SINGLE BOARD FORMATTER

1/4-INCH STREAMING TAPE CARTRIDGE DRIVE

OEM MANUAL

Part Number 20554-001

wangtek

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NOTICE

This document is intended to provide the user with detailed information adequate for the efficient installation, operation, and service of the equipment involved.

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ILLUSTRATIONS

1.0 INTRODUCTION

The purpose for this document is to provide a functional description of the Wangtek Single Board Formatter, detailing specific host commands implemented in the manner in which the tape drive is controlled, monitored, the method of the status and error reporting to the host, and the diagnostic capabilities of the formatter.

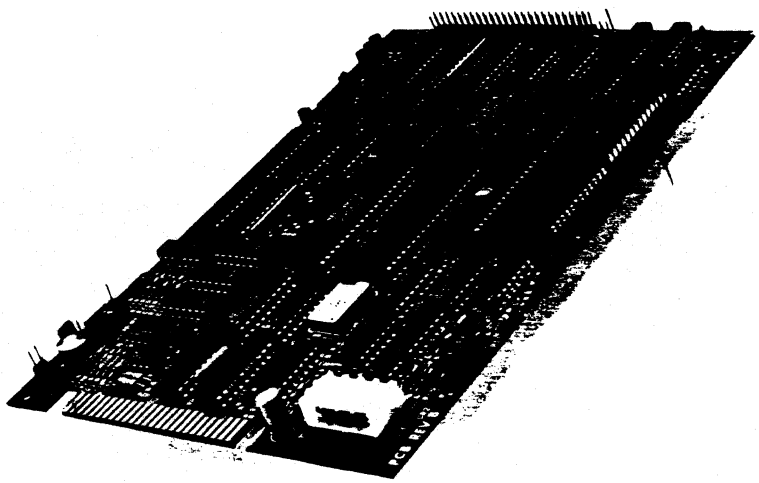
The Wangtek Single Board Formatter, also referred to as simply the SBF, is designed to interface with the Series 5000E and the Series 5125E Basic Drives via the QIC-36 basic streaming tape drive interface. The SBF provides for the implementation of standard set of QIC-02 defined streaming commands with the host adapter. The SBF is a microprocessor-based formatter. Most of its operating characteristics are under firmware control; thus, other optional commands can be implemented by simply upgrading the firmware.

2.0 DEFINITIONS

The following is a definition of the terminology used throughout this document for futher reference.

block	A group of 512 consecutive bytes of data which are transferred as a unit.
BOM	Beginning of Media, the start of recordable area of tape on the initial track (track 0).
BOT	Beginning of Tape, a marker indicating the beginning of tape.
cartridge	Refer to ANSI Specification X3.55-1982.
command	The instruction byte which specifies the operation to be performed.
continuable	Any error after which an operation can be continued by issuing another command.
device	The formatter as described herein; used interchangeably with SBF.
drive	A device used to store and recover data onto and from magnetic tape.
EOT	End of Tape, the marker indicating the end of tape.
erase	To remove magnetically recorded data from the tape.
EW	Early Warning, a marker indicating the approaching end of the permissable recording area.

FIGURE 1.0 SINGLE BOARD FORMATTER



exception condition	Any condition which prevents the performance of a potential command or the continuance of the current operation.
fatal	An error which causes an operation to be aborted and requires that operation to be started over.
file mark	A magnetically recorded identification mark.
LP	Load Point, a marker indicating the beginning of the permissable recording area.
search	A Read operation that logically repositions the tape and does not transfer data to the controller.
status	Bytes transmitted indicating the current condition of a device.
streaming drive	A tape drive that is designed to maintain continuous tape motion without the requirement to start and stop within an inter-record gap. If tape motion is interrupted for any reason, the drive must re-position the tape by moving far enough in the reverse direction to allow the tape to be brought up to speed in the forward direction before it reaches the point at which the preceding operation was terminated.
underrun	A condition developed when the controller transmits or receives data at a rate less than that required by the device to maintain streaming operation.

3.0 SPECIFICATION SUMMARY

Table 1.0 lists specification summary of the SBF.

TABLE 1.0 SPECIFICATION SUMMARY

CHARACTERISTIC	TYPE/VALUE
Host Interface	QIC-02 Standard Interface
Drive Interface	QIC-36 Standard Interface
Data Interchange Format	QIC-24 Standard for Data Interchange or QIC-11 (Archive 8-inch)
Tape Drives Controlled	Four (4) maximum
Transfer Rate	90 Kbytes per second
Recording Tracks/Format	9 track serpentine
Recording Code	(0,2) Run length limited (GCR encoding)
Data Buffering	(3) x 512-byte blocks, or 15 x 512-byte blocks (optional)
Write Re-tries	16 maximum
Read Re-tries	16 maximum
Error Detection	CRC (standard)
Soft Error Rate (Read)	1 in 10^8 bits
Hard Error Rate (Read)	1 in 10^{10} bits
Temperatures:	
Operating	+5 to +45 degrees C (+41 to +113 degrees F)
Non-Operating	-30 to +60 degrees C (-22 to +140 degrees F)
Relative Humidity	20 to 80% non-condensing
Altitude:	
Operating	-1000 to 10,000 feet
Non-Operating	-1000 to 50,000 feet
Power Requirements	+12 VDC @ 0.1 amps +5 VDC @ 2.0 amps
Power Dissipation	11.20 Watts
Physical Characteristics	
Depth (inches/mm)	5.5/139.7
Width (inches/mm)	7.75/193.75
Height (inches/mm)	0.65/16.51
Weight	0.5 pounds
MTBF	25,000 power-on hours
MTTR	Less than 30 minutes

4.0 INTERFACE

This section defines the host level streaming cartridge tape interface. The interface is commonly referred to as QIC-02 interface. Data and comands are transferred to and from the device on an eight bit bi-directional data bus using asynchronous handshaking techniques to eliminate rigorous timing constraints. Up to four formatters are supported on the interface.

4.1 INPUT/OUTPUT SIGNAL CONNECTOR AND CABLE

The signal connector on the formatter is a fifty conductor edge connector (See Figure 2.0). Mating connector 3M type 3415-001 or equivalent shall be used. The signal cable shall be a fifty conductor, flat ribbon cable. 3M type 3365/50 or equivalent shall be used for the cable. This interface supports a total cable length of three meters maximum using a cable of 100 ohms characteristic impedance ±10%.

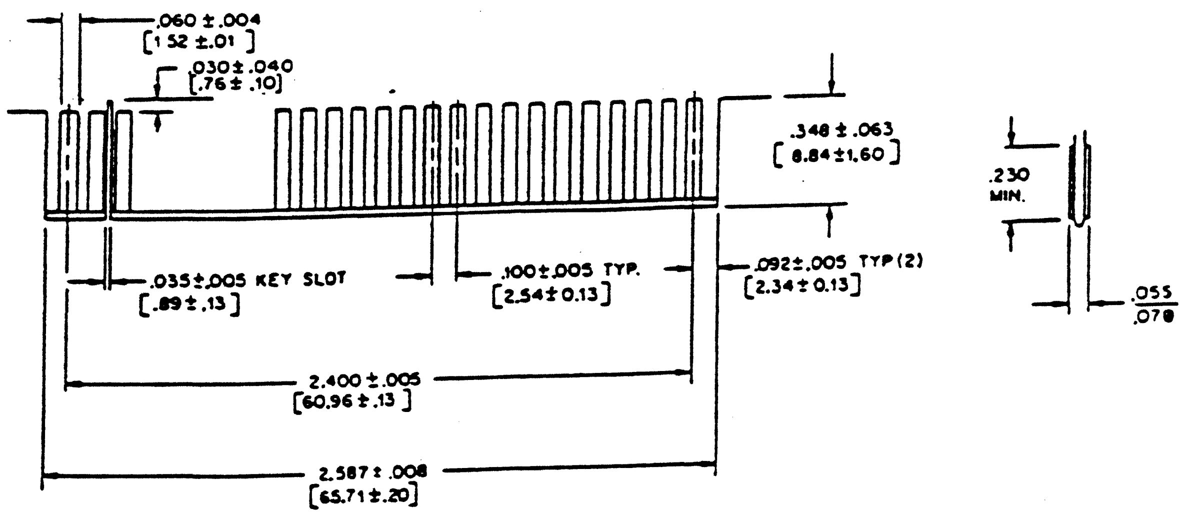


FIGURE 2.0 I/O SIGNAL CONNECTOR - J2

4.2 INPUT POWER CONNECTOR - J3

The power connector is a 4-pin AMP connector (AMP 350211-01). The recommended mating connector is AMP 1-480424-0.

4.3 FORMATTER POWER SUPPLY REQUIREMENTS

The voltages and currents required to operate the SBF are shown in Table 2.0 along with the applicable pin numbers of the J3 power connector.

TABLE 2.0 FORMATTER POWER SUPPLY REQUIREMENTS

PIN NUMBER	PIN NAME	VOLTAGE MINIMUM	VOLTAGE MAXIMUM	CURRENT OPER.	COMMENTS REFERENCE NOTES
1	V12+	11.6	12.4	0.1A	+12VDC (See Note 2)
2	V12-				+12VDC Return
3	V5-				+5VDC Return
4	V5+	4.85	5.25	2.0A	+5VDC (See Note 2)

NOTE 1. Must be tied together and to ground at one point in power supply.

NOTE 2. All voltages measured at formatter power connector.

4.4 INTERFACE SIGNAL LEVELS

All signals to the host from the SBF are standard TTL levels as follows:

False, (Logic Ø) = High = 2.4 to 5.25 VDC
True, (Logic 1) = Low = 0.0 to 0.55 VDC

All signals to the SBF should be standard TTL levels as follows:

False, (Logic Ø) = High = 2.0 to 5.25 VDC
True, (Logic 1) = Low = 0 to 0.8 VDC

Voltages should be measured at the SBF Connector J2.

4.5 SIGNAL LOADING

Signals from the host to the SBF should be loaded on the interface by no more than 2.0mA plus the required terminations.

Signals from the SBF to the host are loaded on the interface by no more than 2.0mA plus the required terminations.

4.6 SIGNAL TERMINATIONS

All host/controller interface signals must be terminated in 220 ohms to +5 VDC and 330 ohms to ground. Resistance tolerance will be ±5 percent. The bi-directional data bus and the four control signals from the host to the controller are terminated at the controller. The bi-directional data bus and the four signals from the controller to the host must be terminated at the host. Figure 3.0 illustrates the host/controller interface signal termination requirements.

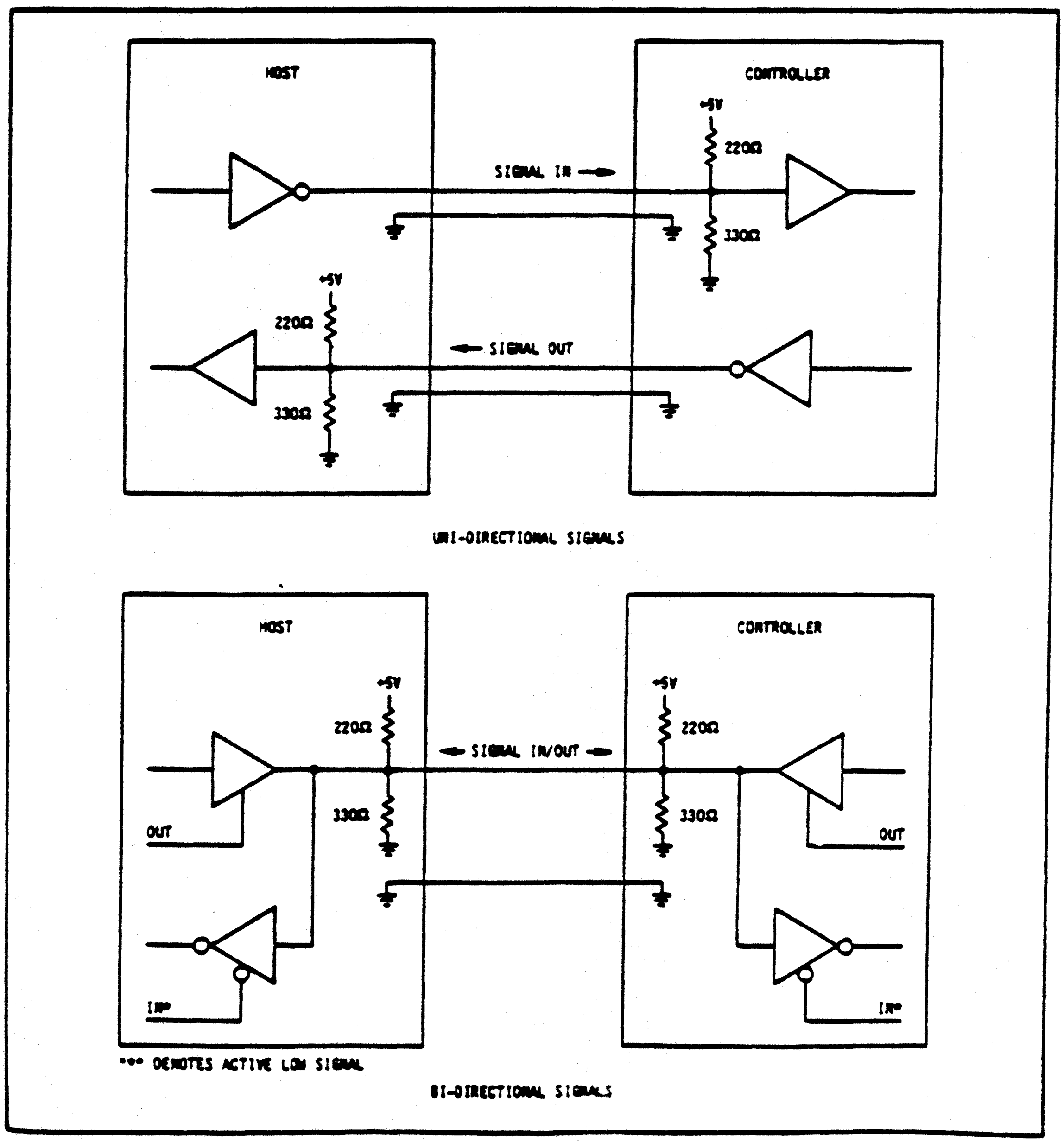


FIGURE 3.0 INTERFACE SIGNAL TERMINATIONS

4.7 INTERFACE CONNECTOR - BASIC DRIVE

The interface connector (J1) to the Series 5000E basic drive is a 50 conductor flat ribbon cable. The recommended mating connector is a 3M P/N 3425 or equivalent.

4.8 I/O PIN ASSIGNMENTS - BASIC DRIVE (J1)

PIN#	MNEMONIC	TO	DESCRIPTION
02	GO-	D	Go control for capstan motor
04	REV-	D	Direction control for capstan motor
06	TR3-	D	Track Select Bit #3
08	TR2-	D	Track Select Bit #2
10	TR1-	D	Track Select Bit #1
12	TR0-	D	Track Select Bit #0
14	RST-	D	Reset
16	DS3-	D	Drive Select #3 control
18	DS2-	D	Drive Select #2 control
20	DS1-	D	Drive Select #1 control
22	DS0-	D	Drive Select #0 control
24	HC-	D	Select Operation with type of tape
26	RDP-	F	Read Pulse output
28	UTH-	F	Upper tape hole position code
30	LTH-	F	Lower tape hole position code
32	SLD-	F	Selected Response from drive
34	CIN-	F	Cartridge in place
36	USF-	F	Unsafe condition (Write Protect)
38	TCH-	F	Tachometer Pulses from capstan
40	WDA-	D	Write Data signal
42	WDA+	D	Write Data signal (inverse)
44	N/A		Reserved for future use
46	HSD-	D	High speed select control
48	WEN-	D	Write Enable control
50	EEN-	D	Erase Enable control

NOTE: All odd pins are signal returns, which should be connected to ground at both the drive (D) and SBF (F).

4.9 I/O PIN ASSIGNMENTS - HOST ADAPTER (J2)

PIN#	MNEMONIC	TO	DESCRIPTION
02-10	N/A		Reserved for future use
12	HB7-	B	Host Bus Bit #7, MSB
14	HB6-	B	Host Bus Bit #6
16	HB5-	B	Host Bus Bit #5
18	HB4-	B	Host Bus Bit #4
20	HB3-	B	Host Bus Bit #3
22	HB2-	B	Host Bus Bit #2
24	HB1-	B	Host Bus Bit #1
26	HB0-	B	Host Bus Bit #0, LSB
28	ONL-	F	Online
30	REQ-	F	Request
32	RSTC-	F	Reset Controller
34	XFR-	F	Transfer
36	ACK-	H	Acknowledge
38	RDY-	H	Ready
40	EXC-	H	Exception
42	DIR-	H	Direction
44-50	N/A		Reserved for future use

NOTE: All odd pins are signal returns, which should be connected to ground at both the drive, and the SBF. B=Bi-directional, F=SBF, H=Host.

5.0 CONTROL LINES

5.1 $\overline{\text{RESET}}$

This signal is generated by the host. All SBF's connected to the bus are reset and operating parameters are initialized. After RESET, the SBF with address 0 takes command of the bus and activates EXCEPTION.

5.1.1 No device with address 0. The bus stays in a nonactive state and no indication is given to the controller. After a time-out, the controller may issue a select command to select another device.

5.2 $\overline{\text{EXCEPTION}}$

This signal is generated by the SBF to indicate that the SBF has information for the host. After a RESET, EXCEPTION is always asserted by the selected device. EXCEPTION may be asserted during an operation and should be treated with priority. After EXCEPTION, the only legal command that should be transmitted to the device is Read Status.

5.3 ONLINE

This signal is generated by the host and is true when the device is either writing, reading or searching. In all other operations, the state of this signal is not relevant. Deasserting the ONLINE signal terminates a write or read operation and rewinds the tape to BOT. During deselection and selection of devices while at position, care must be taken to avoid unwanted rewinds as a result of the ONLINE signal. Following a write or read operation, the device does not perform rewind when deselected with ONLINE asserted. When reselected the device will sample the state of ONLINE. A rewind does not occur if selection is made with ONLINE asserted or deasserted. However, the host must assert ONLINE prior to any subsequent read or write operations.

5.4 REQUEST

This signal is generated by the host to initiate and execute command transfers. REQUEST is also used to handshake with READY when transferring status information from the SBF to the host. This signal should be asserted only when an EXCEPTION or READY is asserted.

5.5 READY

This signal is generated by the SBF to indicate one of the following conditions:

(1) The SBF is available to receive and execute a new command.

(2) A new block is ready for transfer during a read or write operation.

(3) The SBF is ready to receive a new block during write operation.

(4) The SBF is ready to transfer status information to the host when REQUEST is asserted.

5.6 TRANSFER

This signal is generated by the host to indicate that data is being placed on the data bus in write mode or that data has been taken from the bus in read mode. TRANSFER is used in conjunction with ACKNOWLEDGE to move data between the SBF and host.

5.7 ACKNOWLEDGE

This signal is generated by the SBF to indicate that data has been accepted from the data bus in write mode or that data is being placed on the bus in read mode. ACKNOWLEDGE is used in conjunction with TRANSFER to move data between the SBF and host.

5.8 DIRECTION

This signal is generated by the SBF to indicate the direction of the bus. The asserted state of DIRECTION indicates that transfers are from the SBF to the host.

6.0 COMMAND/STATUS

The SBF includes firmware implementation of all standard QIC-02 commands as follows, including the corresponding 8-bit OP Code:

COMMAND	OP CODE BIT 7654	3210	HEX	
Select Drive "0"	0000	0001	01	
Select Drive "1"	0000	0010	02	
Select Drive "2"	0000	0100	04	(Not Used)
Rewind to BOT	0010	0001	21	
Erase Tape	0010	0010	22	
Initialize (Retension) Tape	0010	0100	24	
Write Data	0100	0000	40	
Write File Mark	0110	0000	60	
Read Data	1000	0000	80	
Read File Mark	1010	0000	A0	
Read Status	1100	0000	C0	
Select QIC-11 Format	0010	0110	26	
Select QIC-24 Format	0010	0111	27	
Power-On/Reset				

All unimplemented, reserved, and unassigned commands will return a illegal command status from the SBF.

6.1 COMMAND DESCRIPTIONS

This section defines the commands which are implemented by the SBF.

6.1.1 SELECT (DEVICE N) COMMAND.

The SELECT command selects one of up to two devices. The device remains selected until changed by either a RESET or another SELECT command.

Before a new device is selected, the device's tape must be rewound to BOT, otherwise the SBF will return an illegal command status to the host.

In the case where no device is selected due to a RESET (NO DEVICE IS PRESENT) or the attempted selection of a nonexistent device, the host may then issue a SELECT command to identify another device.

6.1.2 REWIND COMMAND

The REWIND command positions the tape in the device at BOT. The normal completion of this command causes READY to be asserted.

6.1.3 ERASE COMMAND

The ERASE command completely erases the tape in the drive. The command moves the tape in the selected device to BOT, activates the erase head and moves to EOT, deactivates the erase head and moves the tape back to BOT. In addition, this command performs all the functions of the INITIALIZATION command. The normal completion of this command causes READY to be asserted.

6.1.4 INITIALIZATION COMMAND

The INITIALIZATION command conditions the tape in the device according to the recommendations of the media manufacturer. The command moves the tape in the selected device to BOT, then to EOT and then back to BOT. The normal completion of this command causes READY to be asserted.

6.1.5 WRITE COMMAND

The WRITE command causes data to be written on the tape in the device. The host must assert ONLINE before issuing the WRITE command. Then, the device transfers data. The READY line is asserted when the device is ready for a data block transfer. When the READY line is asserted, the host can terminate transfer of write data by alternatively issuing a WRITE FILE MARK command or deactivating ONLINE. Deactivating ONLINE causes a file mark to be written (if not preceded by a WRITE FILE MARK command) and the tape is rewound to BOT. Note: A WRITE command following cartridge insertion, RESET, or any command which positions the tape at BOT will commence recording at BOM. Otherwise, recording will commence at the current tape position. If, between blocks, the controller starts data transfer by asserting TRANSFER before the device asserts READY, then the behavior of the READY signal is device dependent. The device will, regardless of the way READY is handled, continue the TRANSFER and ACKNOWLEDGE handshaking correctly so that no data is lost.

