG. DATE 6-7-67
PROJ. ENG. DATE
PROD. DATE
FIRST USED ON D-UA-TU20-0-0
SCALE
SHEET 1 OF 1

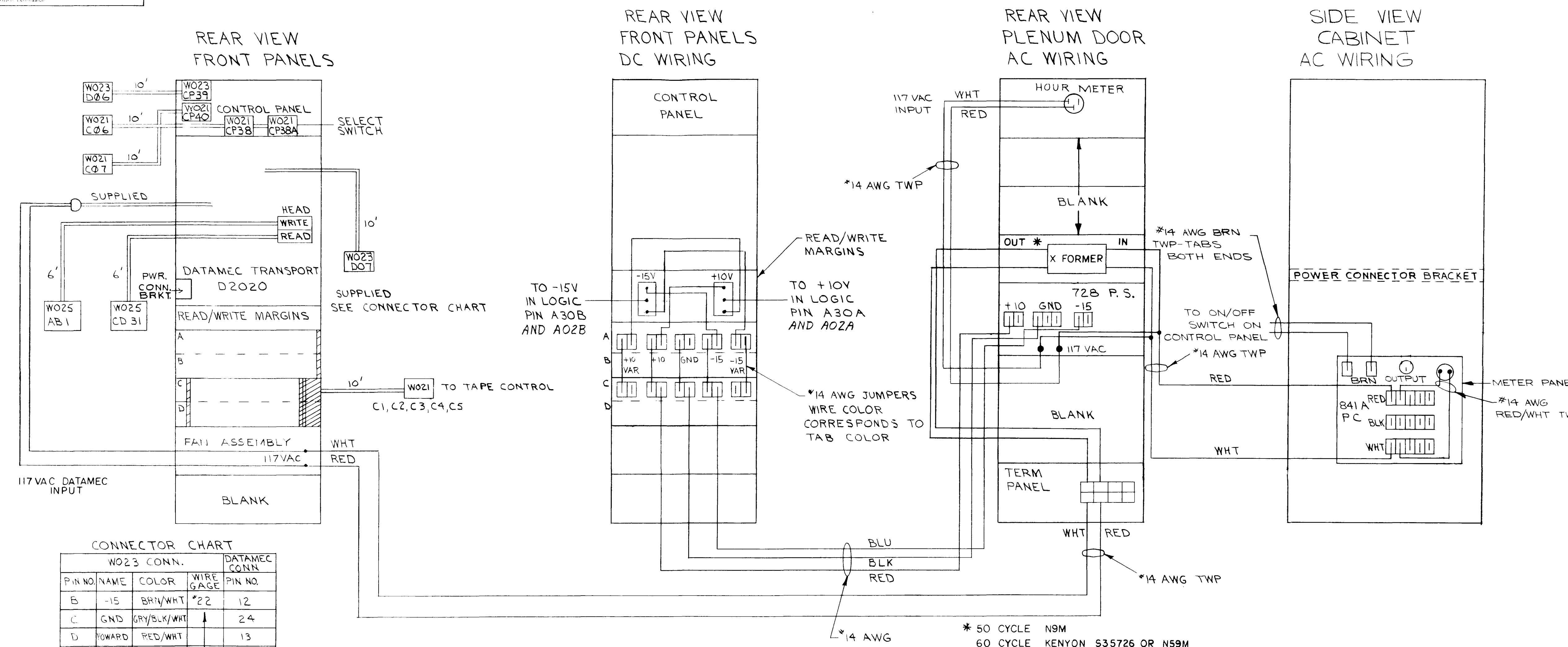
digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS

TITLE MODULE UTILIZATION

SIZE D CODE MU NUMBER TU20-0-4 REV.

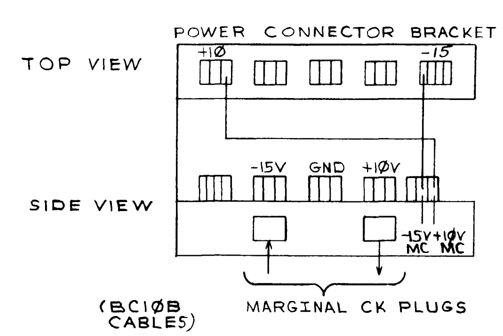
DIST.

DEC FORM NO DRD 105



CONNECTOR CHART

W023 CONN.				DATAMEC CONN
PIN NO.	NAME	COLOR	WIRE GAGE	PIN NO.
B	-15	BRN/WHT	#22	12
C	GND	GRY/BLK/WHT	↑	24
D	FOWARD	RED/WHT		13
E	REVERSE	ORN/WHT		14
F	REWIND	YEL/WHT		15
H	W. L.	BLK/WHT		11
J	VACCUM ON	RED		4
K	SHLD			
L	BOT	BLK/RED/WHT		7
M	GND			
N	EOT	BLK/ORN/WHT		8
P	GND			
R	LOAD	BLK/BLU/WHT	↓	21
S	LOAD	BLU	22	23



UNLESS OTHERWISE SPECIFIED DIMENSION IN INCHES TOLERANCES DECIMALS ± .005 FRACTIONS ± 1/64 ANGLES ± 0°30' FINAL SURFACE QUALITY REMOVE BURRS AND BREAK SHARP CORNERS

MATERIAL —//—

FINISH —//—

DRN. Dick Ruth DATE 3-8-67
CHK'D. DATE 4-9-67
ENG. R. Lenaro DATE 4-9-67
PROJ. ENG. DATE
PROD. DATE

FIRST USED ON D-UA-TU20-0-0

SCALE NONE SHEET 1 OF 1

QTY. | DESCRIPTION | PART NO. | ITEM NO. — PARTS LIST

digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS

TITLE POWER WIRING AC & DC

SIZE D CODE IC NUMBER TU20-0-7 REV. C

DIST.

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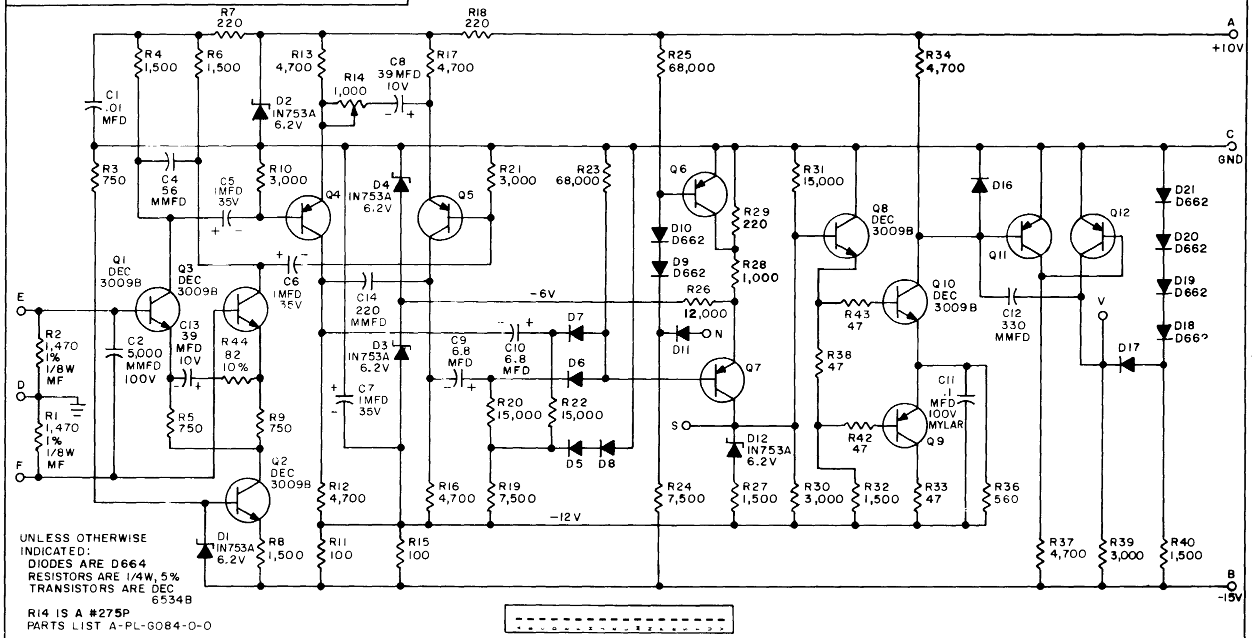

UNLESS OTHERWISE INDICATED:
DIODES ARE D664
RESISTORS ARE 1/4W, 5%
TRANSISTORS ARE DEC 6534B

R14 IS A #275P
PARTS LIST A-PL-G084-0-0

TRANSISTOR & DIODE CONVERSION CHART			
DEC	EIA	DEC	EIA
DEC3009B	2N3009	IN753A	SAME
DEC6534B	MPS6534		
D662	IN645		
D664	IN3606		

DRN m. Waller DATE 4-5-67

digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS

TITLE MAG. TAPE READ AMP. G084

SIZE B CODE CS NUMBER G084-0-1 REV D

PRINTED CIRCUIT REV C

DEC FORM NO DRB 102

PINK 5 DIST. 324 434 435

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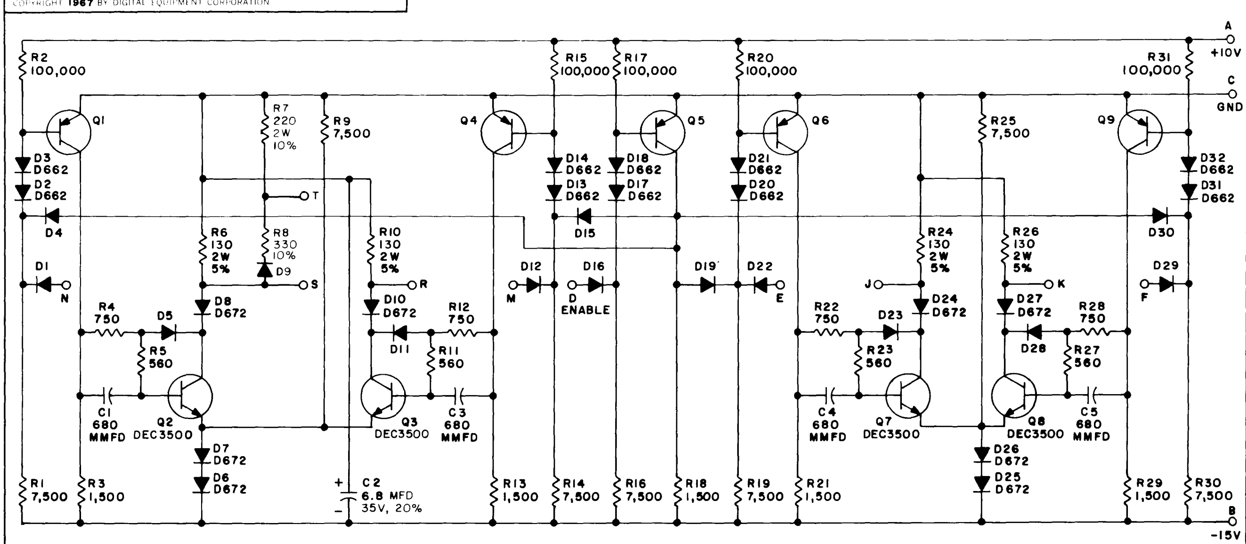