When EW is detected while recording on the last track, the SBF ceases to transfer additional data blocks from the host. The device completes writing the current write block in progress, terminates the WRITE command, and reports EOM by means of an EXCEPTION and READ STATUS. The SBF allows the transfer of two additional blocks of data with WRITE commands after the receipt of EOM. However, EXCEPTION is asserted for each block transferred. The SBF will accept the READ STATUS and WRITE FILE MARK command after detection of EOM.

6.1.6 WRITE FILE MARK COMMAND

The WRITE FILE MARK command causes a FILE MARK to be written on the tape in the device. A WRITE FILE MARK command following cartridge insertion, RESET, or any command which positions the tape at BOT commences recording from BOM. Otherwise, recording commences from the current tape position. The normal completion of this command causes READY to be asserted. Deasserting ON LINE causes the tape to rewind to BOT.

6.1.7 READ COMMAND

The READ command causes data to be read from the tape in the device. The host must assert ONLINE before issuing the READ command. Then, device transfers data. The READY line is activated when the device is ready for a data block transfer. The READ command is terminated by the device if a file mark is detected. The host is informed of file mark detection by means of an EXCEPTION and a read status sequence. When READY is asserted, the host may terminate the READ command by either:

(a) Deactivating ONLINE, which causes the tape to rewind to BOT, or
(b) Issuing another command.

A READ command following cartridge insertion, RESET, or any command which positions the tape at BOT commences reading at BOM. Otherwise, the READ command commences from the current tape position. If the host starts a data transfer between blocks, before READY is asserted READY may not occur.

6.1.8 READ FILE MARK COMMAND

The READ FILE MARK command causes the tape in the device to move to the EOM side of the next file mark. No data is transferred to the host. A READ FILE MARK command following cartridge insertion, RESET, or any command which positions the tape at BOT commences reading from BOM. Otherwise, reading commences from the current tape position. The normal completion of this command causes EXCEPTION to be asserted with FMD asserted.

6.1.9 READ STATUS COMMAND

The READ STATUS command causes the device to transfer to the host information about itself. The device transfers six bytes of status information. The normal completion of this command causes READY to be asserted. The READ STATUS command must be issued in response to an EXCEPTION condition. Any other command will be rejected by the SBF if an EXCEPTION condition exists.

6.1.10 SELECT QIC-11 FORMAT

If the SBF being used has a firmware with default data format of QIC-24, then the SELECT QIC-11 FORMAT command will cause the SBF to write or read data in the QIC-11 (Archive eight-inch) format.

This command should be issued only when the selected drive is READY and the inserted cartridge is at BOT. The SBF will accept the command if a cartridge is not inserted; however, it will then assert EXCEPTION, informing the host of no cartridge in place. If the command is given during a READ or WRITE operation, the SBF will reject it as an illegal command, and the tape will be rewound to BOT.

6.1.11 SELECT QIC-24 FORMAT

If the SBF being used has a firmware with default data format of QIC-11, then the SELECT QIC-24 FORMAT command will cause the SBF to write or read data in the QIC-24 format.

This command should be issued only when the selected drive is READY and the inserted cartridge is at BOT. The SBF will accept the command if a cartridge is not inserted; however, it will then assert EXCEPTION, informing the host of no cartridge in place. If the command is given during a READ or WRITE operation, the SBF will reject it as an illegal command, and the tape will be rewound to BOT.

6.1.12 POWER-ON/RESET

The POWER-ON/RESET sequence provides the host with the information on power on occurrences in the device. It also provides a convenient mechanism for initializing the device during hardware and software debugging of the host interface.

A power-on condition or a pulse on the reset line resets the device, and forces it to assert EXCEPTION. When the power on reset times out or when the reset pulse terminates, the device initializes operating parameters and defaults to drive 0 for subsequent commands. The device waits for the host to issue a command. If the command issued was a READ STATUS command, the device now executes the command by transferring the six required status bytes, and sets bit 0 of byte 1 (the second byte) to indicate that power-up or a reset occurred.

6.2 STATUS DESCRIPTION

All DEVICE STATUS is contained in 6 byte groups as defined in the following sections.

6.2.1 STATUS BYTE SUMMARY

Table 3.0 presents a summary of the 6 status bytes returned by the Read Status command.

TABLE 3.0 STATUS BYTES

	BYTE 0	BYTE 1	ACRONYM (EXS)	DESCRIPTION
BIT	76543210	76543210		
	!!!!!!!!	!!!!!!!+-------	POR	power on/reset occurred
	!!!!!!!!	!!!!!!!+-------	POR	power on/reset occurred
	!!!!!!!!	!!!!!!+--------	RES	reserved for end of recorded media
	!!!!!!!!	!!!!+----------	RES	reserved for bus parity
	!!!!!!!!	!!!!		error
	!!!!!!!!	!!!+-----------	BOM	beginning of media
	!!!!!!!!	!!+------------	MBD	marginal block detected
	!!!!!!!!	!+-------------	NDT	no data detected
	!!!!!!!!	!+-------------	ILL	illegal command
	!!!!!!!!	+--------------	ST1	status byte 1 bits
	!!!!!!!+------------------		FIL	file mark detected
	!!!!!!+-------------------		BNL	bad block not located
	!!!!!+--------------------		UDA	unrecoverable data error
	!!!!+---------------------		EOM	end of media
	!!!+----------------------		WRP	write protected cartridge
	!!+-----------------------		DFF	device fault flag
	!+------------------------		CNI	cartridge not in place
	+-------------------------		ST0	status byte 0 bits

	MSB	LSB		
	BYTE 2	BYTE 3	DEC	data error counter
	BYTE 4	BYTE 5	URC	underrun counter

6.2.2 STATUS BYTE DESCRIPTION

Bytes 0 and 1 contain exception status (EXC) to define the reason that the device asserted EXCEPTION. A description of each status bit is as follows:

STATUS BYTE 1

BIT 0: POR - The Power On/Reset bit is set after the host asserts RESET or when the controller is powered up. The bit is reset by a Read Status Sequence.

BIT 1: RES - Reserved

BIT 2: RES - Reserved

BIT 3: BOM - Beginning of Media bit is set whenever the cartridge is logically at beginning of tape, track 0. The bit is reset when the tape moves away from beginning of tape. This is the only bit in this byte that does not set EXCEPTION when it goes true, nor is it reset by the Read Status Sequence.

BIT 4: MBD - The Marginal Block Detected bit is set when the formatter takes more than eight but less than sixteen retries to read a block with correct CRC. This status bit warns the host that the tape is marginal and should be replaced. This bit is reset by the READ STATUS sequence.

BIT 5: NDD - No Data Detected bit is set when an unrecoverable data error occurs due to lack of recorded data. Absence of recorded data is the failure to detect a data block within 20 inches of tape after three consecutive retries. This bit is reset by a Read Status Sequence.

BIT 6: ILL - Illegal command bit is set if any of the following occurs. The bit is reset by a Reset Status sequence.

a. SELECT command is issued with no drives or more than one drive indicated.

b. ONLINE not asserted when a WRITE, WRITE FILE MARK, READ or READ FILE MARK command is issued.

c. A command other than WRITE or WRITE FILE MARK is issued during the execution of a Write Data sequence.

d. A command other than READ or READ FILE MARK is issued during the execution of a Read Data sequence.

STATUS BYTE 1

e. A command to SELECT a new drive is issues when the current drive's tape is not at BOT.

BIT 7: ST1 - Status Byte 1 bit is set if any other bit in Status Byte 1 is set.

STATUS BYTE 0

BIT 0: FMD - File Mark Detected bit is set when a File Mark is detected during a Read Data or Read File Mark sequence. The bit is reset by a Read Status sequence.

BIT 1: BNL - Block in error Not Located bit is set when an unrecoverable read error occurs and the formatter can not confirm that the last block transmitted was the block in error. The bit is reset by a Read Status sequence.

BIT 2: UDE - Unrecoverable Data Error bit is set when the formatter cannot read a block after sixteen retries and obtain a correct checksum. The UDE bit is also set when the formatter cannot correctly write a block within sixteen retries. It is also set when the formatter cannot locate a block. The UDE bit is reset by a READ STATUS sequence.

BIT 3: EOM - End of Media bit is set when the logical early warning hole of the last track is detected during a write operation. This bit will remain set as long as the drive is at logical end of media. The EOM bit will not be reset by a Read Status sequence.

BIT 4: WRP - Write Protected bit is set if the cartridge write protect plug is set in the file protect "safe" position. Operator must change the write protect plug position before the status bit will reset.

BIT 5: DFF - Device Fault Flag bit is set when the drive detects a problem other than data errors during command execution. RESET or READ STATUS sequence will reset this bit.

BIT 6: CNI - Cartridge Not in Place bit is set if a cartridge is not fully inserted into the drive. Operator must correct the condition before the status bit will reset.

BIT 7: ST0 - Status Byte 0 bit is set if any other bit in Status Byte 0 is set.

Refer to EXCEPTION STATUS SUMMARY and EXCEPTION STATUS DESCRIPTION for further explanation.

Bytes 2 and 3 contain the data error counter (DEC) which accumulates the number of blocks rewritten for WRITE operations and the number of soft read errors during READ operations. These bytes are cleared by a Read Status sequence.

Bytes 4 and 5 contain the underrun counter (URC) which accumulates the number of times that streaming was interrupted because host failed to maintain minimum throughput rate. These bytes are cleared by a Read Status sequence.

6.2.3 EXCEPTION STATUS SUMMARY

	Byte 0	Byte 1	Description
1.	110X0000	00000000	No Cartridge
2.	00100000	00000000	Device Fault Flag
3.	10010000	X000X000	Write Protected
4.	10001000	00000000	End of Media
5.	100X0100	10001000	Read or Write Abort
6.	100X0100	00000000	Read Error, Bad Block Xfer
7.	100X0110	00000000	Read Error, Filler Block Xfer
8.	100X0110	10100000	Read Error, No Data
9.	100X1110	10100000	Read Error, No Data & EOM
10.	100X0001	00000000	Read a Filemark
11.	XXXX0000	1100X000	Illegal Command
12.	XXXX0000	1000X001	Power On/Reset
13.	100X0001	00010000	Marginal Block Detected (Not Used)

NOTE: "X" denotes either 0 or 1 condition.

6.2.4 EXCEPTION STATUS DESCRIPTION

1. NO CARTRIDGE - Selected drive did not contain a cartridge when BOT, RET, ERASE, WRITE, WFM, READ or RFM was issued or cartridge was removed while the drive is selected. FATAL.

2. DEVICE FAULT FLAG - The drive detected a problem other than data errors during command execution. FATAL.

3. WRITE PROTECTED - Selected drive contained write protected (safe) cartridge when ERASE, WRITE, or WFM was issued. FATAL.

4. END OF MEDIA - Tape has passed the logical early warning hole of the last track during WRITE command. CONTINUABLE.

5. READ OR WRITE ABORT - The maximum limit of same block rewrites occurred during a WRITE or WFM command or unrecoverable reposition error occurred during a WRITE, WFM, READ, or RFM command... Tape has returned to BOT. FATAL.

6. READ ERROR, BAD BLOCK XFER - The maximum limit of same block retrys failed to recover block without CRC error, last block transferred contained data from the erroneous data block for off line reconstruction. CONTINUABLE.

7. READ ERROR, FILLER BLOCK XFER - The maximum limit of same block retrys failed to recover block without CRC error, last block transferred contained filler data to keep total block count correct. CONTINUABLE.

8. READ ERROR, NO DATA - No recorded data found on tape for 20 inches. CONTINUABLE.

9. READ ERROR, NO DATA & EOM - The maximum limit of same block retries failed to recover the next or subsequent blocks and the logical end of tape holes on the last track were encountered. CONTINUABLE.

10. FILEMARK READ - A filemark block was read during a READ or RFM command. CONTINUABLE.

11. ILLEGAL COMMAND - One of the following events occurred:

a. Attempt to select other than one drive.

b. Attempt to change drive selection when tape has been moved away from BOT by a read or write operation.

c. Attempt to BOT, RETENSION, or ERASE simultaneously.

d. Attempt to WRITE, WFM, READ, or RFM with ONLINE not asserted.

e. Attempt to issue a command other than WRITE or WFM during a WRITE command. FATAL.

f. Attempt to issue a command other than READ or RFM during a READ command. FATAL.

g. Attempt to issue any command not implemented.

12. POWER ON/RESET - A power on/reset or a reset by the host has occurred. FATAL.

13. MARGINAL BLOCK DETECTED - A data block was detected by the device after more than eight but less than sixteen retries. CONTINUABLE.

7.0 INTERFACE TIMING

Interface signal timing is specified in the following timing sections and corresponding timing diagrams.

7.1 RESET TIMING

Figure 4.0 presents the interface timing diagram which results from the assertion of RESET. As indicated in the diagram the host is required to maintain reset assertion for at least 25 microseconds.

7.2 READ STATUS TIMING

A hardware reset or a power on reset (generated by the drive) will generate an Exception condition, indicated by the assertion of EXCEPTION on the interface. The host clears Exception by performing a Read Status command. Figure 5.0 shows the timing for the Read Status command.

7.3 SELECT COMMAND TIMING

The SBF will respond to the Select Command as defined by the QIC specification. The unit will produce an Exception condition if a drive other than 0 is selected. Timing for the Select Command sequence is shown in Figure 6.0

7.4 POSITION COMMAND TIMING

Figure 7.0 illustrates timing for the Rewind, Erase, and Retension commands.

7.5 WRITE DATA TIMING

One of the two major commands of the unit is Write Data. This is the mechanism by which user data is recorded on the tape media. Figure 8.0 shows the Timing Diagrams associated with this command.

7.6 READ DATA TIMING

Once data has been recorded on tape it is recovered by the Read Data command, the second major command. Figure 9.0 presents the interface timing for the Read Data command.

7.7 WRITE FILE MARK COMMAND TIMING

The File Mark is a method by which the user can separate logical or physical records on the tape. The Write File Mark Command Timing diagram is shown in Figure 10.0.

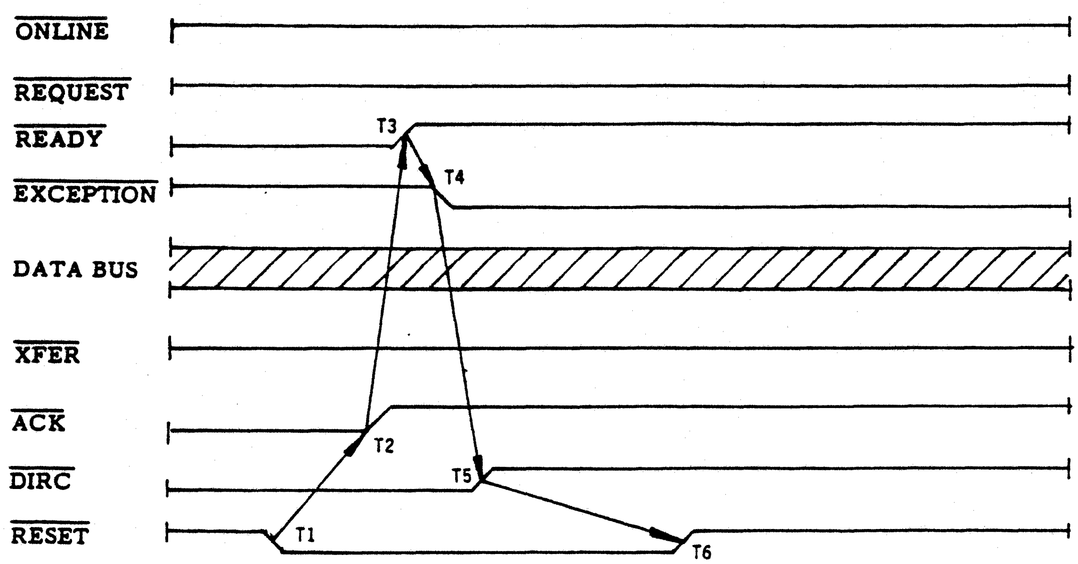
7.8 READ FILE MARK COMMAND TIMING

To position the tape at a file mark a Read File Mark Command is issued. Figure 11.0 shows the timing for this command.

7.9 SBF RESPONSE TIMING TO QIC-02 COMMANDS

Figures 12.0 through 19.0 are timing diagrams giving the SBF response times in comparison to the QIC-02 commands.

FIGURE 4.0 RESET TIMING DIAGRAM

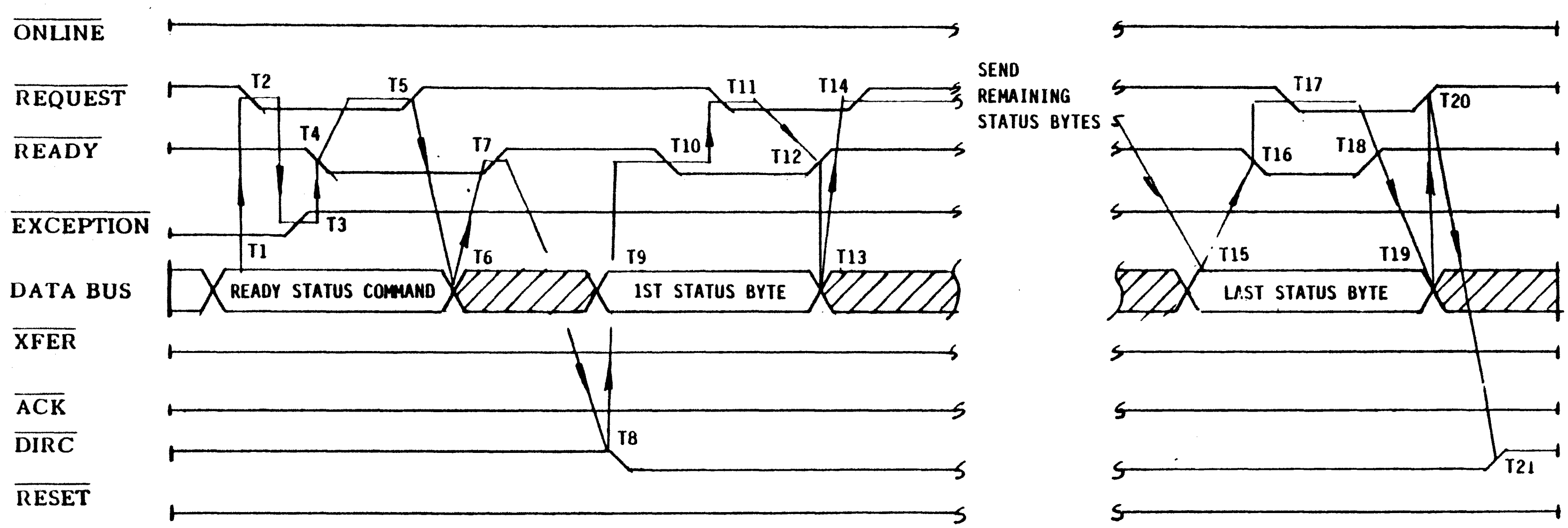


RESET TIMING

ACTIVITY	CRITICAL TIMING
T1 - HOST ASSERTS RESET	N/A
T2 - CONTROLLER DE-ASSERTS ACK	T1 — T2 < 1 Usec
T3 - CONTROLLER DE-ASSERTS READY	T1 — T3 < 1 Usec
T4 - CONTROLLER ASSERTS EXCEPTION	T1 — T4 < 3 Usec
T5 - CONTROLLER DE-ASSERTS DIRC	T1 — T5 < 3 Usec
T6 - HOST DE-ASSERTS RESET	T1 — T6 > 25 Usec

X - DON'T CARE

FIGURE 5.0 READ STATUS COMMAND TIMING



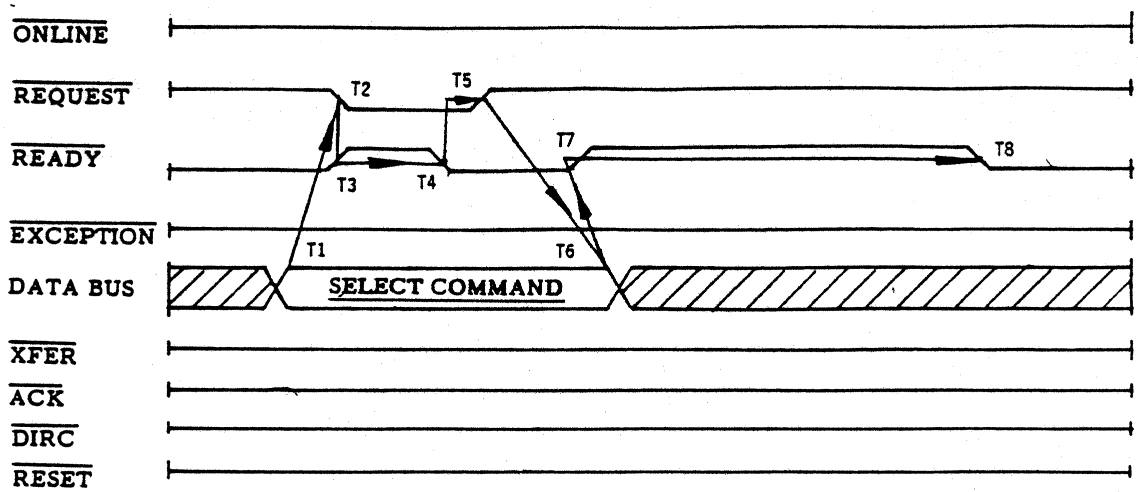
READ STATUS COMMAND

ACTIVITY	CRITICAL TIMING
T1 - HOST COMMAND TO BUS	N/A
T2 - HOST ASSERTS REQUEST	T1 — T2>Usec
T3 - CONTROLLER DE-ASSERTS EXCEPTION	T3 — T4>1ØUsec
T4 - CONTROLLER ASSERTS READY	T2 — T4>20Usec (500 Usec nominal)
T5 - HOST DE-ASSERTS REQUEST	T4 — T5>ØUsec
T6 - BUS DATA INVALID	T4 — T6>ØUsec
T7 - CONTROLLER DE-ASSERTS READY	20 < T5— T7<100 Usec
T8 - CONTROLLER CHANGES BUS DIRECTION	N/A
T9 - 1ST STATUS BYTE TO BUS	N/A
T10- CONTROLLER ASSERTS READY	T7 — T10>20 Usec
T11- HOST ASSERTS REQUEST	T10— T11>500 N.S
T12- CONTROLLER DE-ASSERTS READY	T11— T12<1 Usec
T13- BUS DATA INVALID	T11— T13>Ø Usec
T14- HOST DE-ASSERTS REQUEST	T11— T14>20 Usec

ACTIVITY	CRITICAL TIMIN
T15-LAST STATUS BYTE TO BUS	N/A
T16-SAME AS T10	SAME AS T10
T17-SAME AS T11	SAME AS T11
T18-SAME AS T12	SAME AS T12
T19-SAME AS T13	SAME AS T13
T20-SAME AS T14	SAME AS T14

X - DON'T CARE

FIGURE 6.0 SELECT COMMAND TIMING

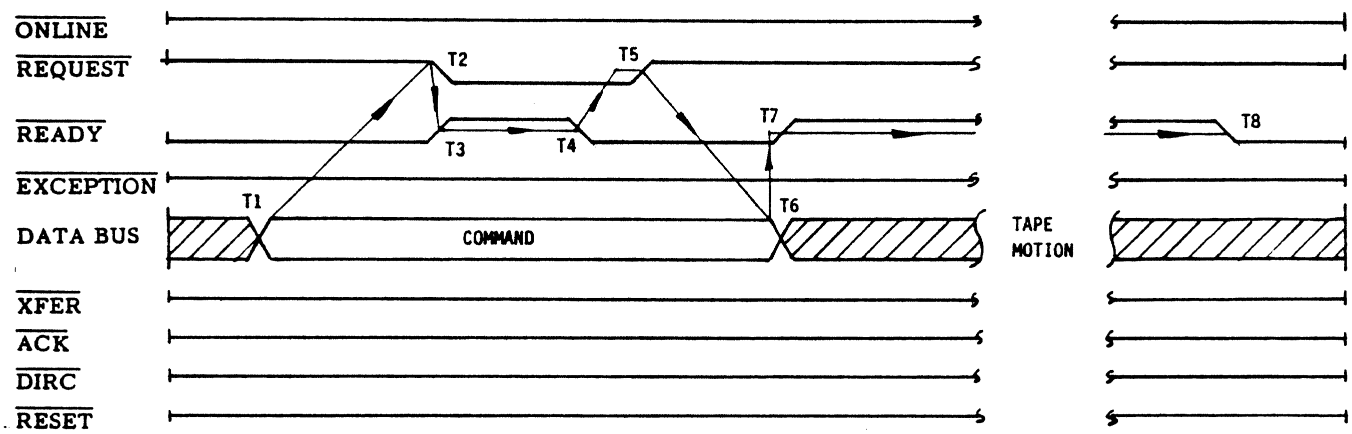


SELECT COMMAND

ACTIVITY	CRITICAL TIMING
T1 - HOST COMMAND TO BUS	N/A
T2 - HOST ASSERTS REQUEST	T1 — T2 > Ø Usec
T3 - CONTROLLER DE-ASSERTS READY	T2 — T3 < 1 Usec
T4 - CONTROLLER ASSERTS READY	T3 — T4 > 50 Usec (500 Usec nominal)
T5 - HOST DE-ASSERTS REQUEST	T4 — T5 > Ø Usec
T6 - BUS DATA INVALID	T4 — T6 > Ø Usec
T7 - CONTROLLER DE-ASSERTS READY	20 < T5 — T7 < 100 Usec
T8 - CONTROLLER ASSERTS READY	T7 — T8 > 20 Usec

X - DON'T CARE

FIGURE 7.0 POSITION COMMAND TIMING

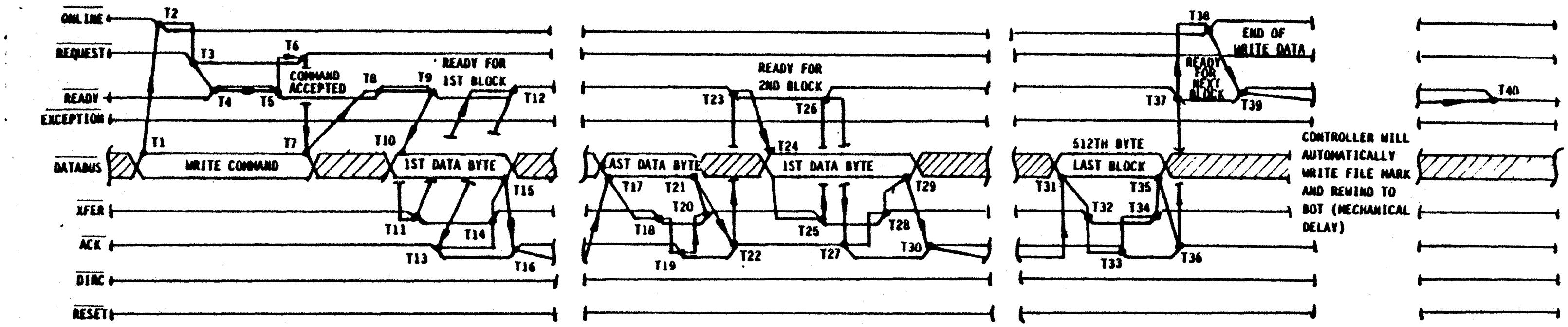


BOT, RETENSION OR ERASE COMMAND

ACTIVITY	CRITICAL TIMING
T1 - HOST BUS DATA VALID	N/A
T2 - HOST ASSERTS REQUEST	T1 — T2 > Ø Usec
T3 - CONTROLLER DE-ASSERTS READY	T2 — T3 < 1 Usec
T4 - CONTROLLER ASSERTS READY	T3 — T4 > 20 Usec (500 Usec nominal)
T5 - HOST DE-ASSERTS REQUEST	T4 — T5 > Ø Usec
T6 - BUS DATA INVALID	T4 — T6 > Ø Usec
T7 - CONTROLLER DE-ASSERTS READY	20 < T5 — T7 < 100 Usec
T8 - CONTROLLER ASSERTS READY	T7 — T8 > 20 Usec

X - DON'T CARE

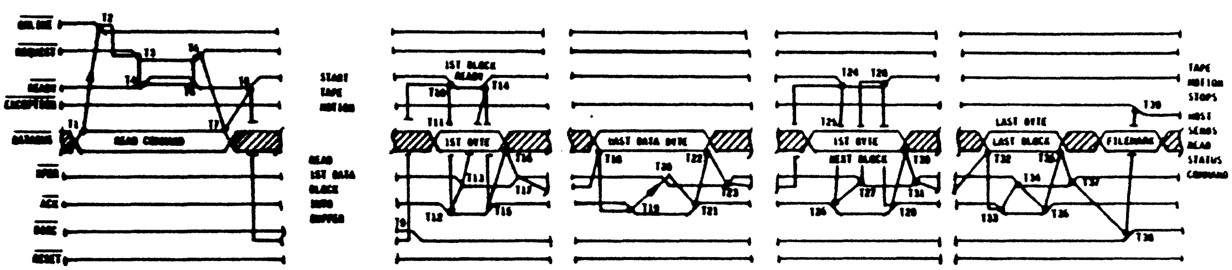
FIGURE 8.0 WRITE DATA COMMAND TIMING



WRITE DATA COMMAND

ACTIVITY	CRITICAL TIMING	ACTIVITY	CRITICAL TIMING	ACTIVITY	CRITICAL TIMING
T1-HOST COMMAND TO BUS	N/A	T15-BUS DATA INVALID	T13-T15>0 U Sec	T28-HOST DE-ASSERTS XFER	SAME AS T14
T2-HOST ASSERTS ONLINE	N/A	T16-CONTROLLER DE-ASSERTS ACK	0<T14-T16<3 U Sec	T29-BUS DATA INVALID	SAME AS T15
T3-HOST ASSERTS REQUEST	T2-T3>0 U Sec	T17-HOST DATA TO BUS	N/A	T30-CONTROLLER DE-ASSERTS ACK	SAME AS T16
T4-CONTROLLER DE-ASSERTS READY	T3-T4<1 U Sec	T18-SAME AS T11	SAME AS T11	T31-HOST DATA TO BUS	N/A
T5-CONTROLLER ASSERTS READY	T4-T5>20 U Sec (500 U sec nominal)	T19-SAME AS T13	SAME AS T13	T32-HOST ASSERTS XFER	SAME AS T18
T6-HOST DE-ASSERTS REQUEST	T5-T6>0 U Sec	T20-SAME AS T14	SAME AS T14	T33-CONTROLLER ASSERTS ACK	SAME AS T19
T7-BUS DATA INVALID	T5-T7>0 U Sec	T21-SAME AS T15	SAME AS T15	T34-HOST DE-ASSERTS XFER	SAME AS T20
T8-CONTROLLER DE-ASSERTS READY	20<T6-T8<100 U Sec	T22-SAME AS T16	SAME AS T16	T35-BUS DATA INVALID	N/A
T9-CONTROLLER ASSERTS READY	T8-T9>20 U Sec	T23-CONTROLLER ASSERTS READY	T22-T23>100 U Sec	T36-CONTROLLER DE-ASSERTS ACK	SAME AS T22
T10-HOST DATA TO BUS	N/A	T24-HOST DATA TO BUS	N/A	T37-CONTROLLER ASSERTS READY	SAME AS T23
T11-HOST ASSERTS XFER	T10-T11>40 NANO Sec	T25-HOST ASSERTS XFER	SAME AS T11	T38-HOST DE-ASSERTS ONLINE	N/A
T12-CONTROLLER DE-ASSERTS READY	T11-T12<1 U Sec	T26-CONTROLLER DE-ASSERTS READY	SAME AS T12	T39-CONTROLLER DE-ASSERTS READY	N/A
T13-CONTROLLER ASSERTS ACK	0.5<T11-T13<100 U Sec	T27-CONTROLLER ASSERTS ACK	SAME AS T13	T40-CONTROLLER ASSERTS READY	N/A
T14-HOST DE-ASSERTS XFER	T13-T14>0 U Sec				

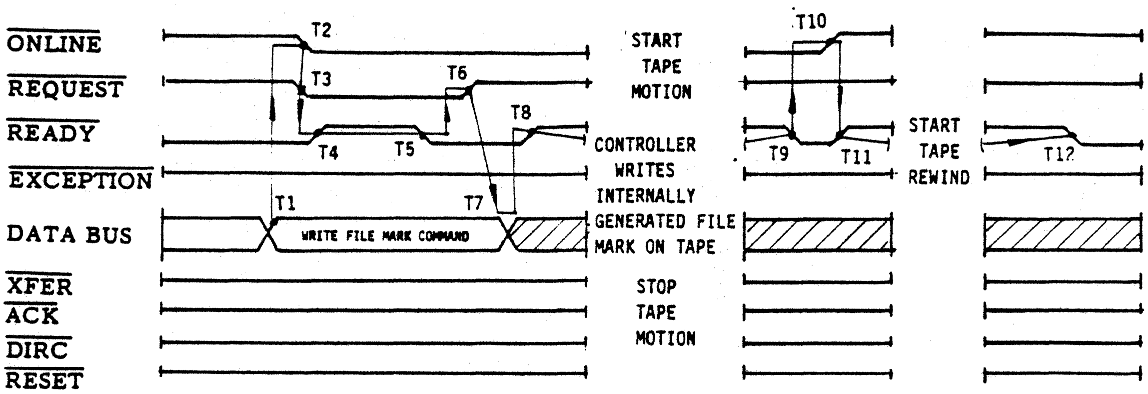
FIGURE 9.0 READ DATA COMMAND TIMING



ACTIVITY	CRITICAL TIMING	ACTIVITY	CRITICAL TIMING	ACTIVITY	CRITICAL TIMING
T1-HOST COMMAND TO BUS	N/A	T14-CONTROLLER DE-ASSERTS READY	T13-T14<1 U Sec.	T27-HOST ASSERTS XFER	SAME AS T13
T2-HOST ASSERTS ONLINE	N/A	T15-CONTROLLER DE-ASSERTS ACK	0.5<T13-T15<3 U Sec	T28-CONTROLLER DE-ASSERTS READY	SAME AS T14
T3-HOST ASSERTS REQUEST	T2-T13>0 U Sec	T16-BUS DATA INVALID	T13-T16>0 U Sec	T29-CONTROLLER DE-ASSERTS ACK	SAME AS T15
T4-CONTROLLER DE-ASSERTS READY	T3-T4<1 U Sec	T17-HOST DE-ASSERTS XFER	T15-T17>0 U Sec	T30-BUS DATA INVALID	SAME AS T16
T5-CONTROLLER ASSERTS READY	T4-T5>20 U Sec (500 U Sec nominal)	T18-BUS DATA VALID		T31-HOST DE-ASSERTS XFER	SAME AS T17
T6-HOST DE-ASSERTS REQUEST	T5-T6>0 U Sec	N/A		T32-LAST BYTE TO BUS	N/A
T7-BUS DATA INVALID	T5-T7>0 U Sec	T19-CONTROLLER ASSERTS ACK	SAME AS T12	T33-CONTROLLER ASSERTS ACK	SAME AS T12
T8-CONTROLLER DE-ASSERTS READY	20<T6-T8<100 U Sec	T20-HOST ASSERTS XFER	SAME AS T13	T34-HOST ASSERTS XFER	SAME AS T13
T9-CONTROLLER CHANGES DIRC	N/A	T21-CONTROLLER DE-ASSERT ACK	SAME AS T15	T35-CONTROLLER DE-ASSERTS ACK	SAME AS T15
T10-1ST DATA BYTE TO BUS	N/A	T22-BUS DATA INVALID	SAME AS T16	T36-BUS DATA INVALID	SAME AS T16
T11-CONTROLLER ASSERTS READY	N/A	T23-HOST DE-ASSERTS XFER	SAME AS T17	T37-HOST DE-ASSERTS XFER	SAME AS T17
T12-CONTROLLER ASSERTS ACK	T11-T12>40 NANO Sec	T24-CONTROLLER ASSERTS READY	N/A	T38-CONTROLLER CHANGES BUS DIRECTION	N/A
T13-HOST ASSERTS XFER	T12-T13>0 U Sec	T25-1ST BYTE TO BUS	N/A	T39-CONTROLLER ASSERTS EXCEPTION	N/A
		T26-CONTROLLER ASSERTS ACK	SAME AS T12		

NOTE: T12 can precede T11 by 40 Nano Seconds.

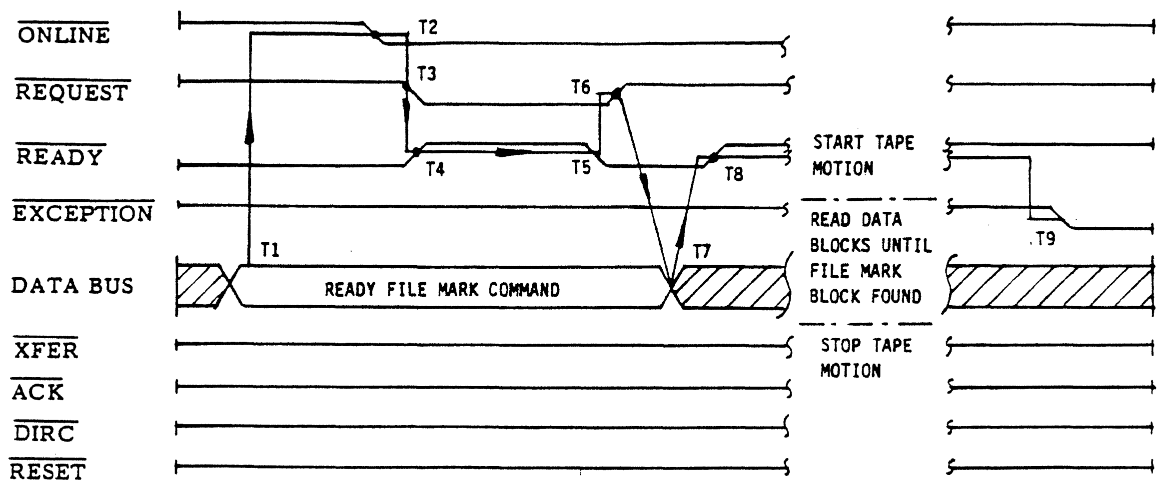
FIGURE 10.0 WRITE FILE MARK COMMAND TIMING



WRITE FILE MARK COMMAND

ACTIVITY	CRITICAL TIMING
T1 - HOST COMMAND TO BUS	N/A
T2 - HOST ASSERTS ONLINE	T1 — T2 > Ø Usec
T3 - HOST ASSERTS REQUEST	T2 — T3 > Ø Usec
T4 - CONTROLLER DE-ASSERTS READY	T3 — T4 < 1 Usec
T5 - CONTROLLER ASSERTS READY	T4 — T5 > 20 Usec (500 Usec nominal)
T6 - HOST DE-ASSERTS REQUEST	T5 — T6 > Ø Usec
T7 - BUS DATA INVALID	T5 — T7 > Ø Usec
T8 - CONTROLLER DE-ASSERTS READY	20 < T6 — T8 < 100 Usec
T9 - CONTROLLER ASSERTS READY	N/A
T10-HOST DE-ASSERTS ONLINE	T9 — T10 > Ø Usec
T11-CONTROLLER DE-ASSERTS READY	N/A
T12-CONTROLLER ASSERTS READY (AT BOT)	N/A

FIGURE 11.0 READ FILE MARK COMMAND TIMING

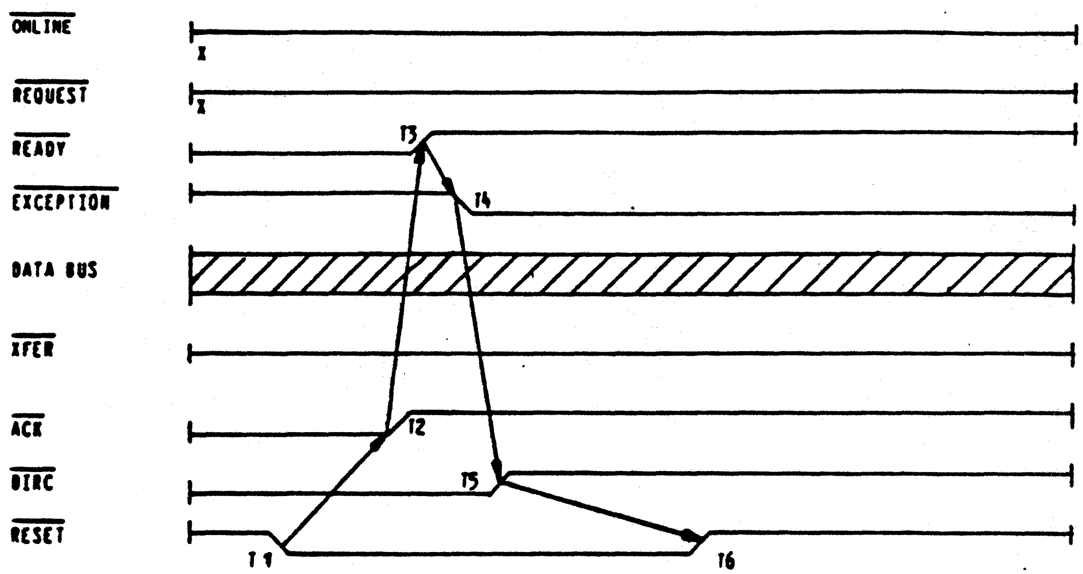


READ FILE MARK COMMAND

ACTIVITY	CRITICAL TIMING
T1 - HOST COMMAND TO BUS	N/A
T2 - HOST ASSERTS ONLINE	T1 — T2 > Ø Usec
T3 - HOST ASSERTS REQUEST	T2 — T3 > Ø Usec
T4 - CONTROLLER DE-ASSERTS READY	T3 — T4 < 1 Usec
T5 - CONTROLLER ASSERTS READY	T4 — T5 > 20 Usec (500 Usec nominal)
T6 - HOST DE-ASSERTS REQUEST	T5 — T6 > Ø Usec
T7 - BUS DATA INVALID	T4 — T7 > Ø Usec
T8 - CONTROLLER DE-ASSERTS READY	20 < T6 — T8 < 100 Usec
T9 - CONTROLLER ASSERTS EXCEPTION	N/A

*SYSTEM MUST ISSUE READ STATUS COMMAND

FIGURE 12.0 SBF RESPONSE TIMING FOR RESET COMMAND



RESET TIMING

ACTIVITY			SBF RESPONSE TIME			
T1	-	HOST ASSERTS READY	N/A			
T2	-	SBF DISABLES ACK	T1	T2	=	90 N.S.
T3	-	SBF DISABLES READY	T1	T3	=	300 N.S.
T4	-	SBF ASSERTS EXCEPTION	T1	T4	=	50 N.S.
T5	-	SBF DISABLES DIRECTION	T1	T5	=	60 N.S.