UNLESS OTHERWISE INDICATED:
TRANSISTORS ARE DEC6534B
DIODES ARE D664
RESISTORS ARE 1/4W; 5%

TRANSISTOR & DIODE CONVERSION CHART			
DEC	EIA	DEC	EIA
DEC3500	2N3500		
DEC6534B	MPS6534		
D662	IN645		
D664	IN3606		
D672	IN3663		

DRN M. Waller DATE 2-16-67

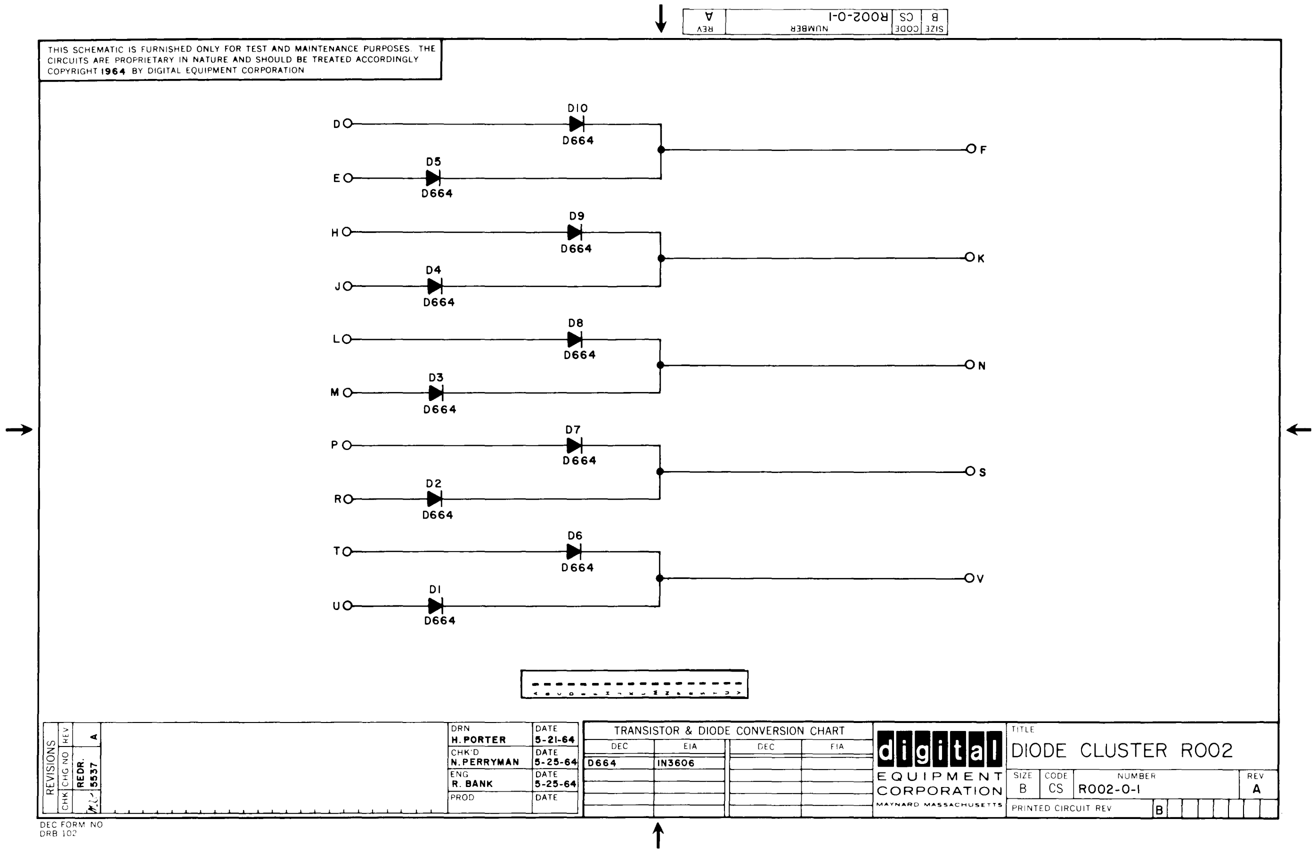
digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS

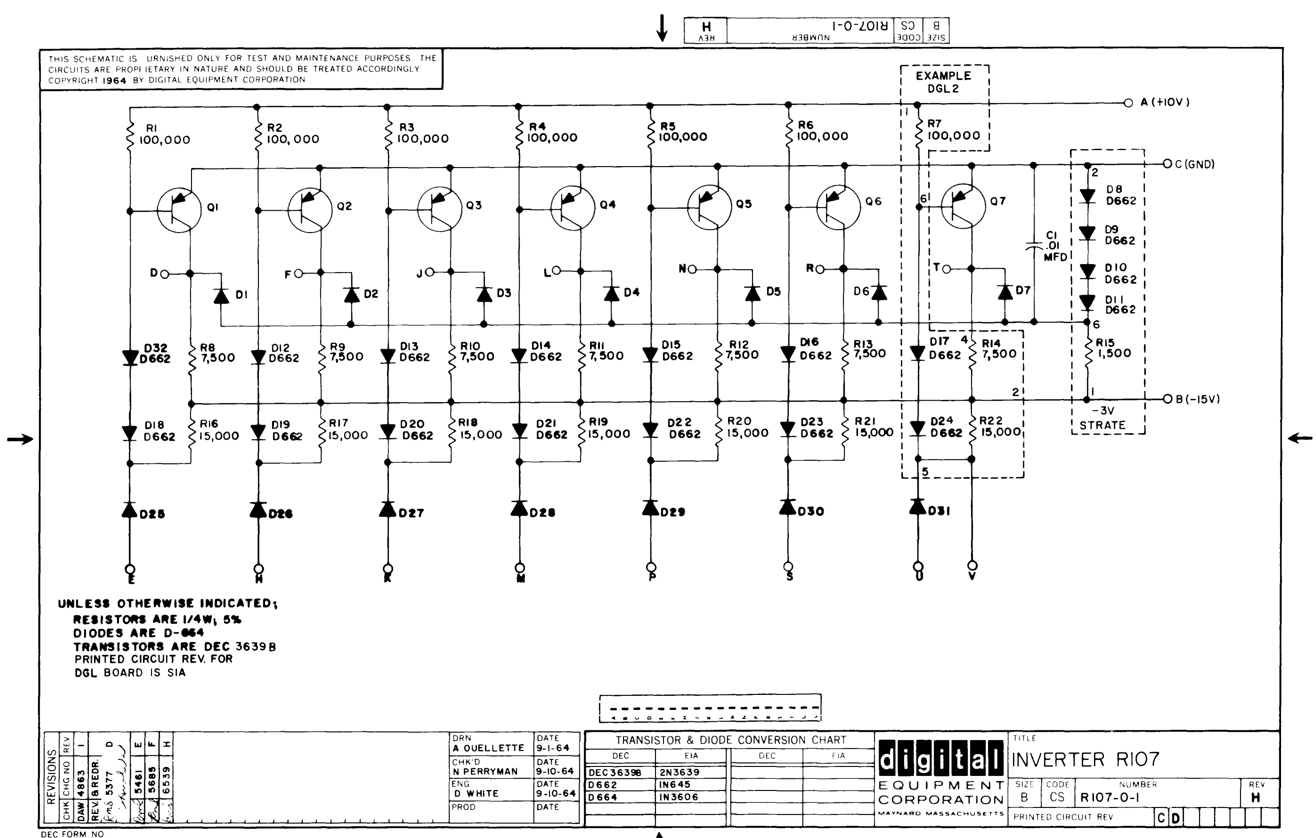
TITLE WRITE DRIVER G287

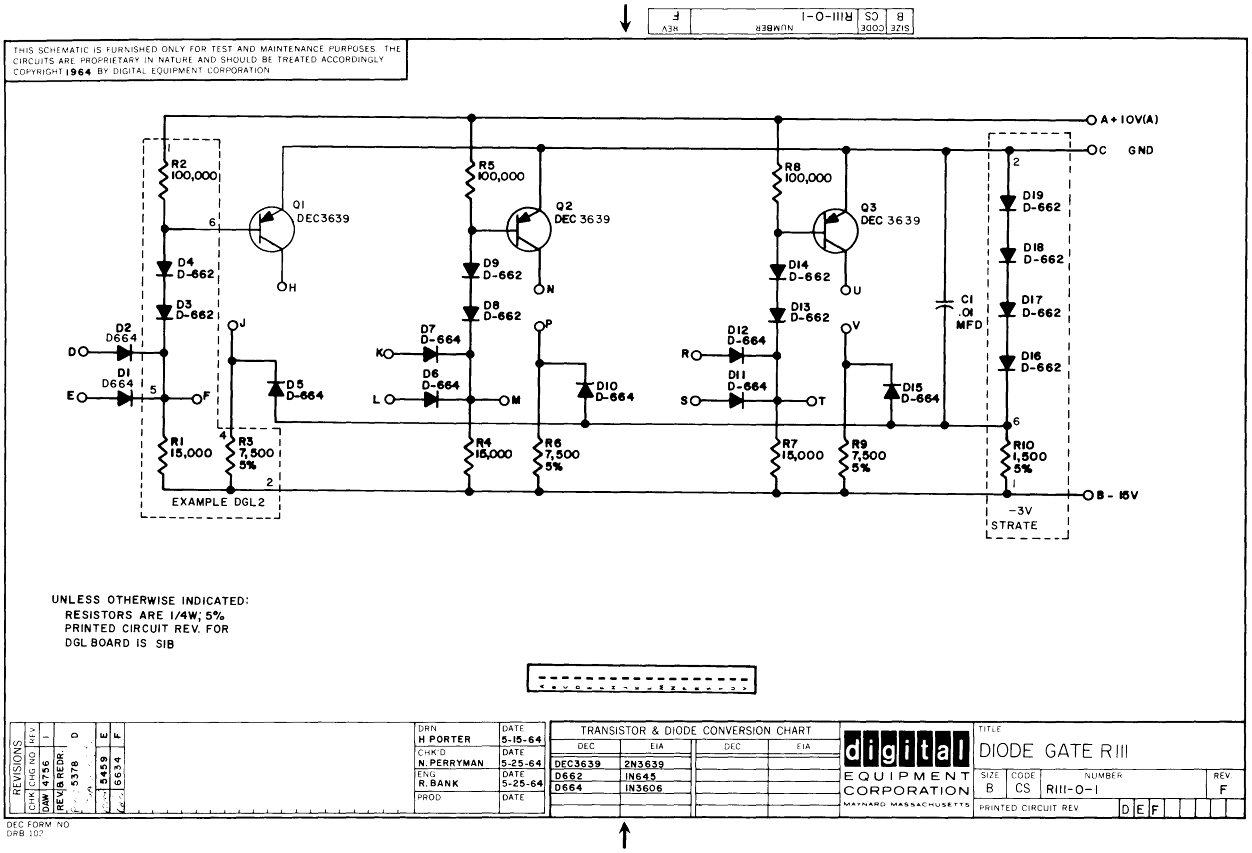
SIZE B CODE CS NUMBER G287-0-1 REV B

PRINTED CIRCUIT REV B

DEC FORM NO DRB 102


THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY
COPYRIGHT 1964 BY DIGITAL EQUIPMENT CORPORATION
D10 D664
D5 D664
D9 D664
D4 D664
D8 D664
D3 D664
D7 D664
D2 D664
D6 D664
D1 D664
D E F H J K L M N P R S T U V
REVISIONS CHK CHG NO REV REDR. 5537 A
DRN H. PORTER DATE 5-21-64
CHK'D N. PERRYMAN DATE 5-25-64
ENG R. BANK DATE 5-25-64
PROD DATE
TRANSISTOR & DIODE CONVERSION CHART
DEC EIA DEC EIA
D664 IN3606
digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS
TITLE DIODE CLUSTER R002
SIZE B CODE CS NUMBER R002-0-1 REV A
PRINTED CIRCUIT REV B
DEC FORM NO DRB 102


THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY
COPYRIGHT 1964 BY DIGITAL EQUIPMENT CORPORATION
EXAMPLE DGL2
A (+10V)
C (GND)
B (-15V)
-3V STRATE
R1 100,000 R2 100,000 R3 100,000 R4 100,000 R5 100,000 R6 100,000 R7 100,000
Q1 Q2 Q3 Q4 Q5 Q6 Q7
C1 .01 MFD
D8 D662 D9 D662 D10 D662 D11 D662
R15 1,500
D1 D2 D3 D4 D5 D6 D7
D32 D662 D12 D662 D13 D662 D14 D662 D15 D662 D16 D662 D17 D662
R8 7,500 R9 7,500 R10 7,500 R11 7,500 R12 7,500 R13 7,500 R14 7,500
D18 D662 D19 D662 D20 D662 D21 D662 D22 D662 D23 D662 D24 D662
R16 15,000 R17 15,000 R18 15,000 R19 15,000 R20 15,000 R21 15,000 R22 15,000
D25 D26 D27 D28 D29 D30 D31
D F J L N R T E H K M P S U V
UNLESS OTHERWISE INDICATED;
RESISTORS ARE 1/4W; 5%
DIODES ARE D-664
TRANSISTORS ARE DEC 3639B
PRINTED CIRCUIT REV. FOR
DGL BOARD IS SIA
REVISIONS CHK CHG NO REV DAW 4863 I REV. & REDR. D 5461 E 5685 F 6539 H
DRN A OUELLETTE DATE 9-1-64
CHK'D N PERRYMAN DATE 9-10-64
ENG D WHITE DATE 9-10-64
PROD DATE
TRANSISTOR & DIODE CONVERSION CHART
DEC EIA DEC EIA
DEC 3639B 2N3639
D662 IN645
D664 IN3606
digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS
TITLE INVERTER R107
SIZE B CODE CS NUMBER R107-0-1 REV H
PRINTED CIRCUIT REV C D
DEC FORM NO DRB 102



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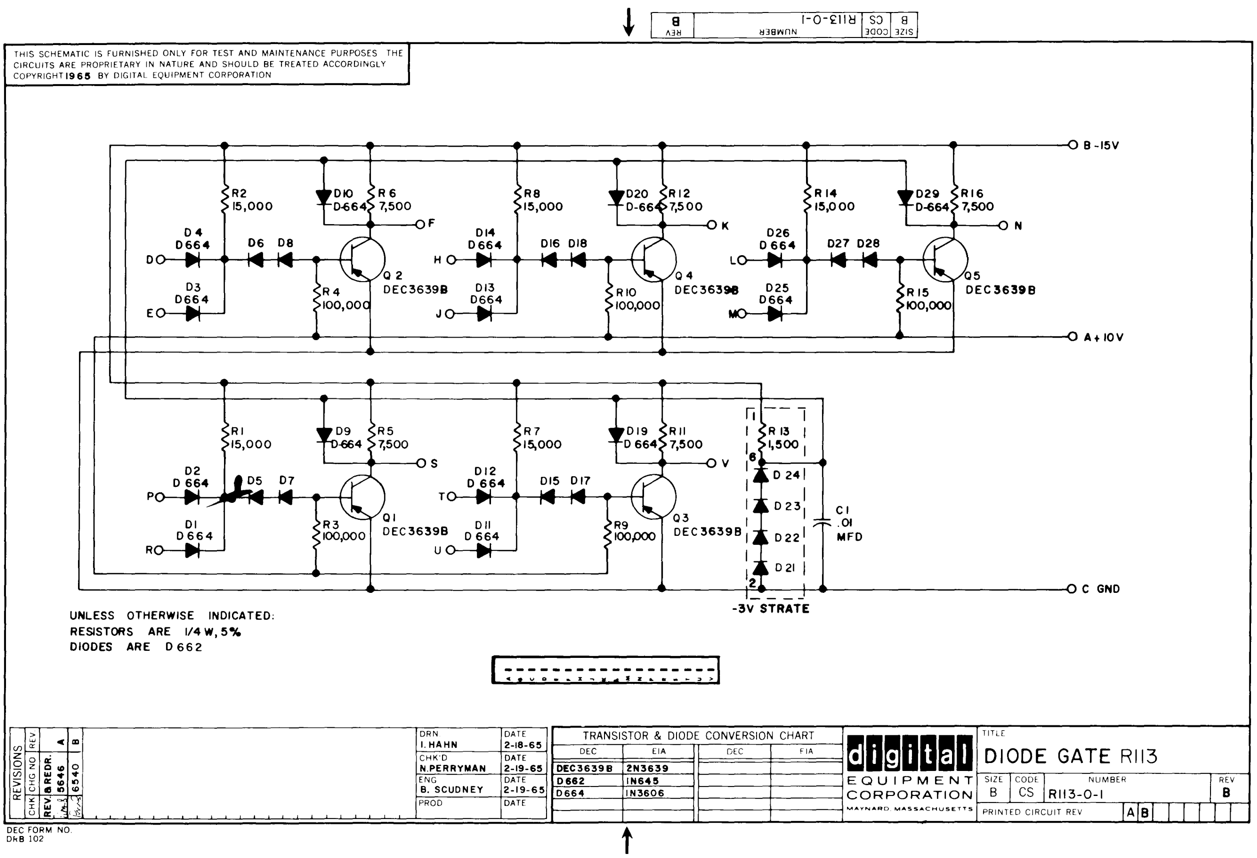
A +10V(A)
C GND
B -15V
R2 100,000
Q1 DEC3639
D4 D-662
D3 D-662
D2 D664
D1 D664
D5 D-664
R1 15,000
R3 7,500 5%
EXAMPLE DGL2
R5 100,000
Q2 DEC 3639
D9 D-662
D8 D-662
D7 D-664
D6 D-664
D10 D-664
R4 15,000
R6 7,500 5%
R8 100,000
Q3 DEC 3639
D14 D-662
D13 D-662
D12 D-664
D11 D-664
D15 D-664
R7 15,000
R9 7,500 5%
C1 .01 MFD
D19 D-662
D18 D-662
D17 D-662
D16 D-662
R10 1,500 5%
-3V STRATE
UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W; 5%
PRINTED CIRCUIT REV. FOR
DGL BOARD IS SIB
TRANSISTOR & DIODE CONVERSION CHART
DEC EIA
DEC3639 2N3639
D662 IN645
D664 IN3606
DRN H PORTER DATE 5-15-64
CHK'D N. PERRYMAN DATE 5-25-64
ENG R. BANK DATE 5-25-64
digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS
TITLE DIODE GATE R111
SIZE B CODE CS NUMBER R111-0-1 REV F
PRINTED CIRCUIT REV D E F
DEC FORM NO DRB 102



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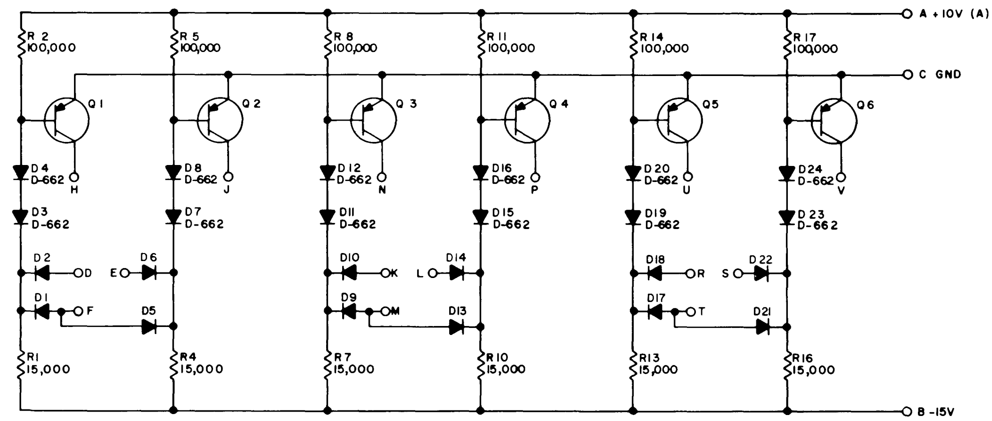
B -15V
A +10V
C GND
R2 15,000
D10 D-664
R6 7,500
D4 D664
D3 D664
D6 D8
Q2 DEC3639B
R4 100,000
R8 15,000
D20 D-664
R12 7,500
D14 D664
D13 D664
D16 D18
Q4 DEC3639B
R10 100,000
R14 15,000
D29 D-664
R16 7,500
D26 D664
D25 D664
D27 D28
Q5 DEC3639B
R15 100,000
R1 15,000
D9 D-664
R5 7,500
D2 D 664
D1 D664
D5 D7
Q1 DEC3639B
R3 100,000
R7 15,000
D19 D 664
R11 7,500
D12 D 664
D11 D 664
D15 D17
Q3 DEC3639B
R9 100,000
R13 1,500
D24 D23 D22 D21
C1 .01 MFD
-3V STRATE
UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4 W, 5%
DIODES ARE D 662
TRANSISTOR & DIODE CONVERSION CHART
DEC EIA
DEC3639B 2N3639
D662 IN645
D664 IN3606
DRN I. HAHN DATE 2-18-65
CHK'D N.PERRYMAN DATE 2-19-65
ENG B. SCUDNEY DATE 2-19-65
digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS
TITLE DIODE GATE R113
SIZE B CODE CS NUMBER R113-0-1 REV B
PRINTED CIRCUIT REV A B
DEC FORM NO. DRB 102