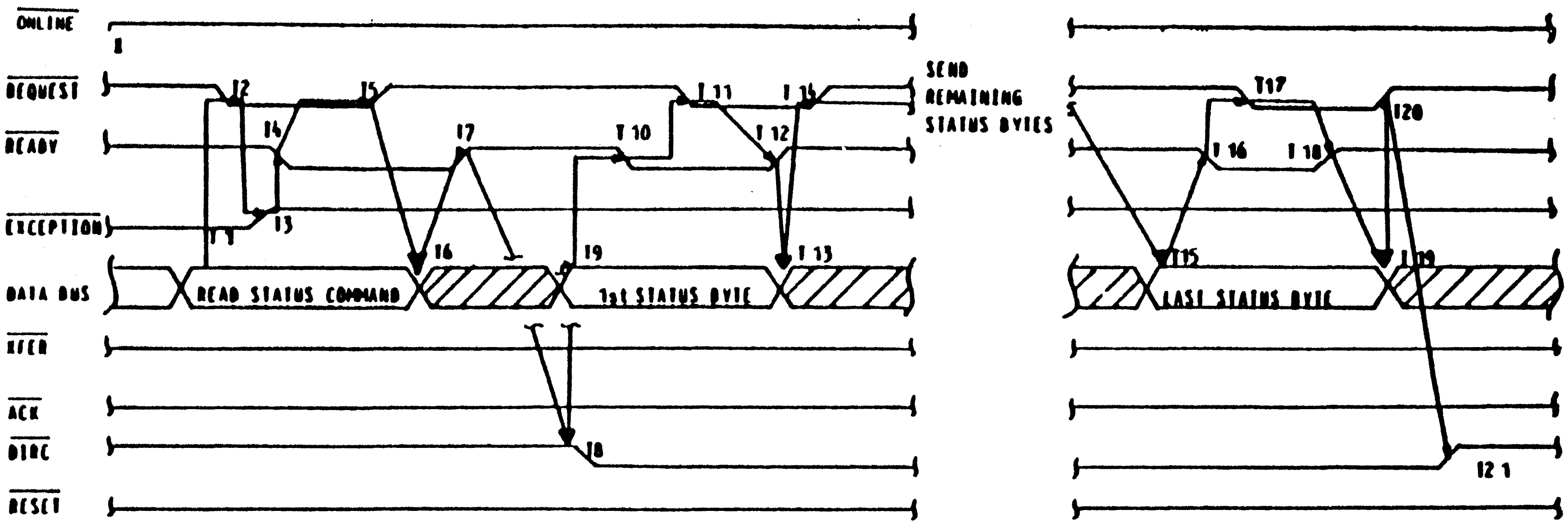


FIGURE 13.0 SBF RESPONSE TIMING FOR READ STATUS COMMAND

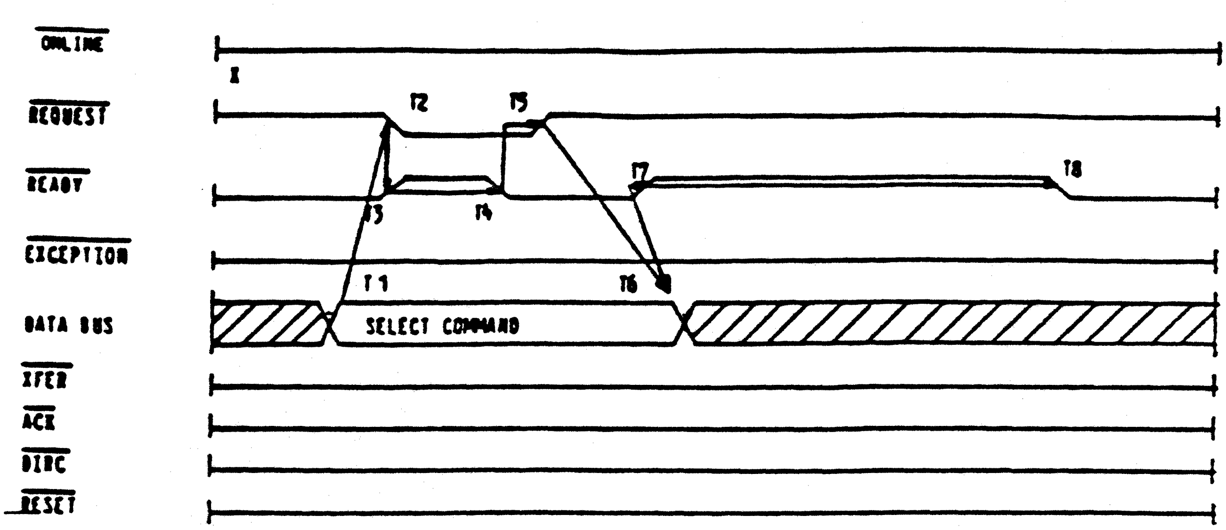
READ STATUS COMMAND

ACTIVITY	SBF RESPONSE TIME
T2 - HOST ASSERTS REQUEST	N/A
T4 - SBF ASSERTS READY	104 USEC $\le$ T2 $\rightarrow$ T4 $\le$ 140 USEC
T7 - SBF DE-ASSERTS READY	40 USEC $\le$ T5 $\rightarrow$ T7 $\le$ 44 USEC
T8 - SBF ASSERTS DIRC	99 USEC $\le$ T7 $\rightarrow$ T8 $\le$ 211 USEC
T10 - SBF ASSERTS READY	141 USEC $\le$ T7 $\rightarrow$ T10 $\le$ 251 USEC
T12 - SBF DE-ASSERTS READY	T11 $\rightarrow$ T12 = 50 N.S
T21 - SBF DE-ASSERTS DIRC	T20 $\rightarrow$ T21 = 68 USEC

NOTE:

1. TIME FOR T14 TO READY FOR NEXT STATUS BYTE IS FROM 64 USEC MINIMUM TO 71 USEC MAXIMUM.
2. TIME FROM T20 TO READY FOR NEXT COMMAND IS FROM 178 USEC MINIMUM TO 184 USEC MAXIMUM.

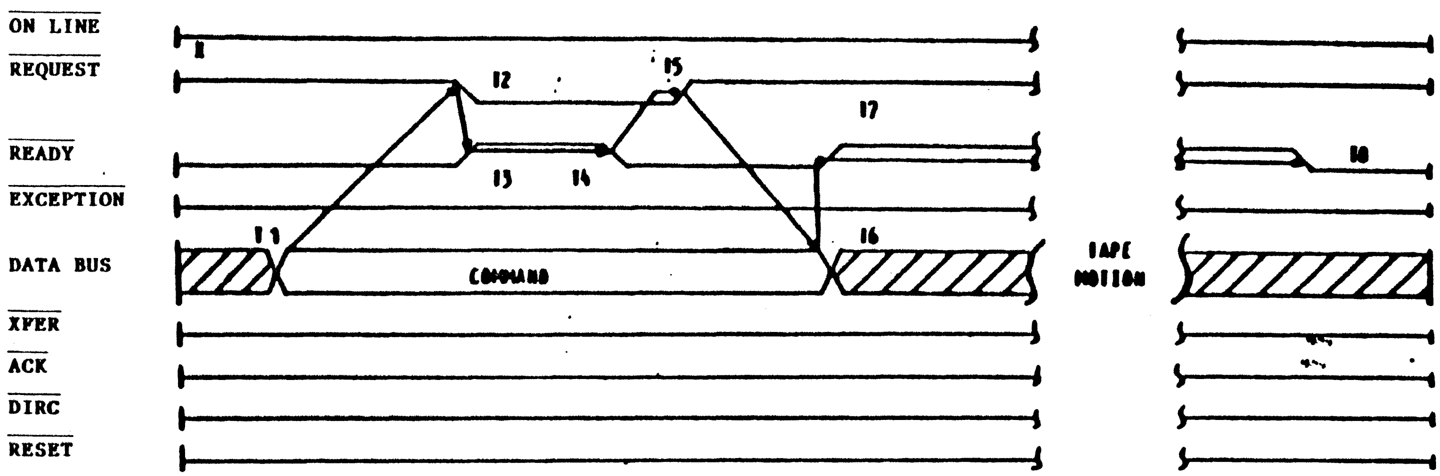
FIGURE 14.0 SBF RESPONSE TIMING FOR SELECT COMMAND



SELECT COMMAND

ACTIVITY	SBF RESPONSE TIME
T2 - HOST ASSERTS REQUEST	N/A
T3 - SBF DE-ASSERTS READY	T2 → T3 = 50 N.S
T4 - SBF ASSERTS READY	124 USEC ≤ T3 → T4 ≤ 140 USEC
T7 - SBF DE-ASSERTS READY	T5 → T7 = 44 USEC.
T8 - SBF ASSERTS READY	T7 → T8 = 55.4 MSEC.

FIGURE 15.0 SBF RESPONSE TIMING FOR BOT, RET, ER COMMAND



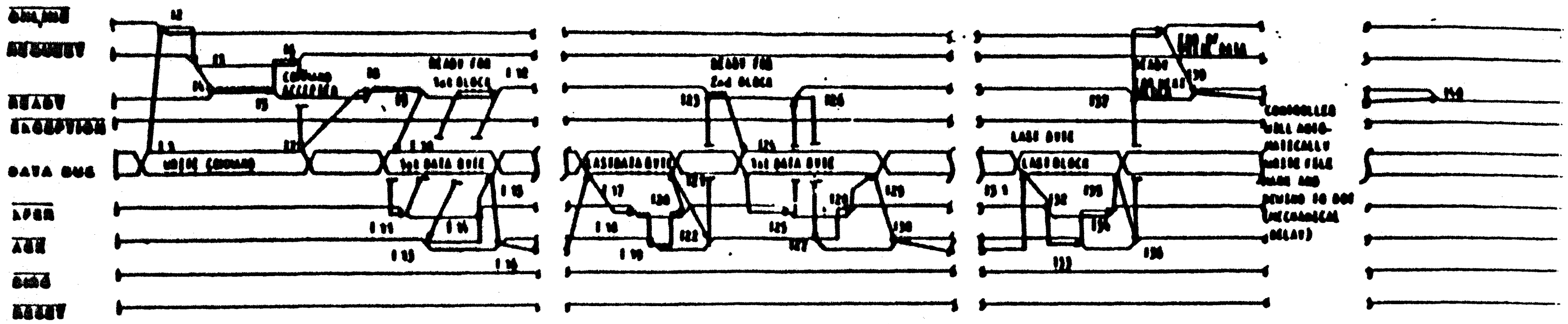
BOT, RETENSION OR ERASE COMMAND

ACTIVITY	SBF RESPONSE TIME
T2 - HOST ASSERTS REQUEST	N/A
T3 - SBF DE-ASSERTS READY	T2 → T3 = 50 N.S
T4 - SBF ASSERTS READY	107 USEC $\leq$ T3 → T4 $\leq$ 139 USEC
T7 - SBF DE-ASSERTS READY	T5 → T7 = 44 USEC
T8 - SBF ASSERTS READY	T7 → T8 (SEE NOTE BELOW)

NOTE: T7 → T8 TIME WILL DEPEND ON THE TAPE POSITION WHEN BOT COMMAND IS GIVEN. IT WILL BE 1½ MINUTES IN A WORST CASE SITUATION FOR A 600 FOOT TAPE.

IN CASE OF RETENSION OR ERASE COMMAND THE T7 → T8 TIME WILL BE APPROXIMATELY 3 MINUTES.

FIGURE 16.0 SBF RESPONSE TIMING FOR WRITE DATA COMMAND



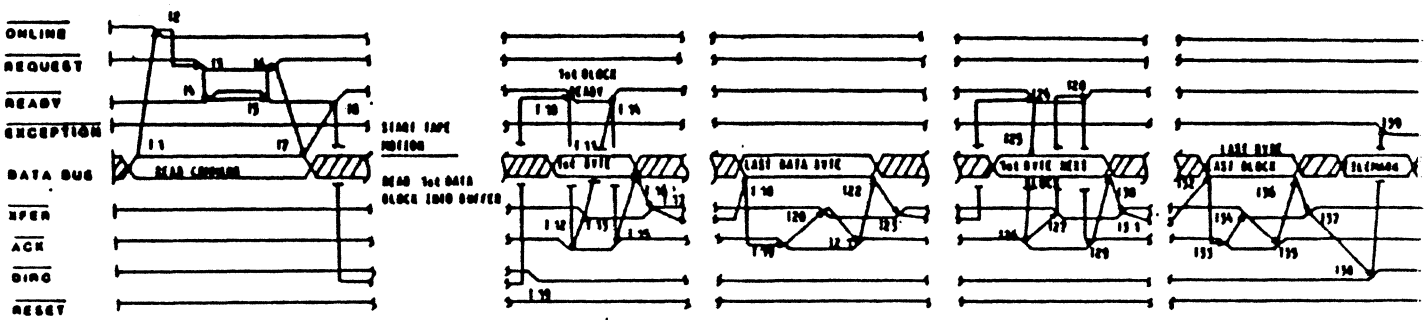
WRITE DATA COMMAND

ACTIVITY	SBF RESPONSE TIME
T3 - HOST ASSERTS REQUEST	N/A
T4 - SBF DE-ASSERTS READY	T3 → T4 = 50 N.S
T5 - SBF ASSERTS READY	2.58 MSEC $\leq$ T4 → T5 $\leq$ 2.625 MSEC
T8 - SBF DE-ASSERTS READY	40 USEC $\leq$ T6 → T8 $\leq$ 44 USEC
T9 - SBF ASSERTS READY	T8 → T9 (SEE NOTE 1 BELOW)
T12 - SBF DE-ASSERTS READY	50 N.S $\leq$ T11 → T12 $\leq$ 60 N.S
T13 - SBF ASSERTS ACK	1.94 USEC < T11 → T13 $\leq$ 4.56 USEC
T16 - SBF DE-ASSERTS ACK	40 N.S $\leq$ T14 → T16 $\leq$ 80 N.S
T23 - SBF ASSERTS READY	1.9 MSEC $\leq$ T22 → T23 $\leq$ 2.5 MSEC

NOTES:

1. T8 → T9 TIME WILL DEPEND ON THE POSITION OF TAPE AT THE TIME OF COMMAND. WORST CASE TIME IS 1½ MINUTES FOR A 600 FT. TAPE.

FIGURE 17.0 SBF RESPONSE TIMING FOR READ DATA COMMAND



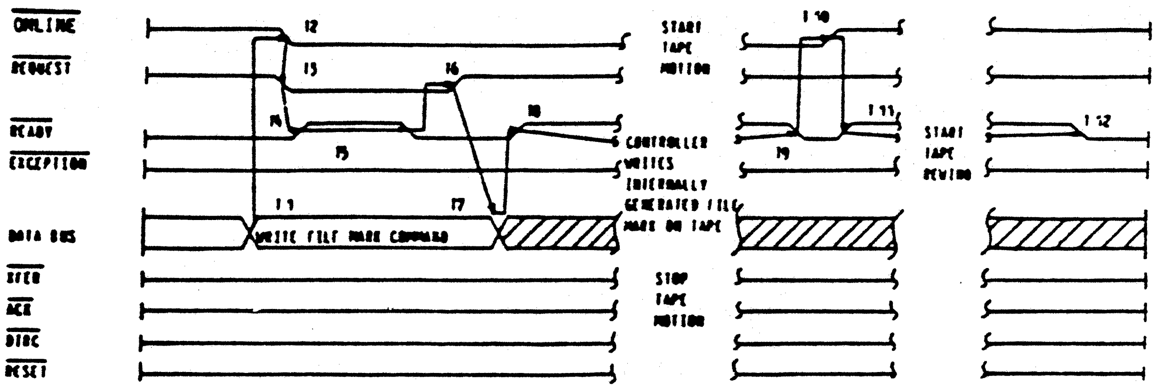
READ DATA COMMAND

ACTIVITY	SBF RESPONSE TIME
T3 - HOST ASSERTS REQUEST	N/A
T4 - SBF DE-ASSERTS READY	T3 → T4 = 50 N.S
T5 - SBF ASSERTS READY	104 USEC ≤ T4 → T5 ≤ 138 USEC
T8 - SBF DE-ASSERTS READY	41 USEC ≤ T5 → T8 ≤ 44 USEC
T10- SBF ASSERTS READY	T8 → T10 (SEE NOTE 1 BELOW)
T14- SBF DE-ASSERTS READY	40 N.S ≤ T13 → T14 ≤ 60 N.S
T15- SBF DE-ASSERTS ACK	520 N.S ≤ T13 → T15 ≤ 1.21 USEC

NOTES:

1. T8 → T10 WORST CASE TIME IS 1½ MINUTES FOR A 600 FT. TAPE
2. T17 → TO ACK ASSERTION FOR NEXT BYTE IS FROM A MINIMUM OF 1.93 USEC TO A MAXIMUM OF 4.0 USEC.
3. DIRECTION SIGNAL WILL BE DE-ASSERTED ONLY IF THE SBF SEES A FILEMARK OR IF THERE IS AN UNDERRUN CONDITION.

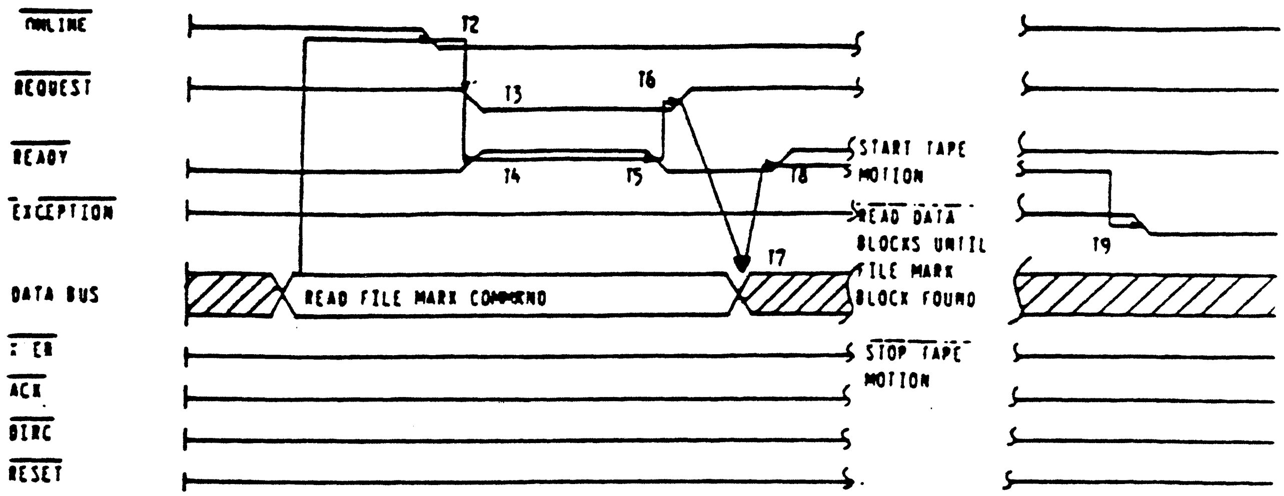
FIGURE 18.0 SBF RESPONSE TIMING FOR WRITE FILE MARK COMMAND



WRITE FILE MARK COMMAND

ACTIVITY	SBF RESPONSE TIME
T3 - HOST ASSERTS REQUEST	N/A
T4 - SBF DE-ASSERTS READY	T3 → T4 = 50 N.S
T5 - SBF ASSERTS READY	104 USEC $\leq$ T4 → T5 $\leq$ 372 USEC
T8 - SBF DE-ASSERTS READY	41 USEC $\leq$ T6 → T8 $\leq$ 43 USEC

FIGURE 19.0 SBF RESPONSE TIMING FOR READ FILE MARK COMMAND



READ FILE MARK COMMAND

ACTIVITY	SBF RESPONSE TIMES
T3 - HOST ASSERTS REQUEST	N/A
T4 - SBF DE-ASSERTS READY	T3 → T4 = 50 N.S
T5 - SBF ASSERTS READY	104 USEC ≤ T4 → T5 ≤ 140 USEC
T8 - SBF DE-ASSERTS READY	40 USEC ≤ T6 → T8 ≤ 44 USEC

NOTE:

1. AFTER T9 HOST MUST ISSUE A READ STATUS COMMAND. ANY OTHER COMMAND WILL BE REJECTED BY THE SBF AS AN ILLEGAL COMMAND.

8.0 DATA FORMAT

8.1 QIC-11 DATA FORMAT

This section defines the requirements necessary to ensure interchange at acceptable performance levels when data is written in QIC-11 (8-inch Archive) data format.

8.1.1 DEFINITIONS

azimuth - the angular deviation, in minutes of arc, of the mean flux transition line from the normal to the cartridge reference plane.

bit - a single digit in the binary number system.

bit cell - a length of magnetic recording tape within which the occurrence of a flux transition signifies a "one" bit and the absence signifies a "zero" bit.

block - a group of 512 consecutive bytes transferred as a unit.

BOT - beginning of tape marker indicating beginning of tape.

byte - a group of 8 binary (10 GCR) bits operated on as a unit.

cartridge - a four by six inch enclosure containing 0.250 in (6.30 mm) wide magnetic tape wound on two coplanar hubs and driven by an internal belt which is coupled by an internal belt capstan to the external drive (ref. ANSI X3.55-1977).

cyclical redundancy check - a two byte code derived from information contained in the data block and block number byte and recorded after the data block and block number byte for read after write check and read only check.

density - the maximum allowable flux transitions per unit length for a specific recording standard.

early warning - early warning marker indicating the approaching end of the permissible recording area.

EOT - end of tape marker indicating the end of tape.

erase - to remove all magnetically recorded information from the tape.

file mark - an identification mark following the lst block in a file.

flux transition - a point on the magnetic tape which exhibits maximum free space flux density normal to the tape surface.

flux transition spacing - the distance on the magnetic tape between flux reversals.

group code recording - (GCR) a data encoding method where a 4-bit group of data bits is encoded into a 5-bit group for recording on magnetic tape (ref. ANSI X3.54-1976).

load point - load point marker indicating the beginning of the permissible recording area.

magnetic tape - an oxide coated mylar base tape capable of accepting and retaining magnetically recorded information.

nibble - a group of 4 binary (5 GCR) bits operated on as a unit.

postamble - guard information recorded after the data block.

recorded block - a group of consecutive bits comprising preamble, data block marker, data block, block number, GCR and postamble.

reference tape cartridge - a magnetic tape cartridge selected for a specific property to be used as a reference.

retension - an operation which restores normal tension to the tape wound on the hubs of a cartridge.

streaming - a method of recording on magnetic tape where the tape is continuously moving and data blocks are continuously recorded.

track - a recording strip parallel to the edge of the magnetic tape containing recorded information.

underrun - a condition developed when host transmits or receives data at a rate less than that required by the device or streaming operation.

8.1.2 RECORDING

8.1.2.1 METHOD

The method of recording is the "non-return to zero, change on one" (NRZI) where a "one" is represented by a flux transition occurring in the bit cell and a "zero" is represented by the absence of a flux transition in the bit cell.

8.1.2.2 CODE

Each 8-bit data byte is separated into two 4-bit groups (nibbles). Each 4-bit data nibble is encoded into a 5-bit GCR nibble for recording on the streaming magnetic tape cartridge. The most significant nibble is recorded first. The encoded data has the property that no more than two consecutive "zeros" occur. The translation table for data nibbles (B3, B2, B1, B0) and GCR nibbles (G4, G3, G2, G1, G0) are as follows:

HEX	B3	B2	B1	B0		G4	G3	G2	G1	G0	HEX
0	0	0	0	0	----	1	1	0	0	1	19
1	0	0	0	1	----	1	1	0	1	1	1B
2	0	0	1	0	----	1	0	0	1	0	12
3	0	0	1	1	----	1	0	0	1	1	13
4	0	1	0	0	----	1	1	1	0	1	1D
5	0	1	0	1	----	1	0	1	0	1	15
6	0	1	1	0	----	1	0	1	1	0	16
7	0	1	1	1	----	1	0	1	1	1	17
8	1	0	0	0	----	1	1	0	1	0	1A
9	1	0	0	1	----	0	1	0	0	1	09
A	1	0	1	0	----	0	1	0	1	0	0A
B	1	0	1	1	----	0	1	0	1	1	0B
C	1	1	0	0	----	1	1	1	1	0	1E
D	1	1	0	1	----	0	1	1	0	1	0D
E	1	1	1	0	----	0	1	1	1	0	0E
F	1	1	1	1	----	0	1	1	1	1	0F

8.1.2.3 NOMINAL DENSITY

The maximum nominal recording density (flux transitions in every bit cell) is 10,000 flux transitions per inch (394 flux transitions per millimeter).

8.1.2.4 NOMINAL BIT CELL LENGTH

The nominal bit cell length is 100 microinches (2.54 micrometers).

8.1.2.5 AVERAGE BIT CELL LENGTH

The average bit cell length is the sum of distances between flux transitions over N bit cells divided by N. Any continuously recorded group code pattern may be used to measure the average bit cell.

8.1.2.6 LONG TERM AVERAGE BIT CELL LENGTH

The long term average bit cell length is the average bit cell length taken over a minimum of 900,000 bit cells. The long term average bit cell length is within $\pm 4\%$ of the nominal bit cell length.

8.1.2.7 MEDIUM TERM AVERAGE BIT CELL LENGTH

The medium term average bit cell length is the average bit cell length taken over a minimum of 126 and a maximum of 130 bit cells. The medium term average bit cell length is within ±7% of the long term average bit cell length.

8.1.2.8 SHORT TERM AVERAGE BIT CELL LENGTH

The short term average bit cell length is the average bit cell length taken over a minimum of 39 and a maximum of 43 bit cells.

8.1.2.9 SHORT TERM AVERAGE CELL CENTER LENGTH

The short term average bit cell center is located at a point 1/2 the short term average bit cell length from either egde.

8.1.2.10 REFERENCE BIT CELL

The reference bit cell is the center bit cell in the bit cell group used to measure the short term average bit cell length. Bit cell centers of the bit cell group are positioned such distanced between flux transitions and bit cell centers are minimized ignoring missing flux transitions.

8.1.2.11 DATA AMPLITUDE

The data amplitude is measured at a point 1/2 the short term average bit cell length after each flux transition and will be greater than 25% of the average standard reference amplitude for all flux transitions in each non-rewritten block.

8.1.2.12 ERASURE

The magnetic tape cartridge is AC erased (demagnetized) prior to recording such that no remaining signal amplitude is greater than 3% of the lowest data amplitude.

8.1.2.13 AZIMUTH

The angular deviation of the mean flux transition line from a normal to the magnetic tape cartridge reference base is less than or equal to 3 minutes of arc.

8.1.3 TRACKS

8.1.3.1 NUMBER AND USE OF TRACKS

There are a maximum of nine tracks numbered 0 through 8 as shown in Figure 20.0. Even numbered tracks are recorded serially in the forward direction of tape movement. Odd numbered tracks are recorded serially in the reverse direction of tape movement. On even tracks, all data for interchange is recorded after the load point marker and before the end of tape marker. On odd tracks 3 and 5, all data for interchange is recorded after the nearly warning marker and before the beginning of tape marker. However, on tracks 1 and 7, all data for interchange is recorded between the early warning marker and the load point marker. Tracks are recorded sequentially in the order, 0, 1, 2, ..., 8.

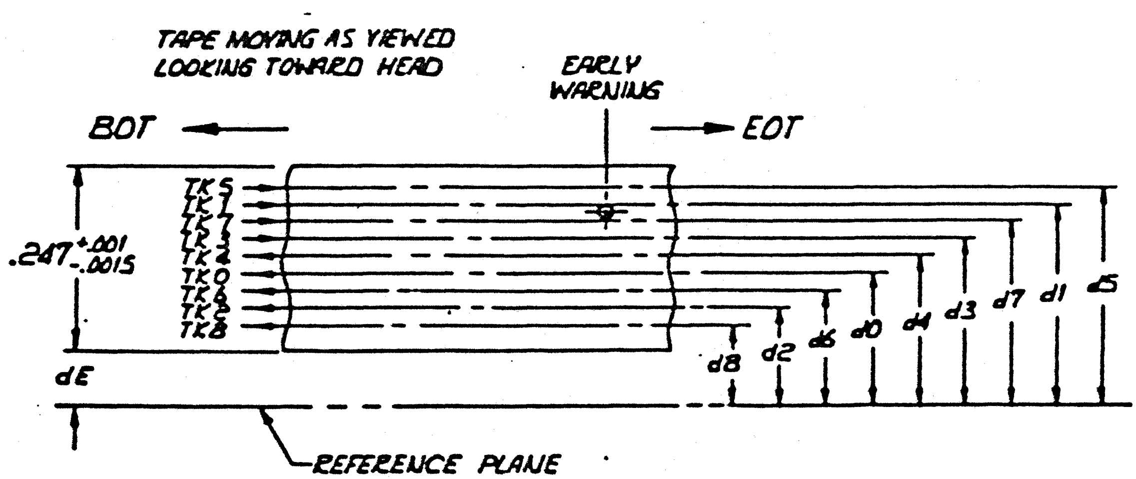
8.1.3.2 REFERENCE PLANE

The top surface of the magnetic tape cartridge base is the reference plane.

8.1.3.3 TRACK CENTER LINE LOCATIONS

The track center lines are located as indicated below:

FIGURE 20.0 TRACK CENTER LINE LOCATIONS



d0 = 0.172 ±0.001 in
d1 = 0.268 ±0.001 in
d3 = 0.124 ±0.001 in
d4 = 0.220 ±0.001 in
d5 = 0.196 ±0.001 in
d6 = 0.292 ±0.001 in
d7 = 0.244 ±0.001 in
d8 = 0.100 ±0.001 in
dE = 0.070 in reference

8.1.3.4 TRACK WIDTH FOR 0.048 IN TRACK SPACING

When an 0.048 in track spacing is used, the number of recorded tracks are limited to a maximum four tracks. The width of the recorded track is 0.036 ±0.002 inches. Th width of the verified recorded track (read after write) is 0.020 ±0.001 inches.

8.1.3.5 TRACK WIDTH FOR 0.024 IN TRACK SPACING

When an 0.024 in track spacing is used, all nine tracks may be recorded. The width of the recorded track is 0.0135 ±0.0005 inches. The width of the verified recorded track is 0.0165 ±0.0005 inches.

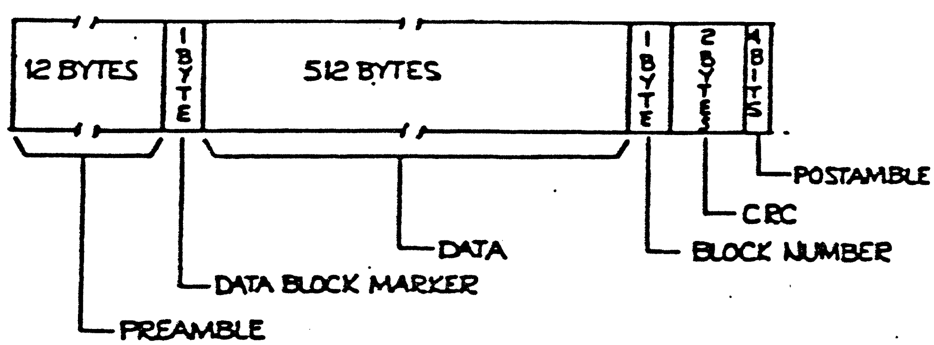
8.1.3.6 INTERCHANGE BETWEEN 0.048 AND 0.024 IN TRACK SPACING

Magnetic tape cartridges recorded with the 0.048 in track spacing provides data interchange with magnetic tape cartridges with the 0.024 in track spacing where the recording has been limited to tracks 0 through 3 subject to the condition that nominal signal amplitudes may be reduced to 70% of normal.

8.1.4 DATA BLOCK

The data block format shall be as follows:

FIGURE 21.0 DATA BLOCK FORMAT



8.1.4.1 PREAMBLE

The preamble contains 120 flux transitions (12 bytes) recorded at the maximum nominal recording density of 10,000 flux transitions per inch (394 flux transitions per millimeter). The preamble is used to synchronize the phase locked loop in the read electronics to the data frequency. The preamble is also used to measure the average preamble amplitude.

A long preamble is used preceding the first data block recorded after an underrun (7.2) and preceding the first data block for interchange recorded at the beginning of a track (8.0).

8.1.4.2 DATA BLOCK MARKER

The data block marker identifies the start of data and consists of the following GCR pattern:

G4	G3	G2	G1	G0	G4	G3	G2	G1	G0
1	1	1	1	1	0	0	1	1	1
MS nibble					LS nibble				

8.1.4.3 DATA BLOCK

The data block contains 512 bytes of data for interchange encoded into GCR bytes in accordance with the CODE.

8.1.4.4 BLOCK NUMBER

The block number uniquely identifies a block over a group of 256 blocks and is used in error detection and tape positioning. The block number is encoded into GCR bytes in accordance with the CODE. The first block on the tape is block 1 and subsequent blocks are numbered sequentially.

8.1.4.5 CYCLICAL REDUNDANCY CHECK

The cyclical redundancy check (CRC) consists of two bytes calculated over the 512 bytes of interchange data and the 1 byte block number starting with all ones CRC initial value and using the CRC generating polynominal:

$$X^{16} + X^{12} + X^{5} + 1$$

The CRC is encoded into GCR bytes in accordance with the CODE.

8.1.4.6 POSTAMBLE

A five flux transition postamble recorded at the maximum nominal flux density is recorded following the CRC as a guard band.

8.1.5 FILE MARK

The file mark block format is identical to the data block format except that the data field contains 512 bytes consisting of the following GCR pattern:

G4	G3	G2	G1	G0	G4	G3	G2	G1	G0
0	0	1	0	1	0	0	1	0	1
MS nibble					LS nibble				

The GCR nibble (00111) is converted to the HEX nibble (1111) to form the data field for CRC generation and checking.

8.1.6 REWRITTEN BLOCKS

Data for interchange is rewritten such that requirements for data interchange are met. Each data and file mark block that do not meet the requirements for interchange is rewritten. A data block is tested for interchange requirements during the read after write check. Writing of block N + 1 begins before the read after write check of block N is completed. If block N satisfies the requirements for interchange, the read after write check of block N + 1 is begun. However, if block N does not satisfy the requirements for interchange, it is rewritten after the writing of block N + 1 is completed. Block N + 1 is also rewritten after block N in order to preserve the sequential order of records. Block N is written up to 16 times before the recording operation is aborted. A sequence of rewritten blocks is shown below.

... N-1 N N+1 N N+1 N+2 ...

8.1.6.1 UNDERRUN, END OF FILE OR END OF TRACK

Streaming operation is normally terminated when underrun, end of file or end of track conditions exist. The normal sequence of recording of blocks N, N + 1, etc. is replaced by the sequence of blocks N, N, etc. until the recording of block N meets the requirements for interchange. When block N is recorded such that the requirements of interchange are met, the associated rewriting of block N is completed and a postamble of 0.354 inches minimum, 0.508 maximum is written as follows:

... N-1 N N ////

Long Postamble
.354" Min.
.508" Max.

Recording in the long postamble begins at 0.309 inches minimum, 0.358 inches maximum from the end of the block preceding the long postamble. A long preamble of 0.209 inches minimum, 0.72 inches maximum is recorded before recording any other field in the block.

Long Postamble

... N-1 N N //// \\\\

Overlap

.309" Min.
.358" Max.

Long Preamble
.209" Min.
.722" Max.

8.1.6.2 FORCED STREAMING

Termination of streaming operation due to underrun may optionally be prevented by continued recording of the last block until end of file or end of track occurs. Standard length format fields are used during forced streaming operation.

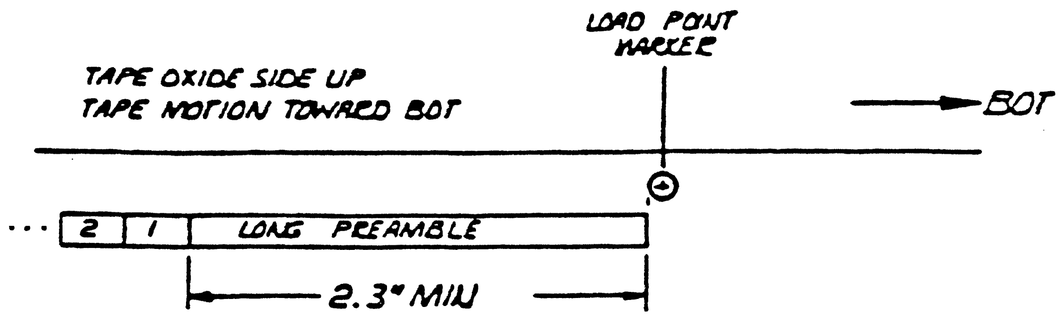
... N-1 N N ... N N ...

8.1.7 BEGINNING OF TRACKS

8.1.7.1 EVEN TRACKS

A long preamble of 2.3 in minimum length is recorded after the load point marker and before the first data block for interchange on all even numbered tracks. It is permissible to substitute redundant data blocks for long preamble.

FIGURE 22.0 EVEN TRACKS



8.1.7.2 ODD TRACKS

A long preamble of 4.0 in minimum length is recorded before the early warning marker on odd numbered tracks. A long preamble of 0.3 in minimum length is recorded after the early warning marker and before the first data block for interchange on odd tracks. It is permissible to substitute redundant data blocks for long preamble.

8.2 QIC-24 DATA FORMAT

8.2.1. SCOPE AND INTRODUCTION

This section defines the QIC-24 format and recording standard for the streaming 0.250 in (6.30 mm) wide magnetic tape cartridge to be used for information interchange among information processing systems, communications systems and associated equipment. Compliance with the standard for the unrecorded magnetic tape cartridge (ref. ANSI X3.55-1977) is a requirement for information interchange.

8.2.2 DEFINITIONS - See Section 8.1.1

8.2.3 RECORDING

8.2.3.1 METHOD - See Section 8.1.2.1

8.2.4 TRACKS

8.2.4.1 NUMBER AND USE OF TRACKS

There are a maximum of nine tracks numbered 0 through 8 as specified in 8.2.4.3. Even numbered tracks are recorded serially in the forward direction of tape movement. Odd numbered tracks are recorded serially in the reverse direction of tape movement. On even tracks, all data for interchange is recorded after the load point marker and before the end of tape marker. On odd tracks 3 and 5, all data for interchange is recorded after the early warning marker and before the beginning of tape marker. However, on tracks 1 and 7, all data for interchange is recorded between the early warning marker and the load point marker. Tracks are recorded sequentially in the order, 0, 1, 2, . . . 8.

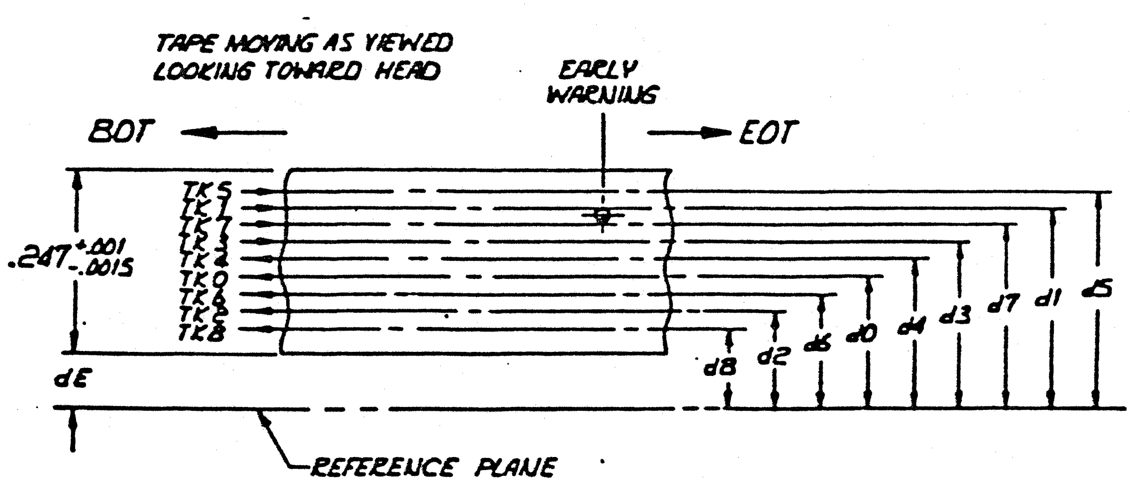
8.2.4.2 REFERENCE PLANE

The reference plane of the magnetic tape cartridge base is the datum for track location.

8.2.4.3 TRACK CENTER LINE LOCATIONS

Track center lines are located as indicated below:

FIGURE 23.0 TRACK CENTER LINE LOCATIONS



d0	=	0.172 $\pm$.0042 in
d1	=	0.268 $\pm$.0042 in
d3	=	0.124 $\pm$.0042 in
d4	=	0.220 $\pm$.0042 in
d5	=	0.196 $\pm$.0042 in
d6	=	0.292 $\pm$.0042 in
d7	=	0.244 $\pm$.0042 in
d8	=	0.100 $\pm$.0042 in
dE	=	0.070 in reference

8.2.4.4 TRACK WIDTH FOR 0.048 IN TRACK SPACING

When an 0.048 in track spacing is used, the number of recorded tracks is limited to a maximum of four tracks. The width of the recorded track is 0.036 $\pm$0.002 inches. The width of the verified recorded track (read after write) is 0.020 $\pm$0.001 inches.

8.2.4.5 TRACK WIDTH FOR 0.024 IN TRACK SPACING

When an 0.024 in track spacing is used, all nine tracks may be recorded. The width of the recorded track is 0.0135 $\pm$0.0005 inches. The verified recorded track width (read after write) is 0.0165 $\pm$0.0005 inches.

8.2.4.6 INTERCHANGE BETWEEN 0.048 AND 0.024 IN TRACK SPACING

Magnetic tape cartridges recorded with the 0.048 in track spacing provide data interchange with magnetic tape cartridges with the 0.024 in track spacing where the recording has been limited to tracks 0 through 3.

NOTE: Nominal signal amplitudes may be reduced due to narrower track width.

8.2.5 DATA BLOCK

The data block format is as follows:

FIGURE 24.0 DATA BLOCK

```
+----/ /----+---+--------/ /--------+-------+---+---------+
:           : 1 :                   :   4   : 2 :         :
:   See     :   :                   :       :   :   See   :
:           : B :                   :   B   : B :         :
: Section   : Y :    512 BYTES      :   Y   : Y : Section :
:           : T :                   :   T   : T :         :
:  8.2.5.1  : E :                   :   E   : E : 8.2.5.6 :
:           :   :                   :   S   : S :         :
+----/ /----+---+--------/ /--------+-------+---+---------+
:___________: : :___________________:   :       :      :
      :       :           :             :       :      :
      :       :           :--DATA       :       :  POSTAMBLE
      :       :                         :       :
      :       :--DATA BLOCK MARKER      :       :--CRC
      :                                 :
      :--PREAMBLE                       :--BLOCK ADDRESS
```

FIGURE 25.0 BLOCK ADDRESS

```
        0                 1                         2                3
 ---------------------------------------------------------------------------
 :                 :             :           :             :              :
 :     Track       :   Control   :           :             :              :
 :    Address      :   Nibble    :           :             :              :
 :                 :             :           :             :              :
 ---------------------------------------------------------------------------
                                 :                                        :
                                 :- - - - - - -   Block Address  - - - - - :
```

BYTE	BITS	FUNCTION
0	7	Track Number Bit 7 (MSB)
	6	Track Number Bit 6
	5	Track Number Bit 5
	4	Track Number Bit 4
	3	Track Number Bit 3
	2	Track Number Bit 2
	1	Track Number Bit 1
	0	Track Number Bit 0 (LSB)
1	7	Control Nibble Bit 3 (MSB)
	6	Control Nibble Bit 2
	5	Control Nibble Bit 1
	4	Control Nibble Bit 0 (LSB)
	3	Block Address Bit 19 (MSB)
	2	Block Address Bit 18
	1	Block Address Bit 17
	0	Block Address Bit 16
2	7	Block Address Bit 15
	6	Block Address Bit 14
	5	Block Address Bit 13
	4	Block Address Bit 12
	3	Block Address Bit 11
	2	Block Address Bit 10
	1	Block Address Bit 9
	0	Block Address Bit 8
3	7	Block Address Bit 7
	6	Block Address Bit 6
	5	Block Address Bit 5
	4	Block Address Bit 4
	3	Block Address Bit 3
	2	Block Address Bit 2
	1	Block Address Bit 1
	0	Block Address Bit 0 (LSB)

8.2.5.1 PREAMBLE

8.2.5.1.1 NORMAL

The preamble contains a minimum of 120 and a maximum of 300 flux transitions recorded at the maximum normal recording density of 10,000 flux transitions per inch (394 flux transitions per millimeter). The preamble is used to synchronize the phase locked loop in the read electronics to the data frequency. The preamble is also used to measure the average preamble amplitude.

8.2.5.1.2 ELONGATED

An elongated preamble contains a minimum of 3500 and a maximum of 7000 flux transitions and precedes the first data block recorded after an underrun (7.2).

8.2.5.1.3 LONG

A long preamble contains a minimum of 15,000 and a maximum of 30,000 flux transitions, and precedes the first data block for interchange recorded at the beginning of a track.

8.2.5.2 DATA BLOCK MARKER

The data block marker identifies the start of data and consists of the following GCR pattern:

G4	G3	G2	G1	G0	G4	G3	G2	G1	G0
1	1	1	1	1	0	0	1	1	1
MS nibble					LS nibble				

8.2.5.3 DATA BLOCK

The data block contains 512 bytes of data for interchange encoded into GCR bytes in accordance with the CODE.

8.2.5.4 BLOCK ADDRESS

The block address consists of 4 bytes which uniquely identify a block recorded on tape. The block address is encoded into GCR bytes in accordance with the CODE, and as defined in Figure 25.0.