B | CS | R123-0-1 | B
SIZE | CODE | NUMBER | REV



UNLESS OTHERWISE INDICATED:
TRANSISTORS ARE DEC 3639
RESISTORS ARE 1/4 W, 5%
DIODES ARE D-664

USE THE ETCH BOARD OF W101

REVISIONS: CHK | CHG NO | REV — DAW | 4864 | 1 — REV B REDR 5644 5676 | B

DRN I. HAHN, DATE 4-20-65
CHK'D R. SILVERMAN, DATE 4-21-65
ENG E. DECASTRO, DATE 4-21-65
PROD, DATE

TRANSISTOR & DIODE CONVERSION CHART

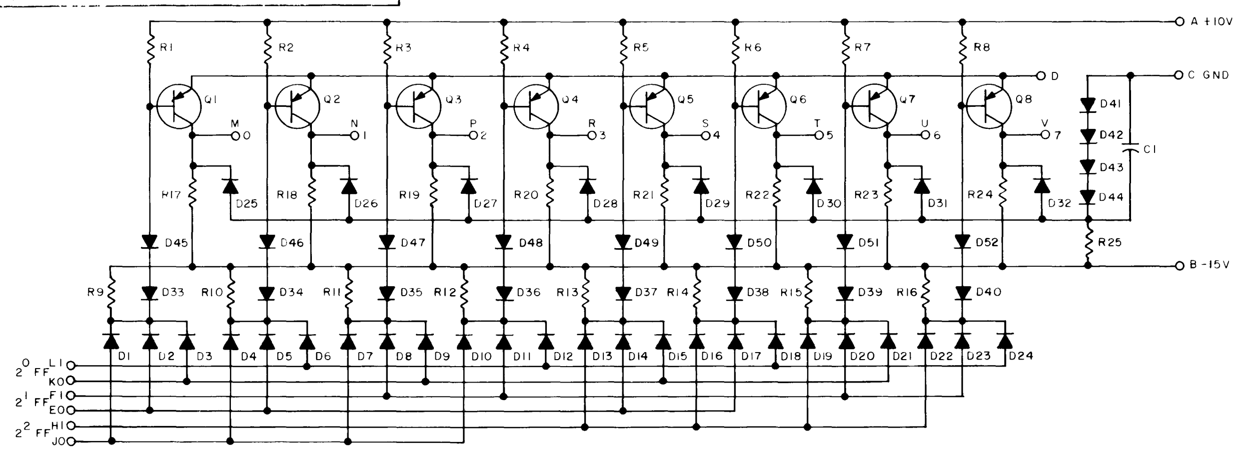
DEC	EIA	DEC	EIA
DEC 3639	2N3639		
D662	1N645		
D664	1N3606		

digital EQUIPMENT CORPORATION, MAYNARD MASSACHUSETTS

TITLE: DIODE GATE R123
SIZE B | CODE CS | NUMBER R123-0-1 | REV B
PRINTED CIRCUIT REV B

DEC FORM NO DRB 102

B | CS | R151-0-1 | E
SIZE | CODE | NUMBER | REV



REFERENCE DESIGNATION	DESCRIPTION	PART NO.
Q1 THRU Q8	TRANSISTOR DEC3639B	1502762
R25	RES. 1.5K 1/4W 5% CC	1300391
R17 THRU R24	RES. 7.5K 1/4W 5% CC	1301422
R9 THRU R16	RES. 15K 1/4W 5% CC	1300496
R1 THRU R8	RES. 100K 1/4W 5% CC	1302466
D33 THRU D52	DIODE D662	1100113
D1 THRU D32	DIODE D664	1100114
C1	CAP. .01 MFD 50V -0 +20% DISC	1000001
	PARTS LIST	A-PL-R151-0-0

PARTS LIST

REVISIONS: CHK | CHG NO | REV — RMS | 6545 | 3 — REV. & REDR. 6856 | E

DRN A. OUELLETTE, DATE 9-1-64
CHK'D N. PERRYMAN, DATE 9-15-64
ENG D.A. WHITE, DATE 9-15-64
PROD, DATE

TRANSISTOR & DIODE CONVERSION CHART

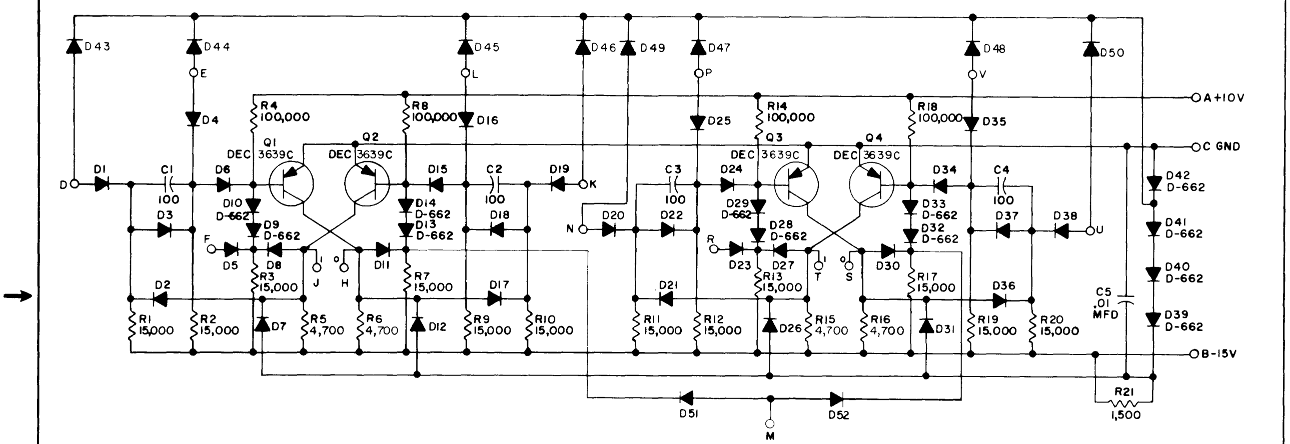
DEC	EIA	DEC	EIA
DEC3639B	2N3639		
D662	1N645		
D664	1N3606		

digital EQUIPMENT CORPORATION, MAYNARD MASSACHUSETTS

TITLE: BINARY TO OCTAL DECODER R151
SIZE B | CODE CS | NUMBER R151-0-1 | REV E
PRINTED CIRCUIT REV D

DEC FORM NO DRB 102

B | CS | R202-0-1 | F
SIZE | CODE | NUMBER | REV



UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W, 5%
CAPACITORS ARE MMFD
DIODES ARE D-664

REVISIONS			
CHK	CHG NO	REV	
RMS	6330	4	
	REV. & REORJ 6549	F	

DRN	DATE
A. OUELLETTE	6-16-64
CHK'D N. PERRYMAN	DATE 6-16-64
ENG R. BANK	DATE 6-22-64
PROD	DATE

TRANSISTOR & DIODE CONVERSION CHART

DEC	EIA	DEC	EIA
DEC3639C	2N3639		
D662	IN645		
D664	IN3606		

digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS

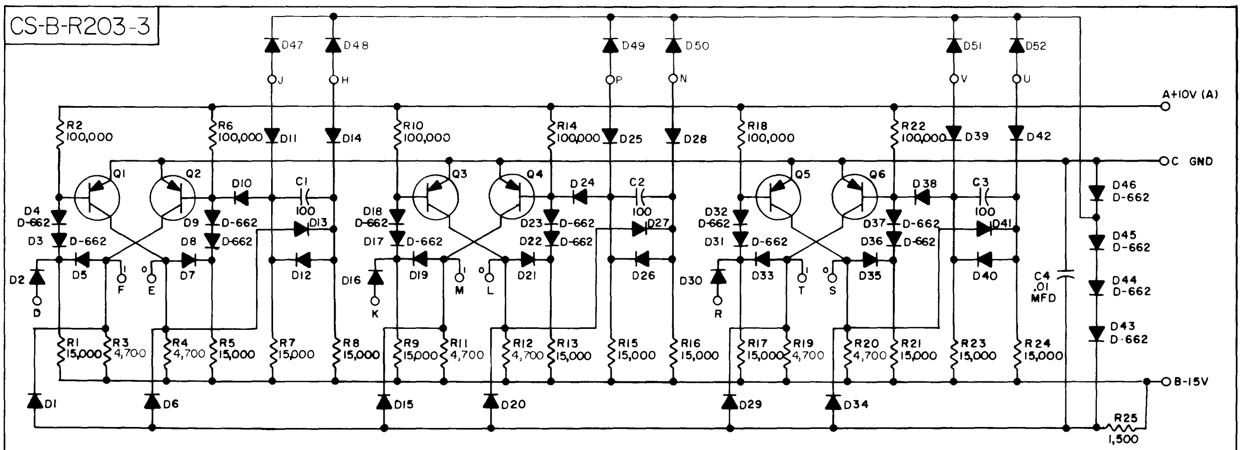
TITLE DUAL FLIP FLOP R202

SIZE	CODE	NUMBER	REV
B	CS	R202-0-1	F

PRINTED CIRCUIT REV D E

DEC FORM NO DRB 102

CS-B-R203-3



UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W, 5%
CAPACITORS ARE MMFD
DIODES ARE D-664
TRANSISTORS ARE DEC 3639C

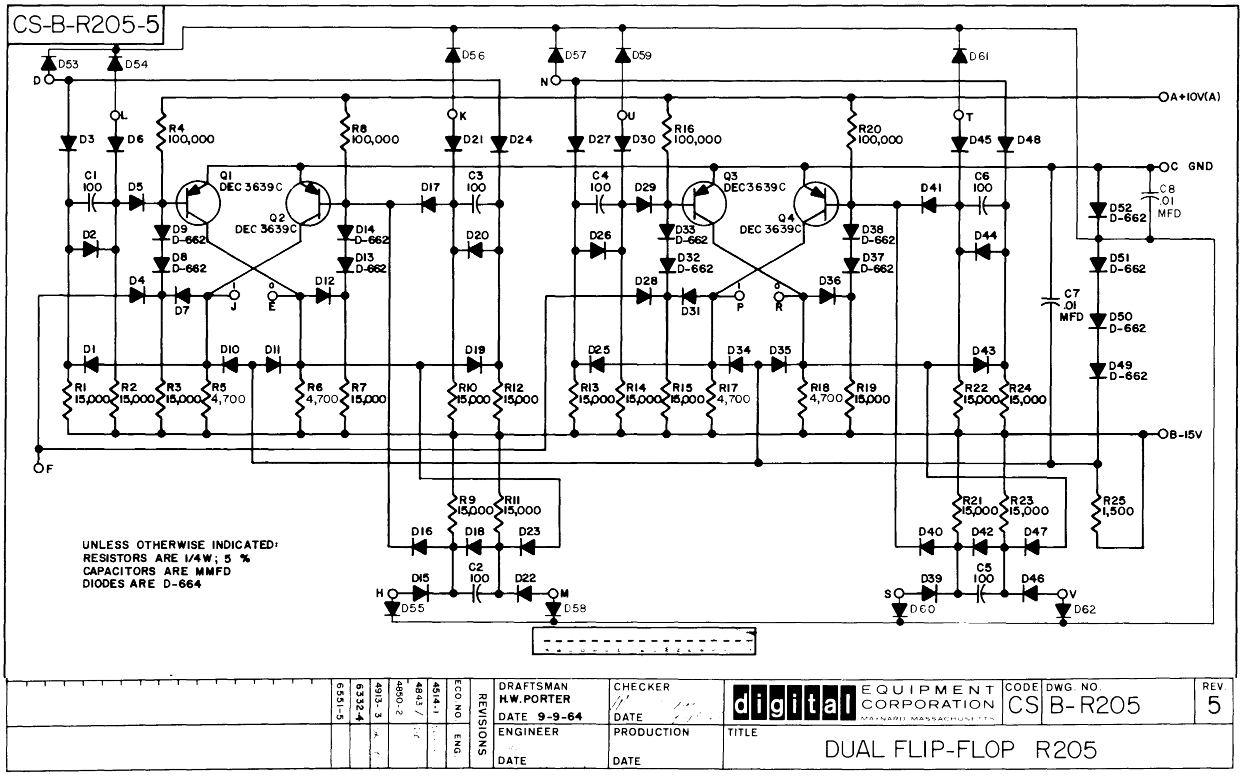
REVISIONS	ECO NO.	ENG.
	4507I	
	4846/ 4852-2	
	6331-3	