8.2.5.4.1 TRACK NUMBER

The track number as specified in Section 8.2.4.3 is recorded in byte 0.

8.2.5.4.2 CONTROL BLOCK

Definition of control block is as follows:

Control Nibble 3 2 1 0	Value	Meaning
0 0 0 0	0	The current block contains user data or file mark.
0 0 0 1	1	The current block contains control information.
0010-1111	2-15	Reserved

NOTE: The use of control blocks as defined herein is an optional feature. It is permissible for a device to recognize and process only blocks with control nibble=0 and to ignore all blocks with control nibble=1 and still meet the requirements for data interchange as specified herein.

8.2.5.4.3 ADDRESS OF BLOCK

The first block on the tape is block 1, and subsequent blocks are numbered sequentially. The block address does not reset at the end of a track.

8.2.5.4.4 CONTROL BLOCK DATA FIELD (OPTIONAL)

When the control nibble equals 1, the current 512-byte date block contains control information. This control information is defined as follows:

BYTE	MEANING
0 (M.S.)	Drive Type 04H = 4-track device 09H = 9-track device

BYTE	MEANING
1	Type of Control Block 00H = None 01H = First block on a track. 02H = Last block on a track. This block may be used to terminate a completed track. 03H = Extended file marks. 04H = Partial block count. This indicates that bytes 2 and 3 specify the number of valid data bytes in the following data block. In the data block, the valid data bytes are recorded first, followed by filler characters. 05-1FH = Reserved. 20-FFH = Not defined.
2	File Mark Number (MSB), or number of data bytes (MSB) in the partial block.
3	File Mark Number (LSB), or number of data bytes (LSB) in the partial block.
4-OF	Reserved (Set to 00H)
10-1FF	Not defined in this document.

NOTE: The use of the partial block option will generate a recorded tape which does not meet the requirements for data interchange at the minimum machine level (QIC-24 with no options).

8.2.5.5 CYCLICAL REDUNDANCY CHECK

The cyclical redundancy check (CRC) consists of two bytes calculated over the 512-bytes of interchange data and the 4-byte block address starting with all ones CRC initial value and using the CRC generating polynominal:

$$X^{16} + X^{12} + X^{5} + 1$$

The CRC is encoded into GCR bytes in accordance with Code.

8.2.5.6 POSTAMBLE

8.2.5.6.1 NORMAL

A normal postamble with a minimum of 5 and a maximum of 20 flux transitions, recorded at the maximum nominal flux density is recorded following the CRC as a guard band.

8.2.5.6.2 ELONGATED

An elongated postamble with a minimum of 3,500 and a maximum of 7,000 flux transitions, recorded at the maximum nominal flux density, is recorded following an underrun sequence.

8.2.6 FILE MARK BLOCK

The file mark block format is identical to the data block format except that the data field contains 512 bytes consisting of the following GCR pattern:

G4	G3	G2	G1	G0	G4	G3	G2	G1	G0
0	0	1	0	1	0	0	1	0	1
MS nibble					LS nibble				

The GCR nibble (00101) is converted to the HEX nibble (1111) to form the data field for CRC generation and checking.

8.2.7 REWRITTEN BLOCKS

8.2.7.1 ERROR

Data for interchange, if written such that all requirements for interchange are not met, is rewritten such that requirements for data interchange are met. Each data and file mark block that do not meet the requirements for interchange is rewritten. A data and file mark block is tested for interchange requirements during the read after write check. Writing of block N + 1 begins before the read after write check of block N is completed. If block N satisfies the requirements for interchange, the read after write check of block N + 1 is begun. However, if block N does not satisfy the requirements for interchange, it is rewritten after the writing of block N + 1 is completed. It shall be permissible to truncate the writing of block N + 1 with postamble before rewriting block N. Block N + 1 is also rewritten after block N in order to preserve the sequential order of records. During error processing of block N, it is permissible to rewrite block N without rewriting block N + 1. A Block in Error shall be written up to 16 times before the recording operation is aborted. Various sequences of rewritten blocks are shown below.

8.2.7.2 UNDERRUN, END OF FILE, OR END OF TRACK

Streaming operation is normally terminated when underrun, end of file, or end of track conditions exist. The normal sequence of recording of blocks N, N + 1, etc., is replaced by the sequence of blocks N, N, etc., until the recording of block N meets the requirements for interchange. When block N is recorded such that the requirements of interchange are met, the associated rewriting of block N is completed or truncated. An elongated postamble (Section 8.2.5.6.2) is written as shown below.

```
...   N-1   N    N    ///////
                         :
                         :--Elongated Postamble
```

Recording in the elongated postamble at 3000 flux transitions minimum, 3500 flux transitions maximum from the end of the block preceding the elongated postamble. An elongated preamble is recorded before recording any other field in the block.

```
                            : --Elongated Postamble
                            :
                            :
                            :
...   N-1   N    N    ////  X  \\\\   ...
                        :   :
                        :   :
                        :   :--Overlap
                        :
                        :      :
                        :      :
3000 Flux Transitions MIN.-- : :
3500 Flux Transitions MAX.     : --Elongated Preamble
```

8.2.7.3 FORCED STREAMING

Termination of streaming operation due to underrun may optionally be prevented by continued recording of the last block until end of file or end of track occurs. Standard length format fields are used during forced streaming operation.

8.2.7.4 END OF RECORDED DATA

On other than the last track, the end of recorded data is indicated by a valid file mark block and optional control blocks followed by a minimum of 45 inches of erased track.

8.2.8 RECORDED TRACKS AT BEGINNING AND END OF TAPE

8.2.8.1 REFERENCE BURST

A track reference burst recorded at the maximum nominal recording density of 10,000 flux transitions per inch (394 flux transitions per millimeter) is written between the BOT holes and recorded data on track 0. The reference burst starts a minimum of 0 inches and a maximum of 15 inches from the BOT hole and extends past the load point hole for a minimum of 3 inches and a maximum of 4 inches. A long preamble precedes the first data block.

8.2.8.2 EVEN TRACKS

All even tracks start a minimum of 3 inches and a maximum of 4 inches past the load point hole. A long preamble precedes the first data block for interchange. On even tracks, no data for interchange is recorded beyond a point 36 inches past the early warning hole.

8.2.8.3 ODD TRACKS

All odd tracks start a minimum of 1 inch and a maximum of 2 inches past the early warning hole. A long preamble precedes the first data block for interchange. On tracks 1 and 7, no data for interchange is recorded past the load point hole. The last block of data for interchange written on these tracks prior to track switching to the next sequential track ends a maximum of 4 inches and a minimum of 0.1 inch before the load point hole is measured from the center line of the hole. On tracks 3 and 5 it is permissible to record data for interchange past the load point hole. No data for interchange is recorded beyond a point 27 inches past the load point hole.

9.0 THEORY OF OPERATION

The Wangtek single-board formatter provides an interface between any host system that conforms to the QIC-02 proposed interface standard and the tape streamers that use QIC-36 interface.

The SBF accepts data from the host in the write mode, formats it into QIC-11 or QIC-24 formats, converts it into GCR code, and sends it to the tape drive via the QIC-36 interface. In the read mode, it reads GCR data from the tape, checks the CRC, decodes the GCR, and sends it to the host via the QIC-02 interface.

Figure 26.0 illustrates a functional block diagram of the Single Board Formatter.

SINGLE BOARD FORMATTER OEM MANUAL
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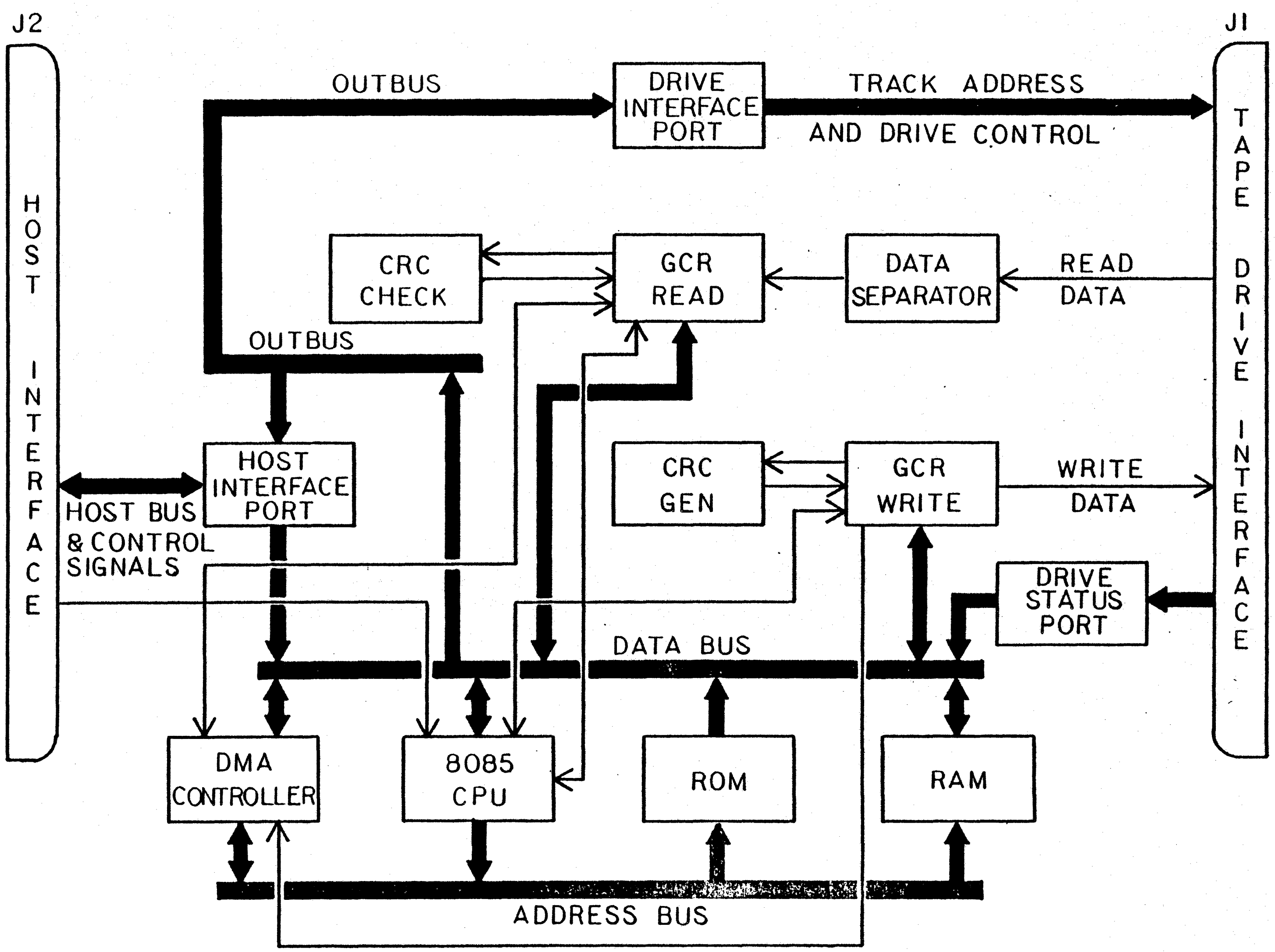


FIGURE 26.0 SINGLE BOARD FORMATTER - BLOCK DIAGRAM

9.1 FUNCTIONAL CIRCUITS

The SBF consists of the following functional circuits:

Host Interface
Tape Drive Interface
8085 Microprocessor
ROM
RAM
DMA Controller
Read Gate Array
Write Gate Array
CRC Gate Arrays
Data Separator

9.1.1 INITIALIZATION FUNCTIONS

The initialization program is stored in the ROM. When power is applied to the SBF or the RSTC signal is asserted by the host, the microprocessor executes the initialization program which does the following:

- Resets the SBF hardware.
- Does a diagnostic check (Checksum test) on ROM.
- Does a diagnostic check (Write/Read test) on RAM.
- Initializes all the tape drives connected to the SBF.
- Clears the SBF status registers.
- Selects Drive 0 for subsequent host commands.
- De-asserts the ACKNOWLEDGE, READY, and DIRECTION signals to the host. (This enables Command Data from host.)
- Asserts EXCEPTION.

9.1.2 HOST INTERFACE FUNCTIONS (QIC-02 Interface)

The host interface of the SBF consists of eight (8) bi-directional command/data bus lines (HB0- through HB7-) and eight (8) control signal lines (RSTC-, ONL-, DIR-, REQ-, RDY-, ACK-, XFR-, and EXC-). These lines are used for communication between the SBF and the host system.

There are three (3) types of communications that take place between the SBF and the host system over the host interface.

9.1.2.1 COMMAND TRANSFERS

When the host issues a command to the SBF, it places the command byte on HB0- through HB7- and asserts REQ-. The SBF responds by reading the command, asserting RDY-, and then de-asserting REY- after the host de-asserts REQ-. This completes the command handshake.

9.1.2.2 READ STATUS

The status byte transfers are accomplished by the RDY-and REQ- signal handshakes for each status byte. The SBF de-asserts EXC- (if asserted), asserts DIR-, places the first status byte on HB0- through HB7-, and asserts RDY-. The host reads the status byte and asserts REQ-, informing the SBF that the byte has been read. This handshake is repeated six times for six status bytes. Upon transfer of the last status byte, the SBF de-asserts DIR- and asserts RDY- for next command.

9.1.2.3 DATA TRANSFERS

For data byte transfers, the handshake signals are XFR-and ACK-. When transferring data to be written on tape, the host asserts XFR- to indicate to the SBF that a byte of data has been placed on the bus. The SBF asserts ACK- to inform the host that the byte was read from the bus. When reading data from the tape, the roles of XFR-and ACK-are reversed.

If an exception condition occurs during any of the above operations, the SBF asserts the EXC- signal to inform the host that an execption condition has occurred.

9.1.3 TAPE DRIVE INTERFACE FUNCTIONS

The SBF communicates with the tape drive over the industry standard QIC-36 interface. The tape drive interface signals can be categorized into three groups: the control signals that are output to the drive; the status signals that are input to the SBF from the drive; and the data signals. The following gives a brief functional description of signals in each category.

9.1.3.1 SBF OUTPUT SIGNALS TO THE TAPE DRIVE

$\overline{\text{RSTD}}$	RESET: This signal, when active low, initializes the tape drive and causes the magnetic recording head to go to the track position closest to the lower edge of the tape.
$\overline{\text{DS0}}$ thru DS2	DRIVE SELECT 0 through 2: These signals are used to select any one of three tape drive units for operation (DS2 not used).
$\overline{\text{GO}}$	GO: This signal, when active low, enables the tape drive motor if the tape drive is selected. Tape motion will not be enabled, however, if REV is high and the tape is at the EOT (end of tape) position or if REV is low and the tape is at the BOT (bottom of tape) position.

$\overline{\text{REV}}$ — REVERSE: This signal output, when high, enables the tape to move from BOT to EOT; when low, tape movement is in the opposite direction.

$\overline{\text{TRK0}}$ thru $\overline{\text{TRK3}}$ — TRACK SELECT 0 through 3: These signals are binary-encoded track-addressing outputs to the tape drive. These signals are used to position the recording head over logically adjacent tracks and enable writing and/or reading the selected track. Tracks 0 through 3 are valid address codes for 9-track drives.

$\overline{\text{WEN}}$ — WRITE ENABLE: This signal, when active low, allows transitions on the write data inputs WDA/WDA* to be recorded on the selected track.

$\overline{\text{EEN}}$ — ERASE/ENABLE: This signal, when active low, causes the tape drive erase bar to be enabled. All tracks are simultaneously erased.

9.1.3.2 STATUS SIGNALS FROM TAPE DRIVE

The SBF controller receives the following status inputs from the tape drive.

$\overline{\text{CIN}}$ — CARTRIDGE INSERTED: This signal input, when active low, indicates that a cartridge is inserted in the tape drive.

$\overline{\text{SLD}}$ — SELECTED: This signal input, when active low, indicates the selected tape drive is powered up and ready for operation.

$\overline{\text{USF}}$ — UNSAFE: This signal input, when active low, indicates that the installed tape cartridge is not write protected (cartridge not set to SAFE position).

$\overline{\text{UTH}}$ and $\overline{\text{LTH}}$ — UPPER TAPE HOLE and LOWER TAPE HOLE: These inputs to the SBF controller provide an indication of the current tape position as indicated below. These status signals are not valid upon initial insertion of tape cartridge until such time that the tape drive is reset or the tape is moved to the EOT or BOT positions.

$\overline{\text{UTH}}$	$\overline{\text{LTH}}$	Interpretation
L	L	Beginning-of-tape position.
L	H	Warning Zone (between load point and early warning hole and BOT).
H	H	In Recording Zone (between load point and early warning hole) if a BOT or EOT was detected since cartridge insertion; otherwise, this code meas "tape position unknown".
H	L	End-of-tape position

$\overline{\text{TCH}}$ TACHOMETER: This signal is a pulse input to the QIC controller whose frequency is proportional to the speed of the tape drive motor. Each TCH pulse represents a movement of approximately 0.14 (±8%) inches of tape past the magnetic recording head. This signal can be used by the controller to determine the current tape speed, how much tape was used, or for other diagnostic purposes.

9.1.3.3 DATA SIGNALS

Signal	Description
WDA- WDA+	WRITE DATA: These signals are differential signal lines containing the information to be recorded on magnetic tape. Data appearing on these signal lines will only be recorded if the write enable ($\overline{\text{WEN}}$) signal line is active. Each change of state in the WDA-/WDA+ signal line recorded as a flux transition on tape.
$\overline{\text{RDP}}$	READ DATA PULSE: This signal input from the tape drive contains the data read from magnetic tape during either a read only or read-after-write operation. Each negative-going edge of the $\overline{\text{RDP}}$ signal line represents a flux transition recorded on magnetic tape.

9.1.4 MICROPROCESSOR

The SBF is controlled by an 8085A-2 microprocessor running at 7.2 MHz input clock frequency. Communications between the microprocessor and other functional blocks of the formatter, such as the RAM, ROM, DMA Controller, WRITE, and READ gate arrays and the host and tape interfaces, is accomplished via an eight-bit bi-directional internal bus. All command handshakes are handled by the microprocessor. Also, all block transfers are initiated by the microprocessor and are then processed by the DMA controller. Since most of the operating functions of the formatter are under microprocessor control, it is possible to configure the formatter to write different tape formats and to handle different commands simply by modifying the firmware residing in the ROM.

9.1.5 ROM

The SBF is designed to accept any of the plug compatible ROM's (JEDEC approved) from 16K (2Kx8) to 128K (16Kx8) in size. No jumpers are required for change in ROM size.

EPROM configuration: One socket is provided for using EPROM chips. The currently used EPROM types are shown (equivalent types may be used).

EPROM type	8 X 4K	Intel 2732
	8 X 8K	Intel 2764 (Standard)
	8 X 16K	Intel 27128

The firmware program executed by the 8085A-2 is contained within the EPROM.

9.1.6 RAM

The SBF is designed to accept either 2K or 8K RAM chips. A jumber change is required to accommodate the different RAM's.

RAM configuration: One socket is provided for using byte-wide static RAM chips. The currently used RAM types are shown below (equivalent types may be used).

RAM type	8 X 2K	AMD 9128-20 (Standard)
	8 X 8K	Hitachi 6264-15P

RAM serves as on-board data buffer and a scratch pad memory storage for the 8085A-2 microprocessor. 2Kx8 and 8Kx8 RAM's provide 3x512 and 15x512 data block buffers, respectively.

9.1.7 DMA CONTROLLER

All data transfers between the formatter RAM and the host system or the basic drive are initiated by the microprocessor but handled by a four-channel 8257 DMA controller. DMA Channel 0 is used to transfer data from RAM to tape via the GCR write gate array. DMA Channel 1 is used to transfer data from the tape via the GCR read gate array to RAM. DMA Channel 2 is used to transfer data between RAM and the host interface. DMA Channel 3 is not used.

9.1.8 GCR READ GATE ARRAY

The GCR read gate array is a semi-custom LSI chip. It performs the GCR decode and serial to parallel conversion necessary to interface with the basic tape drive. It also acts as the sync mark detector and the CRC data error detector during read and read-after-write operating.

The GCR read gate array is designed to interface with both the microprocessor and the DMA controller. The Hold Acknowledge output from the microprocessor is used to differentiate between command and status transfers with the microprocessor and data transfers with the DMA controller. Communication with the microprocessor is via I/O Port B0H and B1H and output ports B2H and B3H. Communication with the DMA controller is on DMA Channel 1.

The GCR read gate array also interfaces with one of the two CRC/ECC gate arrays on the SBF. It passes GCR decoded data to the CRC/ECC and latches the state of the error output at the end of the block.

9.1.9 GCR WRITE GATE ARRAY

The GCR write gate array is a semi-custom LSI device. It performs the GCR encode and parallel to serial conversion necessary to interface with the basic drive. Under firmware control, it also generates the gap and the sync mark. When the formatter is in self-test mode, it acts as a data generator. This device is designed to interface with both the microprocessor and the DMA controller. The Hold Acknowledge output from the microprocessor is used to differentiate between the microprocessor initiated operations and the DMA transfers.

The microprocessor communicates with the GCR write gate array via I/O Port 70H and output Port 71H. The DMA controller communicates via DMA Channel 0.

The GCR write array interfaces with a CRC/ECC gate array to calculate the CRC which is then appended to data written to tape.

9.1.10 CRC GATE ARRAYS

The CRC gate arrays are semi-custom LSI devices. They are capable of calculating a Cyclic Redundancy Check (CRC) character on a serial data stream. Two of these devices are used on the SBF. One is used to append CRC to the data written to tape. The second is used to check the integrity of data read from the tape.

The device used to append CRC to data written is interfaced to the GCR write gate array. At the beginning of each data block, this CRC gate array is initialized via its $\overline{\text{INIT}}$ input by the GCR write array. Data is then shifted serially through the device. At the end of a data block, the GCR write array signals the device to begin outputting the calculated CRC on its Data Out output. This is shifted out serially by the GCR write array's CRC clock.

The device used to check the integrity of data read from tape is interfaced to the GCR read gate array. At the beginning of each data block read, it is initialized via its $\overline{\text{INIT}}$ input. Data and the CRC (appended during the write operation) are then shifted serially through the device. If after the last bit of CRC has been passed to the device its $\overline{\text{ERROR}}$ output is true (low) at this time, an error condition has been detected.