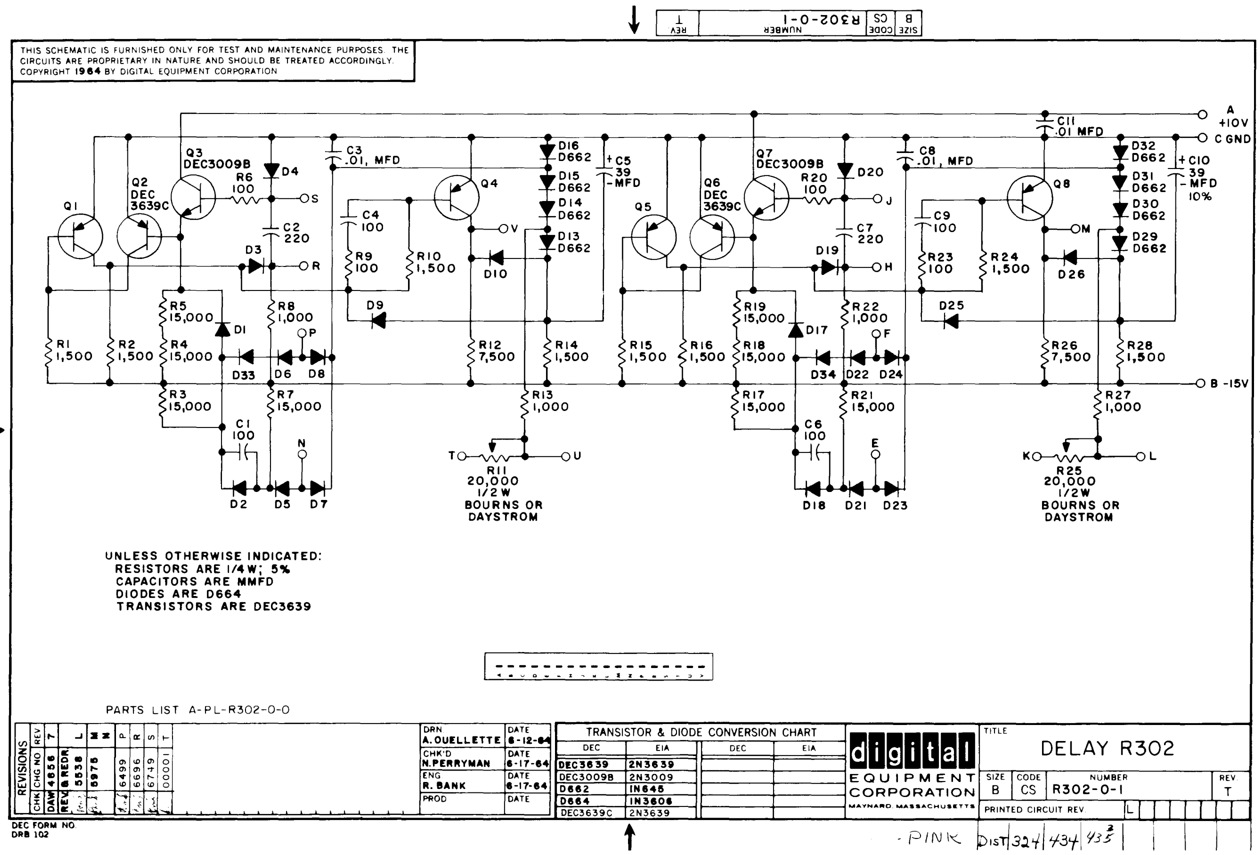
DRAFTSMAN A. OUELLETTE	CHECKER
DATE 6-30-64	DATE 7
ENGINEER	PRODUCTION
DATE	DATE

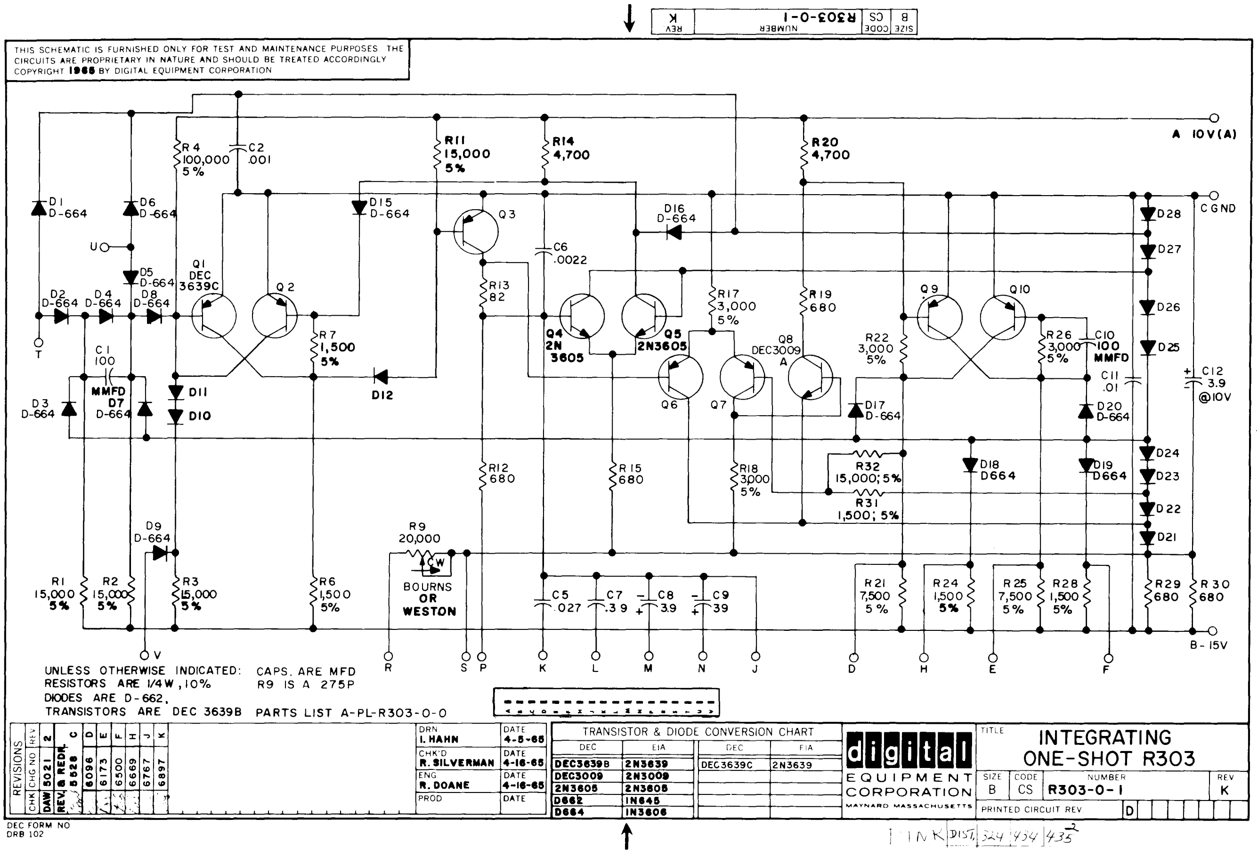
digital EQUIPMENT CORPORATION MAYNARD MASSACHUSETTS

CODE	DWG. NO.	REV.
CS	B-R203	3

TITLE TRIPLE FLIP-FLOP R203


CS-B-R205-5
UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W; 5 %
CAPACITORS ARE MMFD
DIODES ARE D-664
A+10V(A)
C GND
B-15V
DRAFTSMAN H.W. PORTER
DATE 9-9-64
CHECKER
ENGINEER
PRODUCTION
REVISIONS
digital EQUIPMENT CORPORATION
CODE CS
DWG. NO. B-R205
REV. 5
TITLE DUAL FLIP-FLOP R205


CS R302-0-1
THIS SCHEMATIC IS FURNISHED ONLY FOR TEST AND MAINTENANCE PURPOSES. THE CIRCUITS ARE PROPRIETARY IN NATURE AND SHOULD BE TREATED ACCORDINGLY.
COPYRIGHT 1964 BY DIGITAL EQUIPMENT CORPORATION
A +10V
C GND
B -15V
R11 20,000 1/2W BOURNS OR DAYSTROM
R25 20,000 1/2W BOURNS OR DAYSTROM
UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W; 5%
CAPACITORS ARE MMFD
DIODES ARE D664
TRANSISTORS ARE DEC3639
PARTS LIST A-PL-R302-0-0
DRN A. OUELLETTE DATE 8-12-64
CHK'D N. PERRYMAN DATE 8-17-64
ENG R. BANK DATE 8-17-64
TRANSISTOR & DIODE CONVERSION CHART
DEC3639 2N3639
DEC3009B 2N3009
D662 1N645
D664 1N3606
DEC3639C 2N3639
digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS
TITLE DELAY R302
SIZE B CODE CS NUMBER R302-0-1 REV T
PRINTED CIRCUIT REV L
DEC FORM NO. DRB 102
PINK DIST 324 434 433


B CS R303-0-1 K
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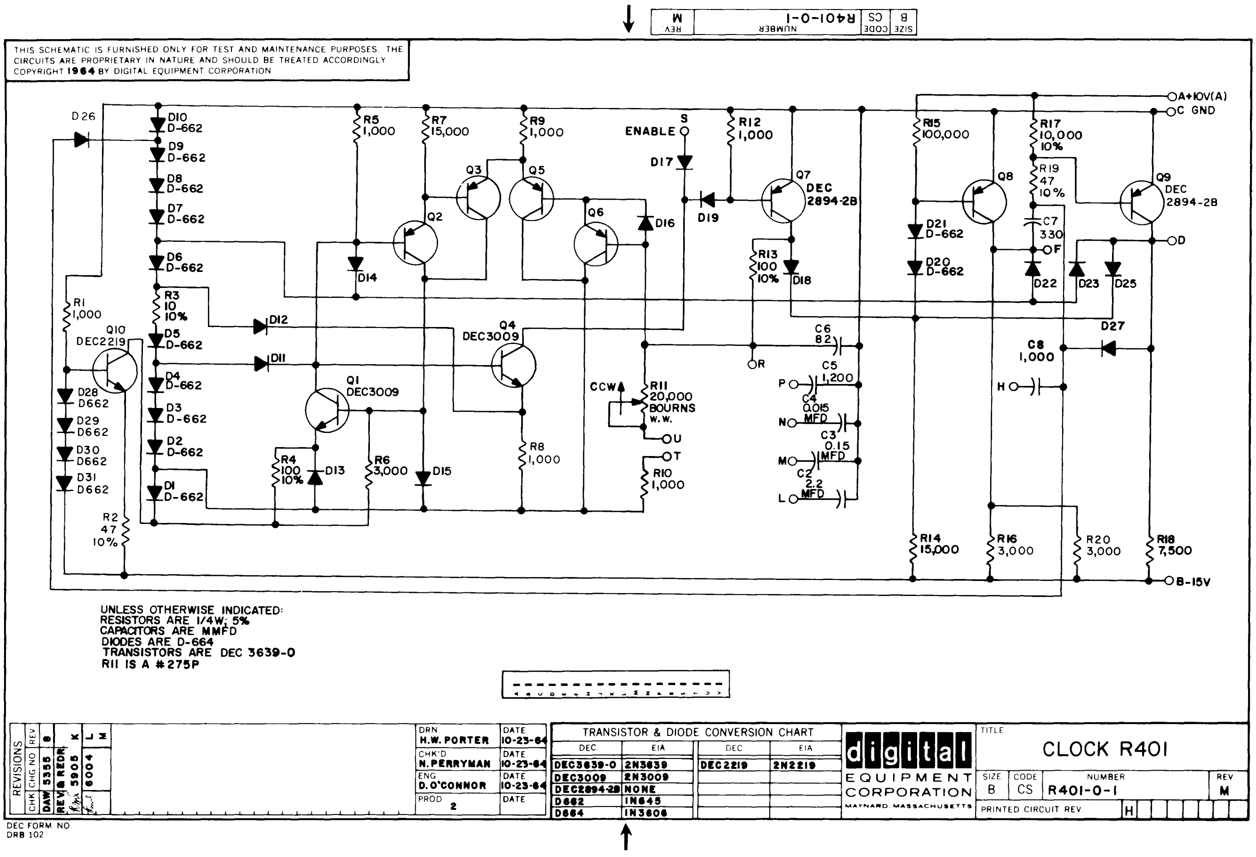
A 10V(A)
C GND
B-15V
BOURNS OR WESTON
UNLESS OTHERWISE INDICATED: RESISTORS ARE 1/4W, 10%
DIODES ARE D-662,
TRANSISTORS ARE DEC 3639B
CAPS. ARE MFD
R9 IS A 275P
PARTS LIST A-PL-R303-0-0
TRANSISTOR & DIODE CONVERSION CHART
DEC3639B 2N3639
DEC3009 2N3009
2N3605 2N3605
D662 IN645
D664 IN3606
DEC3639C 2N3639
DRN I. HAHN 4-5-65
CHK'D R. SILVERMAN 4-16-65
ENG R. DOANE 4-16-65
EQUIPMENT CORPORATION
MAYNARD MASSACHUSETTS
INTEGRATING ONE-SHOT R303
B CS R303-0-1 K
PRINTED CIRCUIT REV D
DEC FORM NO DRB 102