9.1.11 DATA SEPARATOR

The data separator is a high performance phase lock loop (PLL) with the necessary additional logic to track the incoming read data and convert it back into a NRZ data stream and clock. This data stream is then decoded by the GCR read gate array. The data separator utilizes a 4046 PLL chip and various other CMOS FET switches, flip-flops, and other logic elements to perform this function.

9.2 COMMAND SEQUENCE DESCRIPTION

All commands are initiated by the host, and share the same initial sequence of events. The events following acceptance of the command depend upon the specific command issued and the current status of the SBF and drive. This section should also be referred to Interface Timing, Section 7.0.

9.2.1 COMMON COMMAND SEQUENCE

The following commands must be preceded by asserting ONL-(Online):

Read Data
Read File Mark
Write Data
Write File Mark

ONL- must remain asserted until all operation with the selected drive is completed. Deassertion of the ONL- signal during any of the above commands will result in the drive being deselected, and the tape being rewound to BOT.

Errors and completion of the Read Data and Read File Mark commands are indicated by the assertion of EXC- signal in place of the RDY-.

The sequence which takes place in response to a command is as follows:

1. The SBF is in a state waiting for a command, and RDY- is asserted. If the "at-position" flag is set, and ONL- is not asserted, then the controller will deassert RDY-, and perform a BOT sequence described in Section 10.18 prior to reasserting RDY-.

2. If a Write Data, Write File Mark, Read Data, or Read File Mark command is issued, the host asserts ONL-.

3. The host places the command on the data bus and asserts REQ-.

4. The SBF deasserts RDY-, reads the command, and reasserts RDY- to indicate that it has read the command.

5. The host removes the command from the data bus, and deasserts REQ-.

6. The SBF deasserts RDY-.

7. The SBF performs the command.

8. If the command is not valid, or if an error occurs, then the SBF aborts the command, sets the appropriate status bits, and asserts EXC- to notify the host to initiate a Read Status command.

9. When the command is successfully completed, the SBF asserts RDY.

The tape can be at either of two locations at the start of any operational sequences: at logical BOT, or "at-position" point where the tape was stopped by a previous operation.

In the "at-position" case, the SBF firmware sets the "at-position" flag to indicate that any subsequent write or read operation should start with a repositioning sequence to locate the end of the data that has already been written, or read. The "at-position" flag is cleared if the cartridge is at BOT. Current status of the "at-position" flag is not included in the status information returned to the host in response to a Read Status command.

9.2.2 POWER-ON/RESET SEQUENCE

The power-on/reset sequence provides the host with information relating to power-on conditions with the SBF. It also provides a convenient mechanism for initializing the SBF during hardware, and software debugging of the host interface.

The sequence is as follows:

1. The host applies power to the SBF or applies a pulse to the SBF reset line.

2. The SBF hardware asserts EXC-, and deasserts RDY-, DIR-, and ACK-.

3. Diagnostics are performed on ROM (Checksum test) and RAM (read/write test). If either test fails, the SBF will not proceed beyond the diagnostics. It is recommended that the host provide a long timeout (at least 1 second) to detect this failure.

4. Reset is applied to all drives, and the SBF waits a sufficient interval for them to initialize.

5. The SBF initializes all internal parameters, sets default tape drive to Drive 0, and clears the "at position" flag.

6. The Power-on/Reset flag (POR) is set in the status bytes, and the SBF waits for the host to issue a Read Status command. The above steps may require as long as a second to complete. The host should be prepared to wait for a status command response delay of this length.

9.2.3 SELECT COMMAND SEQUENCE

This command allows the host to select one of a maximum of two drives connected to the SBF. Prior to selection of a new drive, the currently selected drive must be at BOT. Selection of a drive turns on the drive select LED. The light remains on until the drive is deselected through completion of one of the following operations: rewinding to BOT or selection of another drive.

Once a drive has been selected, it will be remembered by the SBF even after it has been deselected. Operations following deselection will automatically default to the previously selected drive unless another drive has been selected, and will reselect the drive. Reset will set the default unit to Drive 0.

The sequence of operation is as follows:

1. The host issues the Select command.

2. The SBF checks to determine if the drive being deselected has its cartridge at BOT; otherwise, selection is aborted by setting the Illegal command flag (ILL) and asserting EXC- to notify the host of the error. The BOM flag remains reset.

3. The SBF asserts RDY- to indicate it has completed the command.

9.2.4 READ STATUS COMMAND SEQUENCE

This command provides the host with information about the SBF and the selected drive.

The sequence of operation is as follows:

1. If the SBF has requested that the host read status, then EXC- will be asserted; otherwise RDY- is asserted.

2. The host issues the Read Status command.

3. The SBF deasserts EXC-.

4. The SBF selects the drive and obtains the drive status.

5. The SBF asserts DIR- and transfers six status bytes to the host using RDY- and REQ- handshaking.

6. If the drive was selected when this command was issued, then it remains selected; otherwise, it is deselected.

7. The exception status flags, error counter, and underrun counter are cleared.

8. The SBF deasserts DIRECTION and asserts READY.

9.2.5 REWIND TO BOT COMMAND SEQUENCE

This command allows the host to position the cartridge tape in the selected drive to the BOT position.

The sequence of operations is as follows:

1. The host issues the Rewind to BOT command.

2. If a drive is not already selected, then the last addressed drive is selected.

3. If the drive is not operational with a cartridge present, then the operation is aborted. CNI- and USL status are set and EXC- is asserted.

4. The SBF selects Track 0, sets REV-, clears the at-position flag, and enables the tape drive motor.

5. The SBF waits for an indication from the tape drive that the tape is at BOT.

6. When the BOT hole is detected, the tape is stopped. The drive then moves the tape back between the BOT and LP holes.

7. The at-position flag is cleared.

8. The SBF deselects the drive to turn its LED off. The BOM status is set. The SBF indicates command completion to the host by asserting READY.

9.2.6 INITIALIZE (RETENSION) COMMAND SEQUENCE

This command is used by the host to retension a tape cartridge by winding the tape on the takeup reel and rewinding it to the supply reel at high speed.

Retensioning is recommended by cartridge tape manufacturers prior to writing or reading a cartridge that has been subjected to a change in environment, not used for a prolonged period of time, or when drives are used in frequent start/stop applications.

The sequence of operations is as follows:

1. The host issues the Initialization command.

2. If the drive is not already selected, then the last addressed drive is selected.

3. If a cartridge is not present, then the operation is aborted. The CNI status is set, and EXC- is asserted.

4. The at-position flag is cleared and the cartridge is positioned to BOT. This is accomplished by reversing tape motion until the BOT hole is detected.

5. The SBF selects Track 0, HSD-, and REV for forward tape motion until it is positioned at EOT.

6. The SBF selects HSD- and REV- for reverse tape motion until the tape is positioned at BOT.

7. The tape is stopped, and the drive positions the tape between the BOT and LP holes.

8. The SBF deselects the drive to turn its select LED off. Upon the completion of the command, BOM status is set and RDY- is asserted to the host.

9.2.7 ERASE COMMAND SEQUENCE

This command is used to completely erase the tape before writing on it. It also performs a "retension" function.

The sequence of operations is as follows:

1. The host issues the Erase command.

2. If the drive is not already selected, then the last addressed drive is selected.

3. If a cartridge is not present or is present and write protected, then the operation is aborted, the CNI or WRP status bit is set accordingly, and EXC- is asserted.

4. The at-position flag is cleared and the cartridge is positioned to BOT. This is accomplished by reversing tape motion until the BOT hole is detected.

5. The SBF selects Track 0, HSD-, and REV for forward direction, enables the erase head (EEN-), and positions to EOT.

6. The SBF selects HSD-, selects REV- for reverse direction, disables the erase head, and positions the tape to BOT.

7. The tape is stopped, and the drive then positions the tape between the BOT and LP holes.

8. The SBF deselects the drive to turn the select LED off. Command completion is indicated to the host by the setting of the BOM status and asserting of RDY-.

9.2.8 WRITE DATA COMMAND SEQUENCE

This command provides for the writing of sequential blocks of data to the tape. Blocks are transferred by the host to the SBF where they are buffered and then written to the selected drive.

sequence of operations is as follows:

1. The host asserts ONL-, and issues the Write Data command.

2. The SBF asserts RDY-, indicating to the host that is is ready for data transfers.

3. The SBF checks the at-position flag. If it is not set, a BOT sequence withoug deselection is performed. If the cartridge is write protected, the WRP status is set and the operation is then aborted with EXC- asserted.

4. If the at-position flag is set, the Write Reposition sequence (described in section 9.11) is performed and the recording of data begins at step #7 below. Otherwise, the SBF enables the erase bar to erase the tape ahead of recording new data, initializing at Track 0.

5. The SBF records the reference burst from the BOT hole to approximately 3.5-inches beyond LP hole on Track 0.

6. The SBF records approximately 2.175-inches of long preamble.

7. The SBF begins recording blocks of data on the tape, adding gap, sync, block, address, and CRC. Blocks are numbered sequentially beginning with one. The SBF attempts to keep all buffers filled by initiating a block transfer as soon as a buffer becomes available.

8. As each block reaches the read head, it is checked for errors.

9. After a block has been read without error, its buffer is released for further data reception from the host.

10. Steps 7 through 9 are repeated until the EW hole (in forward) and the LP hole (in reverse) are detected. The SBF then finishes writing the current block, and writes one more block of data.

11. The SBF performs the Last Block sequence (described in Section 9.10), turns the write head off, and continues until it reaches either EOT or BOT. The tape motion is stopped, and if writing track 0, the erase bar is disabled. Data transfers from the host to the SBF buffer are allowed during track turnaround.

12. The SBF requests the transfer of the next three (or fifteen) data blocks, switches to the next track, resumes motion in the opposite direction, and positions to approximately 3.5-inches beyond LP (in forward) or 1.5-inches beyond EW (in reverse). Writing is then continued at step 7.

13. The host concludes the write data sequence at a block boundry when RDY- is asserted by issuing a Write File Mark command or asserting ONL-. These actions will result in the SBF writing and checking the remaining blocks it has buffered and then peforming a Write File Mark sequence (described in section 9.9). If ONL-was deassserted, then the SBF will also perform a BOT sequence after writing the file mark, which will leave the current drive deselected.

14. If the host does not discontinue writing before the end of the last track is encountered, then the SBF performs an End-of-Media sequence as follows:

    a. The EW hole on track 8 is encountered since the tape is positioned at the end of the last track.

    b. The SBF ceases to accept additional data blocks and completes writing the current block.

    c. The SBF sets EOM, asserts EXC- to alert the host, and returns to a command state to wait for the host to issue a Read Status.

    d. After reading the status, the host can issue a Write or Write File Mark command. The SBF will write two (2) additional blocks of data (or File Mark) after detecting EOM. However, it will assert exception after each block.

15. It is the responsibility of the host to keep the SBF streaming by supplying it with data at an appropriate rate. If a full block is not available when it is time to start writing a new block, then the following steps occur:

    a. The buffer underrun counter is incremented.

    b. The SBF concludes writing by performing a Last Block sequence. If a full buffer is available before the conclusion of checking the last block, then writing continues at step #7 with a single block having been written.

    c. If tape motion is stopped, the SBF waits for the host to send it three (or fifteen) data blocks. When they have been received, a Write Reposition sequence is performed.

9.2.9 WRITE FILE MARK COMMAND SEQUENCE

This command will generate a standard length data block with unique codes in the user data field.

The sequence of operations is as follows:

1. The host asserts ONL- and issues the Write File Mark command.

2. The SBF checks the at-position flag. If it is set, a Write Reposition sequence without deselection is performed. Otherwise, a BOT sequence without deselection is performed.

3. The SBF generates a file mark block, and writes it to tape.

4. A Last Block sequence is performed, which again writes the file mark, an extended postamble, and if on track Ø, erases 45 inches of tape.

5. The host is notified of the command completion by the SBF asserting RDY-, and returning to the command state.

9.2.10 LAST BLOCK SEQUENCE

The last block sequence is performed by the SBF during Write Data and Write File Mark commands to record the final data block (or file mark) on the tape.

The sequence of operations is as follows:

1. The read channel is read, checking the last block.

2. The write channel finishes writing the last block, and commences to rewrite the last block.

3. The read channel finishes re-checking the last block. If the block is in error, then the block must be rewritten. This involves incrementing the rewritten block counter. If less than 16 retries have been made, then repeat step 2 to rewrite the block again; otherwise, the writing is aborted.

4. The read channel commences to read, but not to check the final block.

5. The write channel finishes writing the rewritten last block and starts writing the postamble.

6. The read channel finishes reading the rewritten block and reads two milliseconds of postamble, the write head is turned off.

7. If a file mark is being written on track 0, then the erase bar is left enabled and 45-inches of tape is erased (or EOT is reached).

8. Unless recording the last block at the end of other than the last track, the at-position flag is set, the erase bar is disabled, and the tape is stopped.

9.2.11 WRITE REPOSITION SEQUENCE

This sequence is performed during execution of Write Data and Write File Mark commands to continue writing after the tape has been stopped and the at-position flag is set.

The sequence of operations is as follows:

1. The SBF causes the tape to reverse direction, and tape is moved 20-inches (80-inches for more than two consecutive repositions) or to the upper warning hole at the start of the track.

2. The SBF selects the original direction, starts the tape motion, and delays approximately 4.0-inches of tape movement.

3. The SBF searches for block N-1 (last block rewritten) as follows:

    a. Each block is read and its CRC is checked. If it contains a valid CRC, then its address is checked. Reading continues until a record with an address equal to N-1 is located, or until 20-inches of tape passes without reading data.

    b. If no data is detected, then two additional attempts are made to locate block N-1 by returning to step 1 above.

    c. If the block cannot be located, a write abort is performed by initiating a BOT sequence, setting the BNL flag, asserting EXC-, and returning to the command state.

4. The SBF searches for the extended postamble written by the Last Block sequence. If 20-inches of tape pass without detecting a gap, return to step 1 above.

5. When the SBF detects 1 millisecond of postamble, the write head is enabled. If recording on track 0, then the erase head is enabled.

6. An extended postamble of .58-inches is written.

7. The SBF resumes writing.

9.2.12 WRITE ERROR SEQUENCE

Due to the excessive time it takes to reposition a tape, write errors are corrected "on-the-fly", by rewriting the data until it is written and read correctly. Since the read head follows the write head by 0.3-inches, and the inter-record gap is only 0.013-inches, the SBF must begin writing the next record (N+1) prior to the preceding record (N) can be checked. When an error is detected, both records N and N+1 must be rewritten.

Read-after-write check error is processed as follows:

1. The read channel finishes reading block N, and it has a CRC error.

2. The rewritten blocks count is incremented by 2.

3. If 16 attempts have been made to rewrite this block, then the write operation is aborted. This is accomplished by disabling the erase bar, write head, and stopping tape. A BOT sequence is then performed. The UDA flag is set, EXC- is asserted, and the SBF returns to the command state waiting for the Read Status command.

4. The SBF begins reading, but not checking block N+1.

5. The SBF finishes writing block N+1 and begins rewriting block N.

6. The read channel finishes reading block N+1 and starts reading and checking block N.

7. The SBF completes writing and begins rewriting block N+1.

8. The read channel finishes reading block N. If the error occurs again, the above procedure is repeated until the 16 retry limit is exceeded, or a successful read occurs.

9. A successful read enables the continuation of the process. If an end of track is detected during the process it is ignored, and is processed normally upon successful completion of this procedure.

9.2.13 READ DATA COMMAND SEQUENCE

This command provides for the reading of sequential blocks of data from tape. Data is read from the selected drive, checked, and buffered by the SBF. The host then transfers the data to its memory for processing.

The sequence of operations for the Read Data command is as follows:

1. The host asserts ONL-, and issues the Read Data command.

2. The SBF checks the at-position flag. If it is set, then a Read Reposition sequence (section 9.15) is performed, and the reading of data commences. Otherwise, a BOT sequence without deselection is performed.

3. The SBF causes the tape to move forward, until it passes LP, and then begins searching for the first data block.

4. The SBF reads the entire data block to the read buffer, and checks the CRC, and block address. CRC and sequence errors are processed (as described in section 9.17). If the SBF does not read data within 20-inches of tape, it performs a No Data sequence (described in section 9.16).

5. If the CRC and block address are good, then the block is stored in the FIFO queue, and RDY- is asserted to initiate the transfer to the host. After each block is transferred, its buffer is made available for reading. The SBF can retrieve two (or fourteen) whole blocks ahead of the host.

6. Steps 4 and 5 are repeated until either the EOT hole, on even tracks, or BOT hole, on odd tracks are encountered, at which point the following procedure is initiated:

    a. The tape is stopped, and direction is reversed.

    b. Tape is advanced past the LP on even tracks, or the EW hole on odd tracks.

    c. Search for the first block on the track is initiated.

    d. Operation resumes at step 4 above.

7. Reading is terminated when a File Mark is detected. At this point, tape motion is stopped, and the at-position flag is set. Any remaining blocks of data buffered by the SBF are transferred to the host. The SBF then sets FIL status flag, asserts EXC- to alert the host, and returns to the command state.

8. When the SBF is at a block transfer boundary, and RDY-is asserted, the host may terminate the Read Data command by deactivating ONL-. In this case, the SBF terminates data transfer immediately. Any remaining buffers are ignored. RDY- is deasserted and a BOT sequence is performed. RDY- is reasserted and the SBF returns to the command state for further direction from the host.

9. The host may alternatively terminate the Read Data command by issuing a Read File Mark command at the beginning of a data block transfer sequence when RDY-is asserted. In this case, the SBF terminates data transfer on the next block boundary. No further data will be transferred. A Read File Mark sequence (described in section 9.14) is then performed.

10. The host must accept transfer of blocks fast enough to keep the tape streaming or it will stop. This occurs when the host falls two (or fourteen) blocks behind. If this occurs, the buffer underrun counter is incremented, and the tape is stopped. The SBF then waits for the host to complete transfer of all blocks it has queued. The SBF then performs a Read Reposition sequence, and resumes at step 5.

9.2.14 READ FILE MARK COMMAND SEQUENCE

The Read File Mark command is used to position the tape to the next file mark.

The sequence of operation is as follows:

1. The host asserts ONL- and issues the Read File Mark command.

2. The SBF checks the at-position flag. If it is set and the previous operation was a Read Data sequence, then a Read Reposition sequence is performed, and processing skips to step 4 below. Otherwise, a BOT sequence without deselection is performed.

3. The SBF then starts forward, waits for the LP hole to pass, and searches for the first data block.

4. The SBF reads the entire data block to the read buffer, and checks the CRC and block address. If the SBF does not read data within 20-inches of tape, it performs a No Data sequence. CRC and block address sequence errors are processed by a Read Repositioning sequence until a successful read is attained, or until it reaches the 16 retry limit, at which point it aborts the read operation.

5. If the CRC and block are good, then the block is checked to determine if it is a file mark. Data is not transferred to the host. Reading is terminated by the SBF when a file mark is detected by stopping the tape and setting the at-position flag. The SBF then sets the FIL status flag, asserts EXC- to alert the host, and returns to the command state to await a Read Status command.

6. Steps 4 and 5 are repeated until the EOT hole (even tracks), or BOT hole (odd tracks) are encountered. The sensing of either of the holes causes the tape to be stopped, and direction reversed. Then the tape is advanced past the LP (even tracks), or EW (odd tracks) in search of the first data block on the track. Operation then resumes at step 4.

7. The host may terminate the Read File Mark command at any time by deasserting ONL-. A BOT sequence will be performed and the SBF will assert RDY-, and return to the command state.

9.2.15 READ REPOSITION SEQUENCE

The Read Reposition sequence is initiated during Read Data or Read File Mark operations to restart reading a tape with block N after the tape has been stopped. Block N-1 is the last block read. This requires the tape to be backed-up and rereading the last block processed.

The sequence of operations is as follows:

1. Tape motion is started in the reverse direction.

2. Tape is reversed 20-inches (80-inches if two or more consecutive retries or a no data timeout have occurred) or until EOT or BOT holes are sensed.

3. Tape is stopped and restarted in its normal read direction, 0.7-inches of tape is skipped (or until warning holes are sensed), and reading is enabled.

4. Blocks are read and checked. If the block contains a valid CRC, then its address is checked. If block N+2 is found, control is returned to the calling sequence with block N+2 in the read buffer. This will result in a read error sequence being performed. CRC errors are ignored. If a block is not read within 20-inches of tape motion, then a No Data sequence is initiated. Reading continues until block N is read.

5. After block N is found, control is returned to the calling sequence with block N in its buffers.

9.2.16 NO DATA SEQUENCE

The No Data sequence is initiated by the Read Data and Read file Mark command sequences whenever 20-inches of tape have passed while waiting to read without recovering a block.

The sequence of operations is as follows:

1. The SBF has failed to recover a block within 20-inches of tape motion.

2. The SBF causes the tape to be moved back an additional 80-inches (or to a warning hole), and reverses the tape motion in an attempt to read again. If successful, then control is returned to the calling sequence.

3. The SBF then asserts the NDT flag, assert EXC- to alert the host, and returns to the command state awaiting the Read Status command.

9.2.17 READ ERROR SEQUENCE

The Read Error sequence is invoked by the Read Data and Read File Mark command sequences when a block is read with an invalid CRC, or block address.

The control nibble of the data format must be 0 for all data blocks and file marks. Blocks with a non-zero control nibble will be ignored, but must contain a valid track and block address.

If block N contains an error, 15 retries will be made to read this block. If the block cannot be read with 16 retries, then a "hard" error indication is returned to the host. Data written to tape may be in error repeatedly, thus causing a search for a valid block N, until block N+2 is read. When block N+2 is encountered, tape motion is reversed, and then again read forward searching for a valid block N.

The sequence of operations is as follows:

1. The SBF reads the next data block. If a data block is not read within 20-inches, skip to step 4.

2. If the data block contains a valid CRC and the correct block address, and if the retry counter is less than 16, then control is returned to the calling sequence without error.