B CS R401-0-1 M
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A+10V(A)
C GND
ENABLE
B-15V
UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W; 5%
CAPACITORS ARE MMFD
DIODES ARE D-664
TRANSISTORS ARE DEC 3639-0
R11 IS A #275P
TRANSISTOR & DIODE CONVERSION CHART
DEC3639-0 2N3639
DEC3009 2N3009
DEC2894-2B NONE
D662 IN645
D664 IN3606
DEC2219 2N2219
DRN H.W. PORTER 10-23-64
CHK'D N. PERRYMAN 10-23-64
ENG D. O'CONNOR 10-23-64
EQUIPMENT CORPORATION
MAYNARD MASSACHUSETTS
CLOCK R401
B CS R401-0-1 M
PRINTED CIRCUIT REV H
DEC FORM NO DRB 102

SIZE	CODE	NUMBER	REV
B	CS	R405-0-1	J

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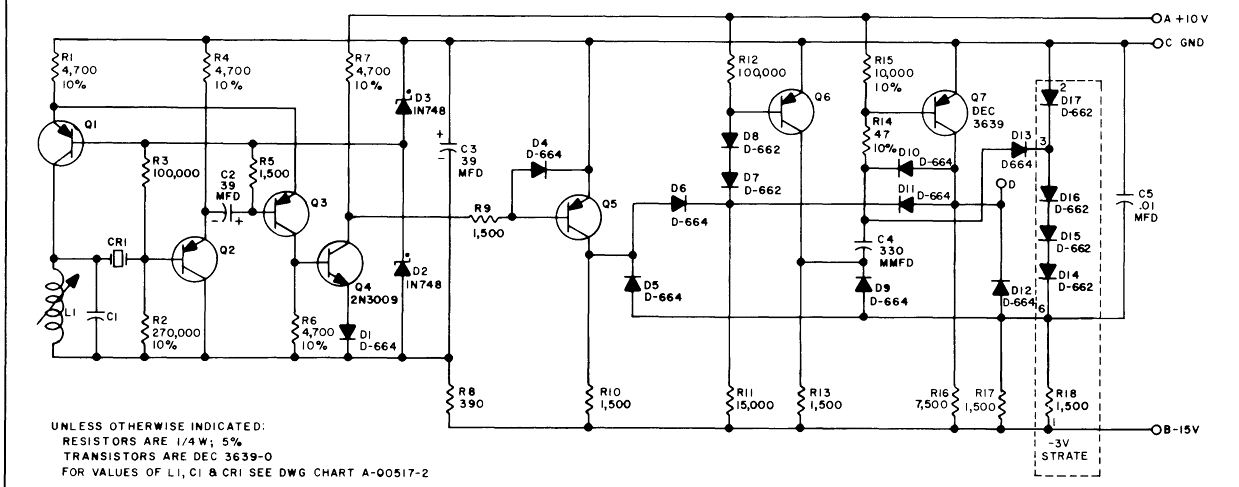

UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W; 5%
TRANSISTORS ARE DEC 3639-0
FOR VALUES OF L1, C1 & CR1 SEE DWG CHART A-00517-2

REVISIONS			
CHK	CHG NO	REV	
DAW	5089	3	
REV.	B.REDR.	H	
	5394		
	6555	J	

DRN	DATE
H. PORTER	11-21-64
CHK'D N PERRYMAN	12-4-64
ENG D. O'CONNOR	12-4-64
PROD	

TRANSISTOR & DIODE CONVERSION CHART

DEC	EIA	DEC	EIA
DEC3639	2N3639	IN748 3.9V	SAME
DEC3639-0	2N3639		
2N3009	SAME		
D662	IN645		
D664	IN3606		

digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS

TITLE CRYSTAL CLOCK R405

SIZE	CODE	NUMBER	REV
B	CS	R405-0-1	J

PRINTED CIRCUIT REV H J

DEC FORM NO DRB 102

SIZE	CODE	NUMBER	REV
B	CS	R602-0-1	R

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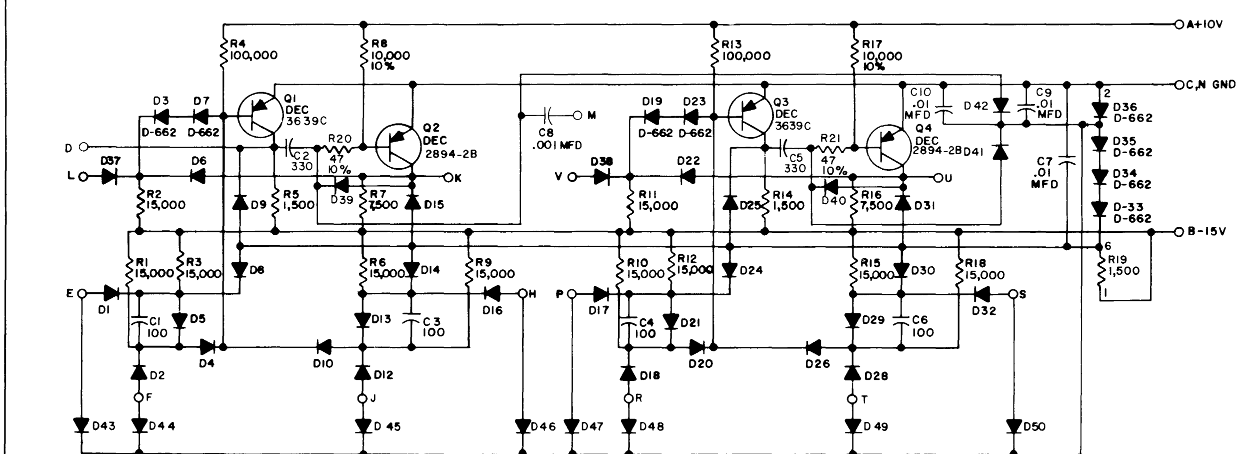


UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W; 5%
CAPACITORS ARE MMFD
DIODES ARE D-664

REVISIONS			
CHK	CHG NO	REV	
DAW	5274	9	
REV.	B.REDR.	L	
	5382	M	
	6334	N P	
	6557	R	

DRN	DATE
A OUELLETTE	6-10-64
CHK'D N PERRYMAN	6-12-64
ENG R BANK	6-12-64
PROD	

TRANSISTOR & DIODE CONVERSION CHART

DEC	EIA	DEC	EIA
DEC2894-2B	NONE		
DEC3639C	2N3639		
D662	IN645		
D664	IN3606		

digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS

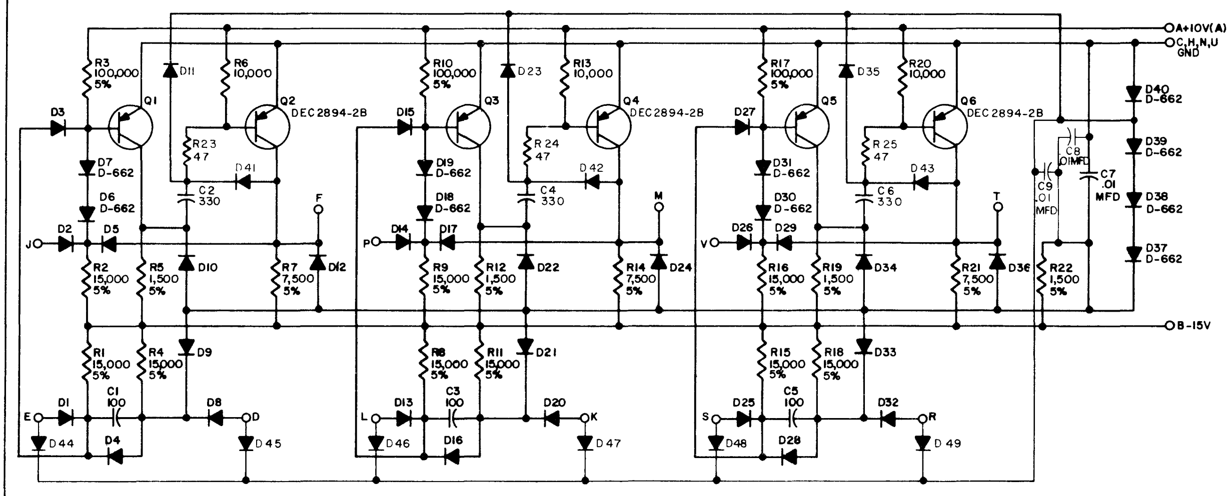
TITLE PULSE AMPLIFIER R602

SIZE	CODE	NUMBER	REV
B	CS	R602-0-1	R

PRINTED CIRCUIT REV H K

DEC FORM NO DRB 102

CS-B-R603-6

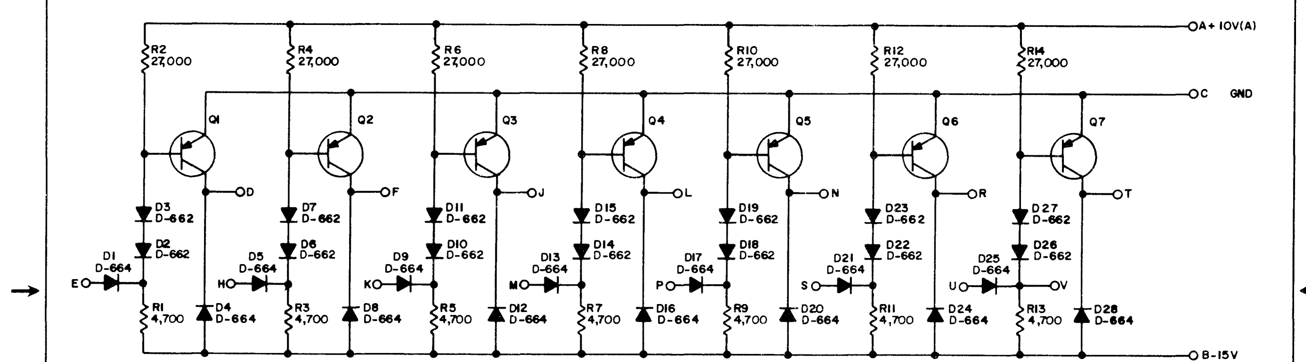


UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W; 10%
CAPACITORS ARE MMFD
DIODES ARE D-664
TRANSISTORS ARE DEC 3639-C

REVISIONS	ECO NO. 4485-1	4501-2	4861/4875-3	5117-4	5272-5	6335-6
ENG						

DRAFTSMAN H.W. PORTER DATE 10-5-64	CHECKER DATE	digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS	CODE CS · DWG. NO. B-R603 · REV. 6
ENGINEER DATE	PRODUCTION DATE	TITLE	PULSE AMPLIFIER R603

SIZE B · CODE CS · NUMBER W051-0-1 · REV E



UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4W; 10%
TRANSISTORS ARE DEC 6534B

REVISIONS	CHG NO	REV
	5612	2
RMS	REV & REDR. 6389	E

DRN H.W. PORTER	DATE 11-18-64
CHK'D N. PERRYMAN	DATE 11-20-64
ENG D.A. WHITE	DATE 11-20-64
PROD	DATE

TRANSISTOR & DIODE CONVERSION CHART

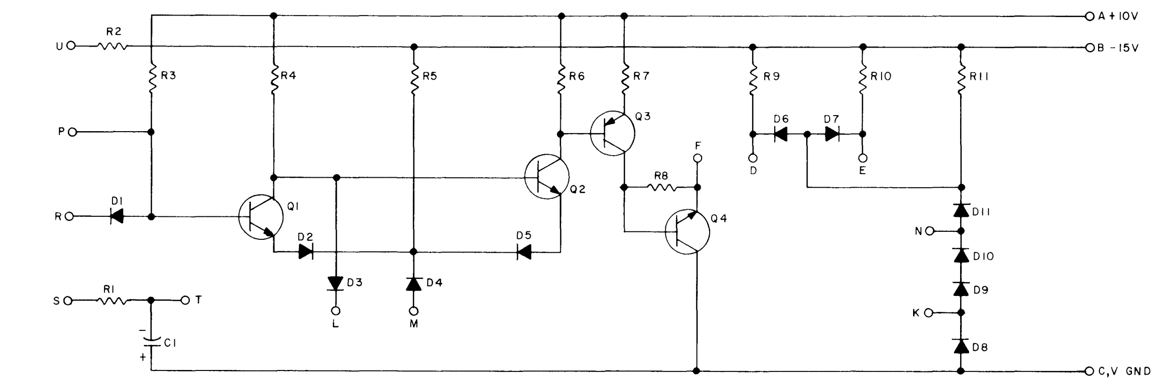
DEC	EIA	DEC	EIA
DEC6534B	MPS6534		
D662	IN645		
D664	IN3606		

digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS	TITLE 100 MA INDICATOR & RELAY DRIVER W051
SIZE B · CODE CS · NUMBER W051-0-1 · REV E	PRINTED CIRCUIT REV D

DEC FORM NO DRB 102

B | CS | W501-0-1 | F

SIZE | CODE | NUMBER | REV



REFERENCE DESIGNATION	DESCRIPTION	PART NO.
Q1,Q2,Q4	TRANSISTOR DEC3009B	1503100
Q3	TRANSISTOR DEC999	1501836
R6, R7,R8,R10,R11	RES. 1.5K 1/4W 5% CC	1300391
R3,R4,R9	RES. 7.5K 1/4W 5% CC	1301422
R2, R5	RES. 4.7K 1/4W 10% CC	1300448
R1	RES. 330 1/4W 10% CC	1300293
D8-D11	DIODE D662	1100113
D1-D7	DIODE D664	1100114
C1	CAP. 6.8MFD 35V 20% S.TANT	1000067
	PARTS LIST	A-PL-W501-0-0

PARTS LIST

REVISIONS: REV 4, CHK, CHG NO 5216, DAW; REV F, REV B REDR. 7167

DRN. H.W. PORTER — DATE 9-23-64
CHK'D N. PERRYMAN — DATE 9-29-64
ENG. P. SULLIVAN — DATE 9-29-64
PROD. D Chase — DATE 9/4/64

TRANSISTOR & DIODE CONVERSION CHART

DEC	EIA	DEC	EIA
DEC999	MM999		
DEC3009B	2N3009		
D662	IN645		
D664	IN3606		

digital EQUIPMENT CORPORATION, MAYNARD, MASSACHUSETTS

TITLE: SCHMITT TRIGGER W501

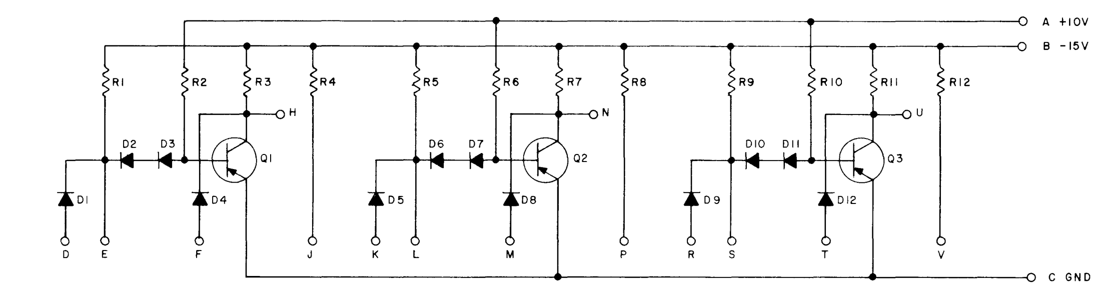
SIZE B | CODE CS | NUMBER W501-0-1 | REV F

PRINTED CIRCUIT REV. F

DEC FORM NO DRB 102

B | CS | W600-0-1 | A

SIZE | CODE | NUMBER | REV



REFERENCE DESIGNATION	DESCRIPTION	PART NO.
Q1 - Q3	TRANSISTOR DEC-6B	1509090-01
R4, R8, R12	RES. 1.8K 1/4W 5% CC	1300398
R3, R7, R11	RES. 7.5K 1/4W 5% CC	1301422
R2,R6,R10	RES. 100K 1/4W 10% CC	1300534
R1, R5,R9	RES. 15K 1/4W 10% CC	1300494
D1, D4,D5,D8,D9,D12	DIODE D664	1100114
D2,D3,D6,D7, D10,D11	DIODE D662	1100113
	PARTS LIST	A-PL-W600-0-0

PARTS LIST

REVISIONS: REV A, CHK, CHG NO, REV B REDR 7172

DRN. A. OUELLETTE — DATE 7-30-64
CHK'D N. PERRYMAN — DATE 8-4-64
ENG. B. SCUDNEY — DATE 8-4-64
PROD. — DATE

TRANSISTOR & DIODE CONVERSION CHART

DEC	EIA	DEC	EIA
DEC-6B	NONE		
D662	IN645		
D664	IN3606		

digital EQUIPMENT CORPORATION, MAYNARD, MASSACHUSETTS

TITLE: NEGATIVE LEVEL AMPLIFIER W600

SIZE B | CODE CS | NUMBER W600-0-1 | REV A

PRINTED CIRCUIT REV. A

DEC FORM NO DRB 102

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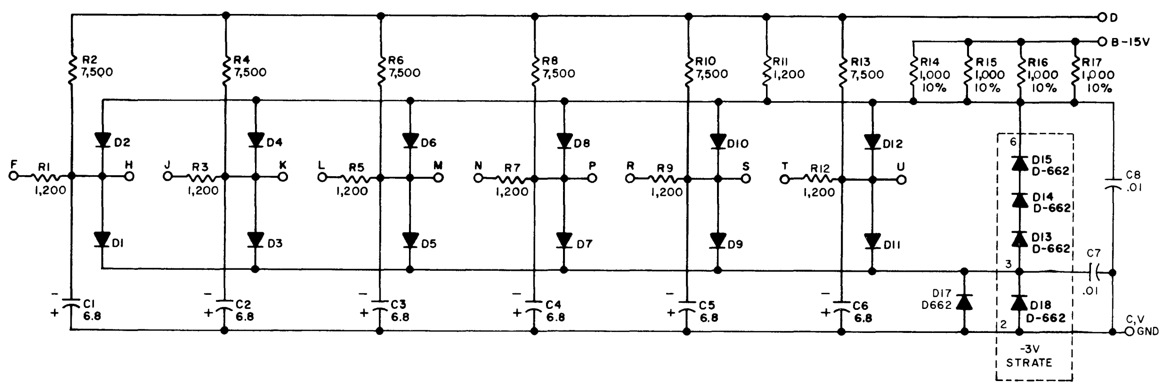


UNLESS OTHERWISE INDICATED:
RESISTORS ARE 1/4 W; 5%
CAPACITORS ARE MFD
DIODES ARE D-664

REVISIONS			
REV	2	C	
CHG NO	5283	5408	
CHK	DAW	B.REDR.	

DRN.	A. OUELLETTE	DATE 8-3-64
CHK'D	N. PERRYMAN	DATE 8-4-64
ENG	B. SCUDNEY	DATE 8-4-64
PROD		DATE

TRANSISTOR & DIODE CONVERSION CHART

DEC	EIA	DEC	EIA
D662	1N645		
D664	1N3606		

digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS

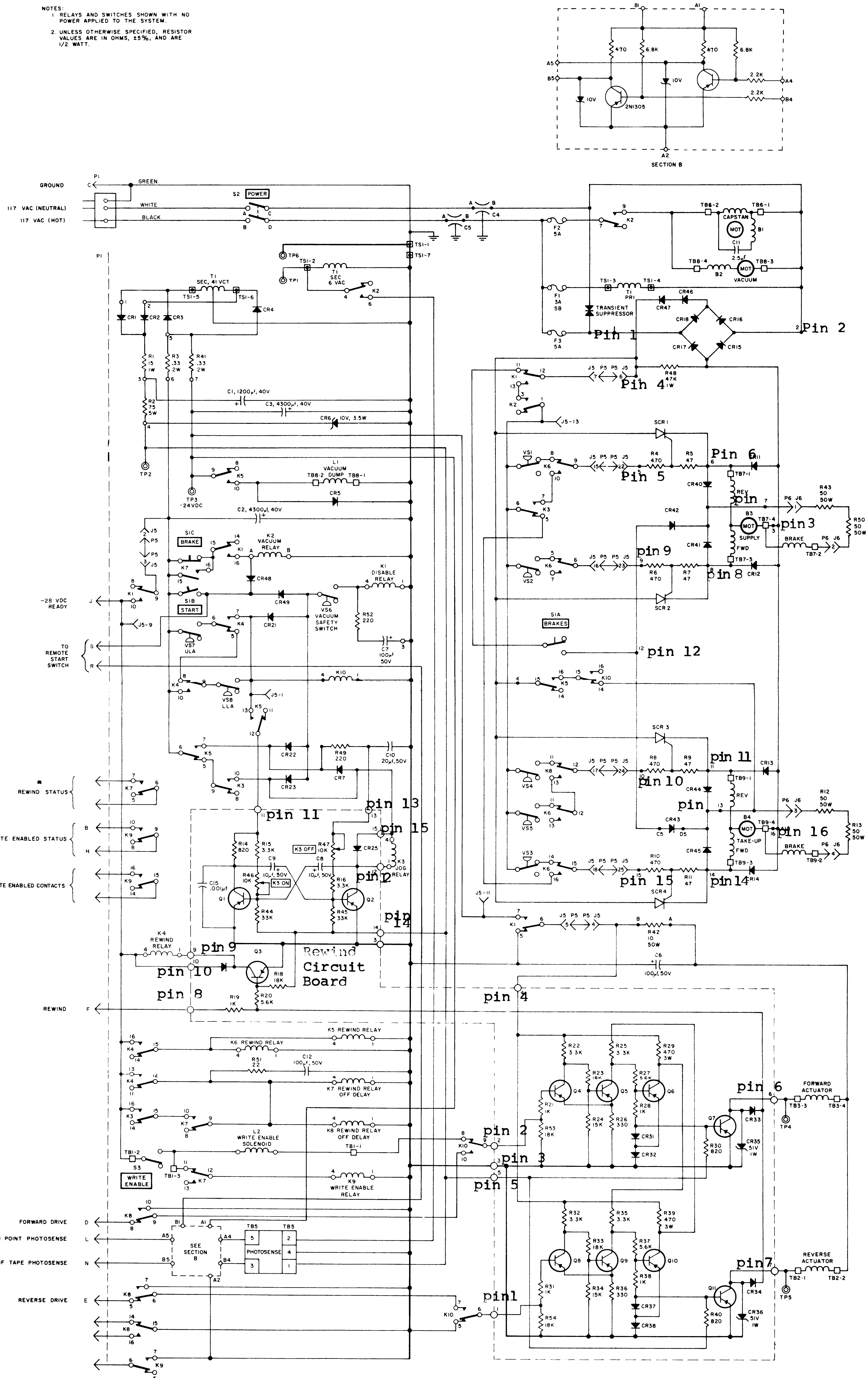
TITLE: SWITCH FILTER W700

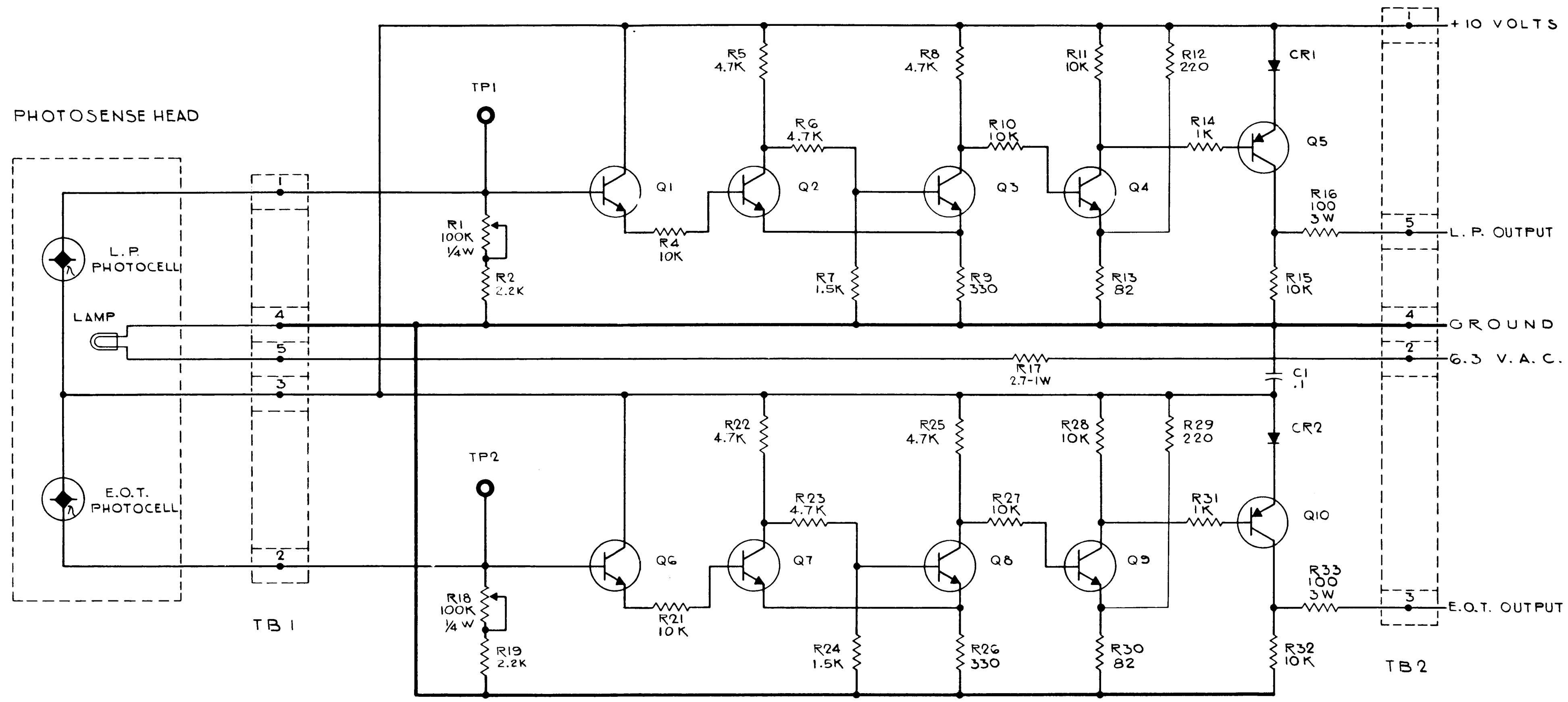
SIZE	CODE	NUMBER	REV
B	CS	W700-0-1	C

PRINTED CIRCUIT REV B

DEC FORM NO DRB 102

NOTES:
1. RELAYS AND SWITCHES SHOWN WITH NO POWER APPLIED TO THE SYSTEM.
2. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS, ±5%, AND ARE 1/2 WATT.

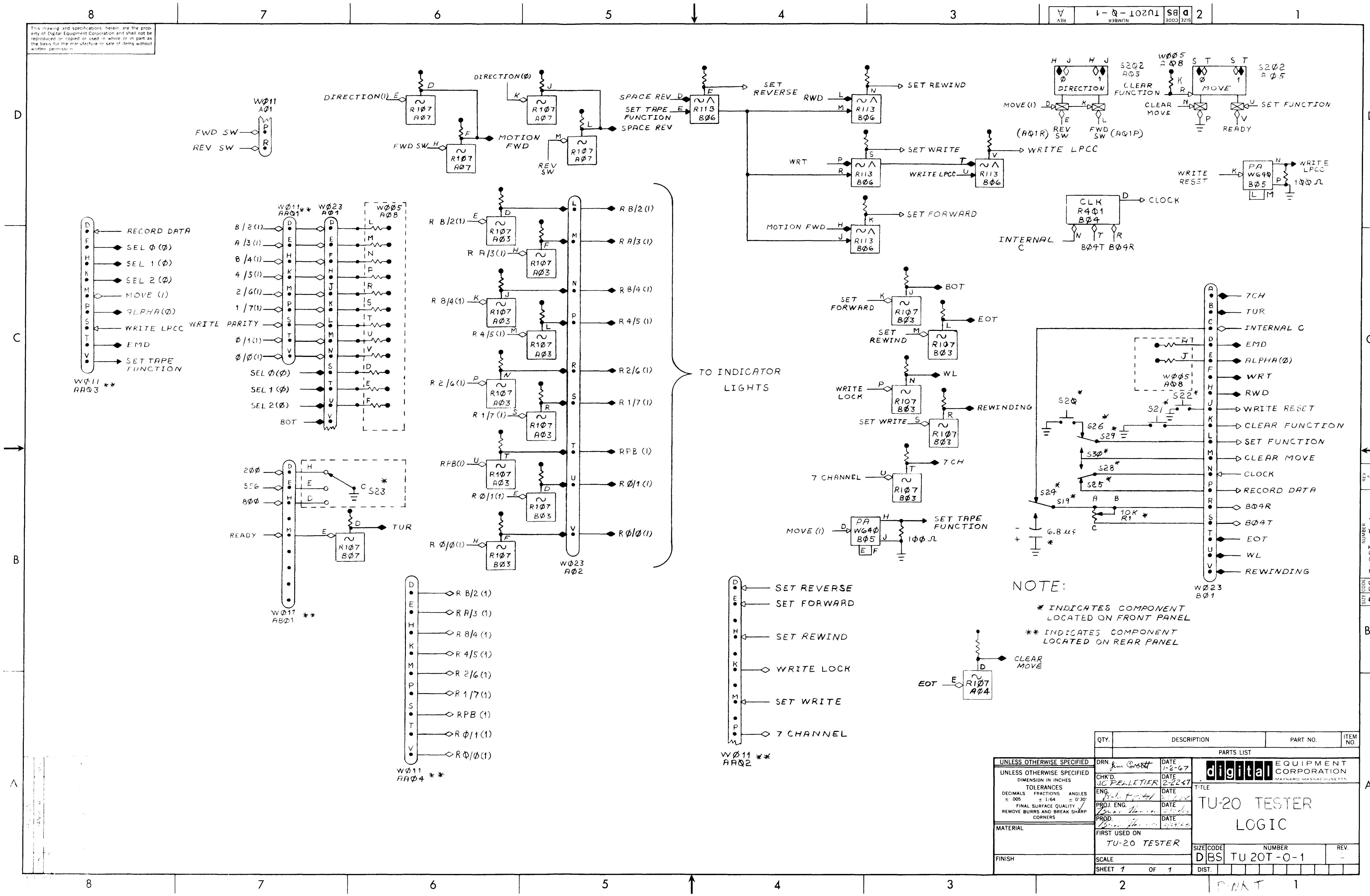




NOTES:

1. ALL RESISTORS ARE 1/2 WATT, 5% IN OHMS UNLES OTHERWISE SPECIFIED.
2. CATALOG NO. 10270.

COMPONENT	LAST USED	OMITTED
RESISTORS	R33	R3, 20
CAPACITORS	C1	
DIODES	CR2	
TRANSISTORS	Q10	


TO INDICATOR LIGHTS
SET REVERSE
SET REWIND
SET WRITE
WRITE LPCC
SET FORWARD
SET FUNCTION
CLOCK
MOTION FWD
SPACE REV
SET TAPE FUNCTION
RECORD DATA
SEL Ø (Ø)
SEL 1 (Ø)
SEL 2 (Ø)
MOVE (1)
ALPHA (Ø)
EMD
WRITE PARITY
BOT
EOT
WL
REWINDING
7 CH
TUR
INTERNAL C
WRT
RWD
WRITE RESET
CLEAR FUNCTION
CLEAR MOVE
SET WRITE
WRITE LOCK
7 CHANNEL
READY
TUR
NOTE:
* INDICATES COMPONENT LOCATED ON FRONT PANEL
** INDICATES COMPONENT LOCATED ON REAR PANEL
digital EQUIPMENT CORPORATION MAYNARD, MASSACHUSETTS
TITLE TU-20 TESTER LOGIC
FIRST USED ON TU-20 TESTER
SIZE D CODE BS NUMBER TU 20T-0-1
SHEET 1 OF 1
CHK'D. JC PELLETIER 2-22-67
DRN. 1-2-67
UNLESS OTHERWISE SPECIFIED DIMENSION IN INCHES TOLERANCES
PARTS LIST
QTY. DESCRIPTION PART NO. ITEM NO.

Digital Equipment Corporation
Maynard, Massachusetts

digital

printed in U.S.A.