3. If the data block is in error or is block N+1, then it is skipped and step 1 is repeated.

4. If the block address is greater than N+1, or a no data timeout has occurred, than a retry is initiated as follows:

    a. If the retry counter is at 15, the operation is concluded by skipping to step 5.

    b. If this is the first retry, then the Error Counter status bytes are incremented.

    c. Tape is repositioned by reversing 20-inches (80-inches if two or more consecutive retries have occurred). If BOT or EOT is sensed, tape is again reversed, and moved 1.75-inches beyond LP (even tracks), or 4.35-inches beyond EW (odd tracks).

    d. The balance of the 20-inches (or 80) are backed up. Control is then transferred to step 1 above.

5. After 16 retries to read a block in error, a "hard" read error is returned to the host. This is done by first stopping the tape. The last block read in error is buffered by the SBF (unless this sequence was entered from a Read File command in which case the UDA flag is set, and EXC- is asserted). The UDA and BIE flags are set and EXC- is asserted to notify the host. The SBF returns to the command state awaiting a Read Status command.

9.2.18 BEGINNING-OF-TAPE SEQUENCE

The BOT sequence allows the host to position the tape in the selected drive at the start of Track 0.

The sequence of operations is as follows:

1. The host verifies that RDY- is true, places the rewind to BOT command on the bus, then asserts REQ-.
2. Drive reset RDY- and after reading the command, again sets RDY- to its true state to indicate the completion of the command.
3. Host resets REQ-, and removes the command from the bus. The drive completes the handshake by reasserting RDY-.
4. When the command has been validated the drive selects HSD-, sets reverse direction, clears the at-position flag, enables the capstan motor, and rewinds the cartridge to BOT.
5. The drive asserts RDY- to the host indicating completion of the command.
6. Drive is deselected if the select command selects another device.

10.0 ADJUSTMENT AND ALIGNMENTS

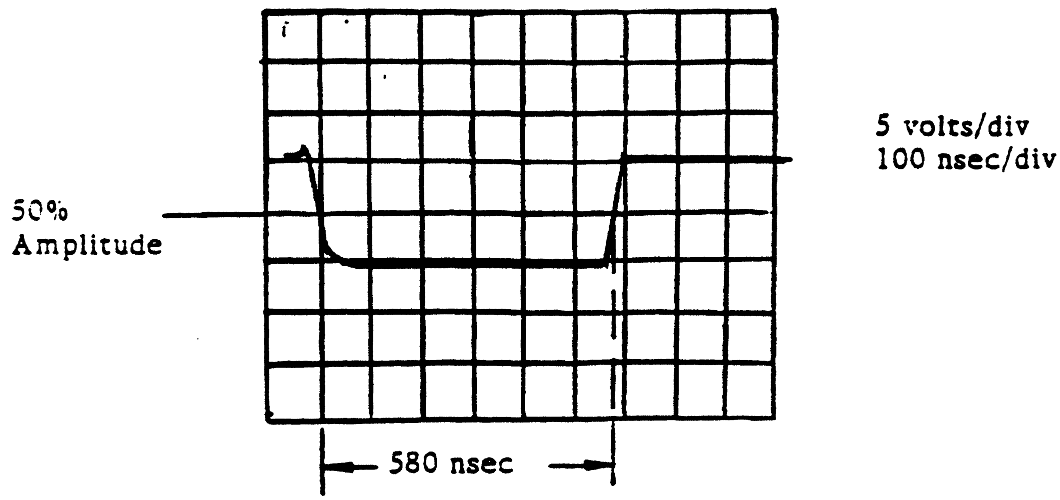
The Wangtek SBF data separator logic requires two adjustments for optimum Phase Lock Loop (PLL) operation.

The following procedure is recommended for adjusting the SBF-I PLL data separator. For SBF-II PLL adjustment, refer to Section 12.0.

EQUIPMENT REQUIRED:

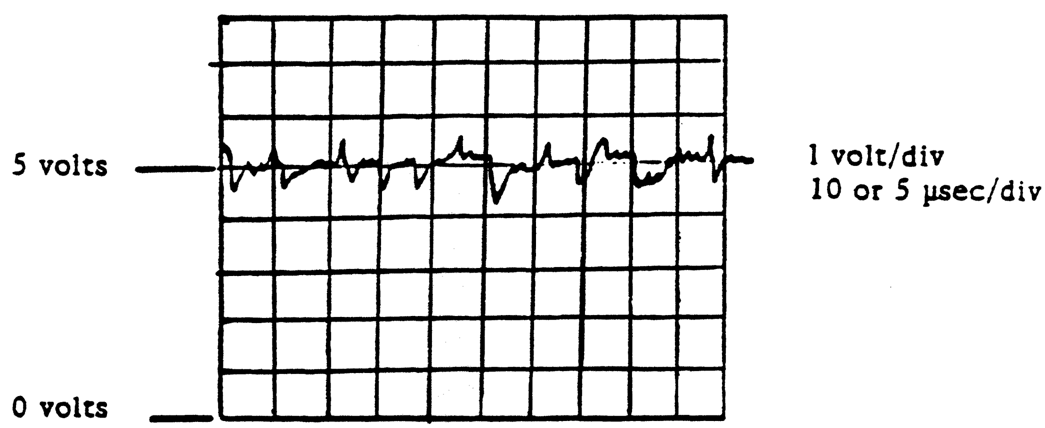
Oscilloscope and two (2) 10X probes
Digital frequency counter
Two (2) IC clips and a miniature clip lead

1. Install an IC clip on IC37, then connect Pin 9 to Pin 7 (ground). This will supply a 900 KHZ signal to the Phase Lock Loop input circuitry.
2. Connect one channel of the oscilloscope to TPI (or IC18 Pin 2) and adjust the trim-pot R15 for a negative pulse width of 580 nsec. (Measure at the 50% amplitude points.)



3. Connect the scope to TP3 (IC17 Pin 9). Adjust the trimming capacitor (C11) for an average DC voltage of 5.0 volts.

   Notice how the settle time of the wave form is at 5 volts DC average.



   (If 5 volts DC cannot be set, check the value of C11, C5, R5, or R6.)

4. With frequency counter on the VCO output TP2 (IC20 Pin 8), measure the frequency range of the VCO.

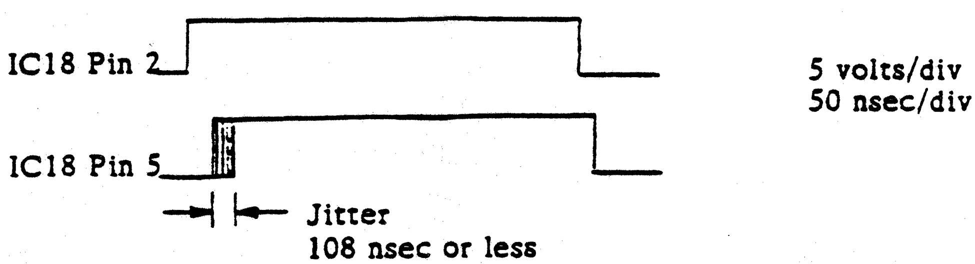
5. Connect IC17 Pin 9 (VCO input) to ground and measure the frequency. Then connect IC17 Pin 9 to +10V (CR3 Cathode) and measure the frequency. (See table for the frequency limits.)

VCO INPUT	FREQUENCY	
Ground 0V	650 KHZ or less	Range $\geq$370 KHz
(CR3 cathode) +10V	1.02 MHz or greater	

6. If the frequency limits are not met, but the range of maximum-minimum is at least 370 KHZ, re-tweek trimming capacitor C11 to center the VCO frequency limits of "650 KHZ or less" to "1.02 MHZ or greater."

7. Check static jitter. Connect both scope probes, one to TPI (IC18 Pin 2) and the other to IC18 Pin 5.

8. Trigger the scope on the positive edge of the signal on IC18 Pin 2 (TPI). Compare the positive going edge of IC18 Pin 5 as shown in the picture.



If jitter is excessive, check for defect in IC17, 18, and 19 or check the value of C4, C3, R4, and R3.

The formatter requires no other adjustment.

10.1 JUMPER SETTINGS

Jumper pins are designated as E1 thru E19.

The following descriptions define the functions of each jumper setting.

Jumpers E1 thru E6 are used to select the SBF (or SBF II) configuration for proper tape drive speed.

Jumper	Tape Drive Speed
E1 to E6	30 IPS (inches per second)
E2 to E5	60 IPS
E3 to E4	90 IPS - Normal

Jumpers E7 thru E10 are used to define RAM size installed in the socket located at IC-25 (SBF-I) or U20 (SBF-II).

Jumper	Setting
E8 to E9	2K byte RAM (standard)
E7 to E10	8K byte RAM

Jumper E11 to E12 is used for selecting the block input for the microprocessor. This jumper is provided for test purposes only.

Jumper	Setting
E11 to E12	ON - Normal mode OFF - Test mode (allows external clock use)

Jumpers E13 thru E16 are used for Wangtek internal test purposes only. These jumpers should not be installed.

Jumper E17 to E18 is used to provide a high coercivity signal input at pin 24 of the QIC-36 interface.

Jumper	Setting
E17 to E18	OFF - Normal mode. ON - For drives that require externally generated high coercivity signal input.

Jumper E19 when installed provides the status of the ninth track to the QIC-02 interface at pin 44. It is installed only as an option. Normally it is not installed.

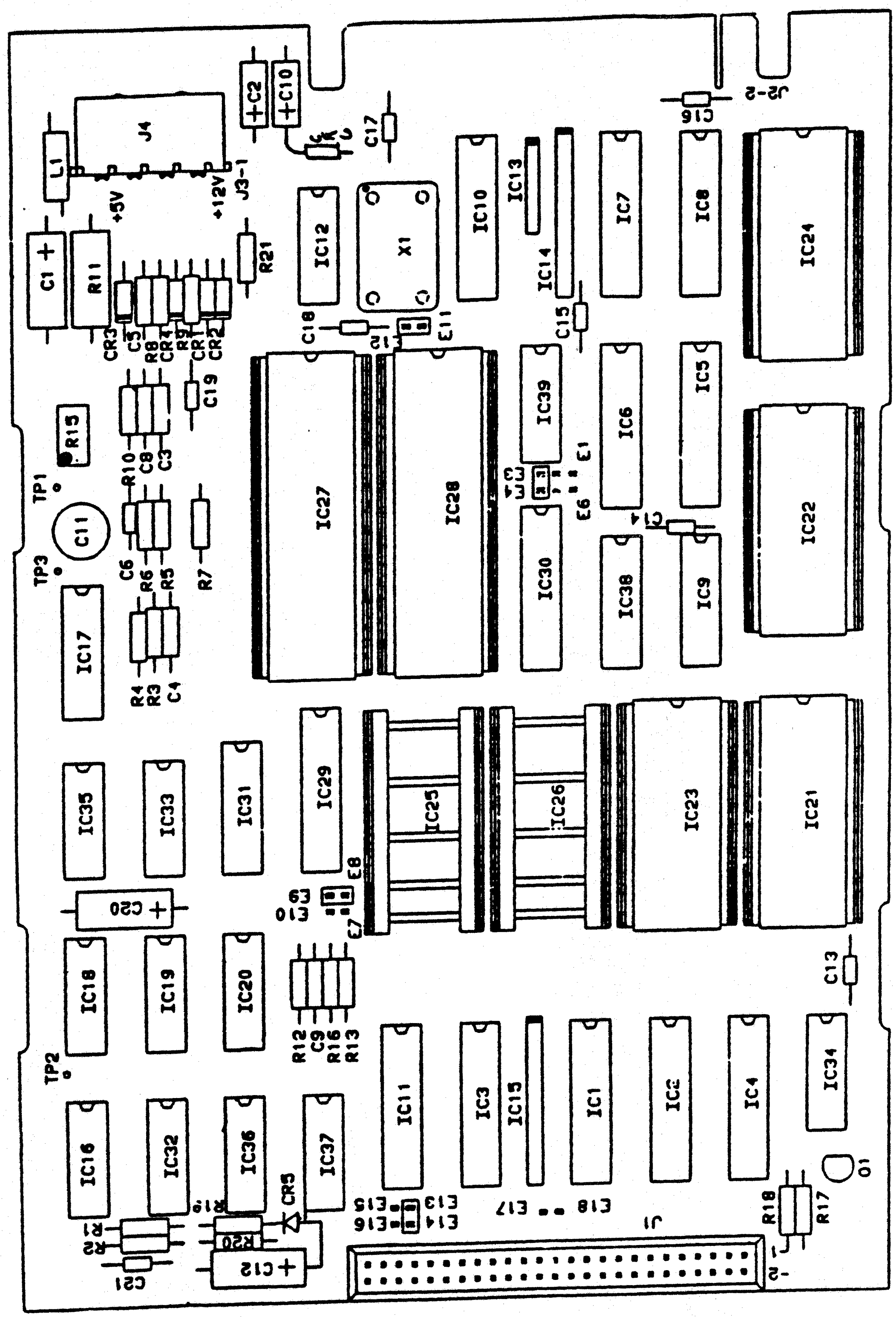
11.0 WANGTEK SINGLE BOARD FORMATTER PARTS LIST (SBF-I)

DESCRIPTION	REFERENCE DESIGNATOR
IC's	
74LS02IC 34	
74LS04	IC 33
74LS08	IC 32
74LS26	IC 37
74LS32	IC 35
74LS74	IC 12,36
74LS92	IC 39
74LS138	IC 31
74LS174	IC 9
74LS240	IC 3,4,5,8,11
74S240	IC 10
74S241	IC 7
74LS257	IC 38
74LS373	IC 29,30
74LS374	IC 6
74S374	IC 1,2
4013B	IC 18,19
4046B	IC 17
4066B	IC 16
4070B	IC 20
8085A-2 MICROPROCESSOR	IC 28
8257-5 DMA CONTROLLER	IC 27
E-PROM, PROGRAMMED	IC 26
STATIC RAM (2K)	IC 25
GATE ARRAY - CRC/ECC	IC 22,24
GATE ARRAY - WRITE	IC 21
GATE ARRAY - READ	IC 23
CAPACITORS	
15-60 PF, Var.	C 11
CER, 27PF, 5% NPO	C 6
CER, 47PF, 10%, NPO	C 4,8,9
.01 MF, AXIAL	C 13-19,21,22
CER, 430PF, 5%, NPO	C 3
CER,.1MF, +80%/-20%, AXIAL	C 5
1 MF, 35V	C 2
4.7 MF	C 10
100 MF, 6V	C 1,12
47 MF, 16V	C 20

11.0 WANGTEK SINGLE BOARD FORMATTER PARTS LIST

DESCRIPTION	REFERENCE DESIGNATOR
RESISTORS	
68, 5%, 1WR 11	
1K, 5%, 1/4W	R 16
3.3K, 5%, 1/4W	R 1,2,7,8,10,12,21
6.8K, 5%, 1/4W	R 22
9.1K, 5%, 1/4W	R 13
10K, 1%, 1/8W	R 4
14.7K, 1%, 1/8W	R 5
24.9K, 1%, 1/8W	R 6
33K, 1%, 1/8W	R 3
300K, 5%, 1/4W	R 9
VAR, 10K, 5%, 1/2W	R 15
220/330 OHM, 10-PIN, SIP	IC 14,15
220/330 OHM, 6-PIN, SIP	IC 13
DIODES	
10V, ZENER, 1/4W, 2%	CR 3
1N270, GERMANIUM	CR 1,2,4,6
DJ1655	CR 5
OSCILLATOR	
7.2 MHZ	X 1
CHOKE	
POWER FILTER	L 1

FIGURE 27.0 SINGLE BOARD FORMATTER LAYOUT (SBF-I)



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	A	ENG RELEASE	8/15/84	CB V.H.
	B	SEE ECO 472	9/17/84	CB V.H.
	C	SEE ECO 503	10/15/84	CB
	D	SEE ECO 532	11/13/84	CB
	E	SEE ECO 534	11/13/84	CB
	F	SEE ECO 587	1/10/84	CB
	G	SEE ECO 594	1/17/85	CB
	H	SEE ECO 608	2/1/85	S.
	J	SEE ECO 717	[illegible]	[illegible]

FIGURE 28
PAGE 89

△4

DESIGNATOR	GND	+V	+10
IC1-IC3, IC5-IC8, IC10, IC29, IC30, IC4, IC11	10	20	
IC9, IC31, IC38	8	16	
IC12, IC33 - IC36, IC32	7	14	
IC16, IC18 - IC20	7		14
IC17	8		16
IC21-IC24	7, 22	15, 28	
IC13	8	1	
IC14, IC15	10	1	
IC39	10	5	
IC28	20	40	
IC27	20	31	
IC25, IC26	14	26, 28	

△5

FUNCTION		CONNECT	NO CONNECTION
90 IPS		E3 TO E4	E1, E2, E5, E6
60 IPS		E2 TO E5	E1, E3, E4, E6
30 IPS		E1 TO E6	E2, E3, E4, E5
IPS OPERATION E1, E2, E3, E4, E5, E6			
2K RAM		E8 TO E9	E7, E10
4K RAM		E7 TO E10	E8, E9
8K RAM		E7 TO E10	E8, E9
2K, 4K, 8K RAM OPERATION E7, E8, E9, E10			
TEST JUMPER		E11 TO E12	
BASIC DRIVE INPUT AT J1-24		E17 TO E18	
TRACK FORMAT OPTION	9 TK		E13, E14, E15, E16
	12 TK	E13 TO E14	E15, E16
READ BASIC DRIVE		E15 TO E16	E13, E14

△3

HIGHEST RESISTOR, CAPACITOR & DIODE USED ON THIS DRAWING		
R24	C22	CR6
NOT USED		
R14	C7	

NOTES.
1. FOR ASSEMBLY SEE 400545
2. UNLESS OTHERWISE SPECIFIED ALL RESISTOR VALUES ARE IN OHMS, 1/4W, 5%. ALL CAPACITOR VALUES ARE IN μF, 50V

△3 HIGHEST USED, NOT USED CHART
△4 POWER AND GND CHART
△5 JUMPER CHART

	QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION
PARTS LIST					

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±
MATERIAL
FINISH
DO NOT SCALE DRAWING

NEXT ASSY	USED ON
APPLICATION	

CONTRACT NO.

APPROVALS	DATE
DRAWN I.J.	8/13/84
CHECKED	8/15/84
ISSUED	

wangtek
SIMI VALLEY, CA 93065

SCHEMATIC, SINGLE BOARD FORMATTER (NT)

SIZE C | FSCM NO. | DWG. NO. 40018 | REV. J
SCALE | SHEET 1 OF 4

DWG. NO. 40018 SH 1 REV

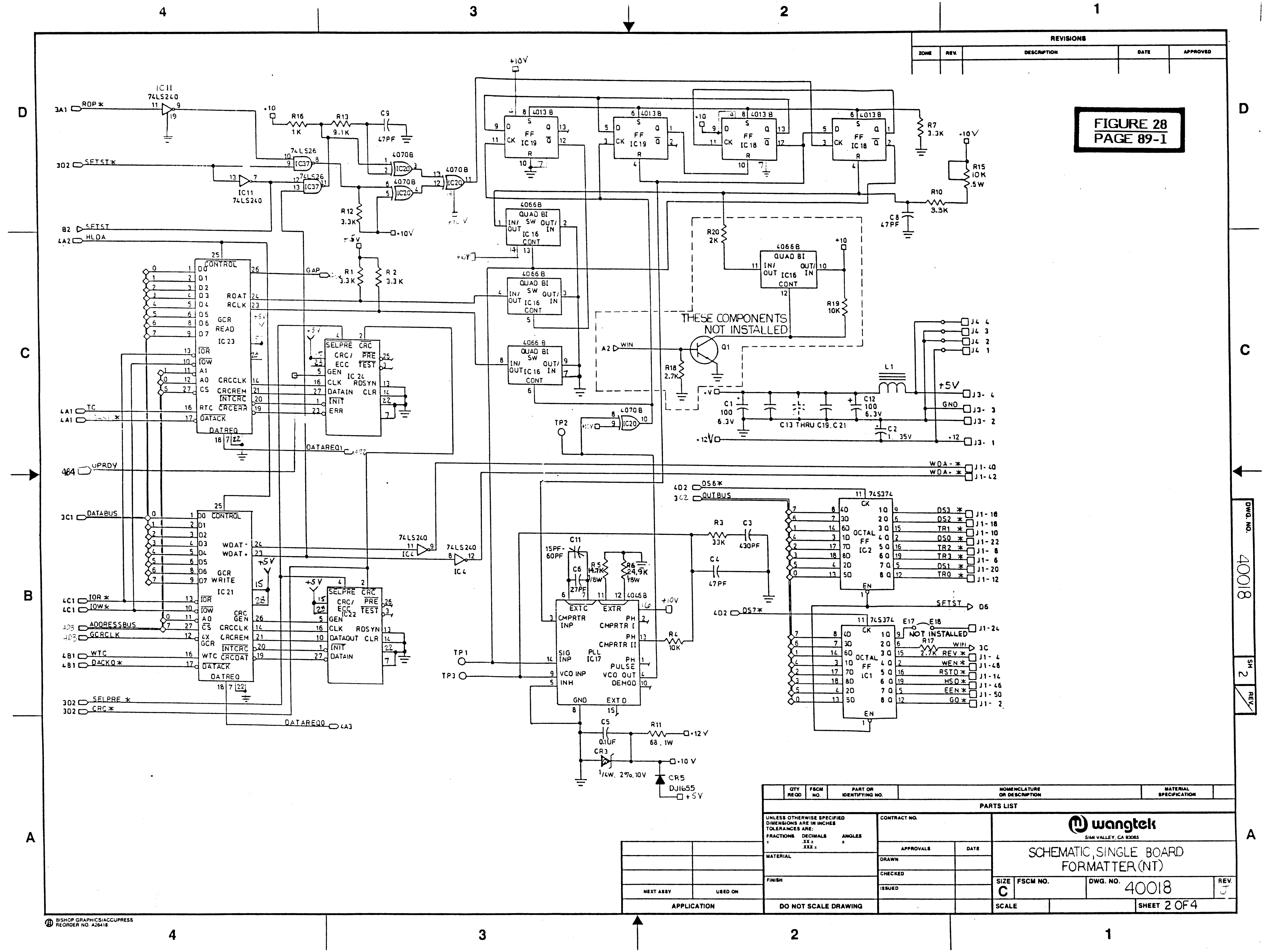
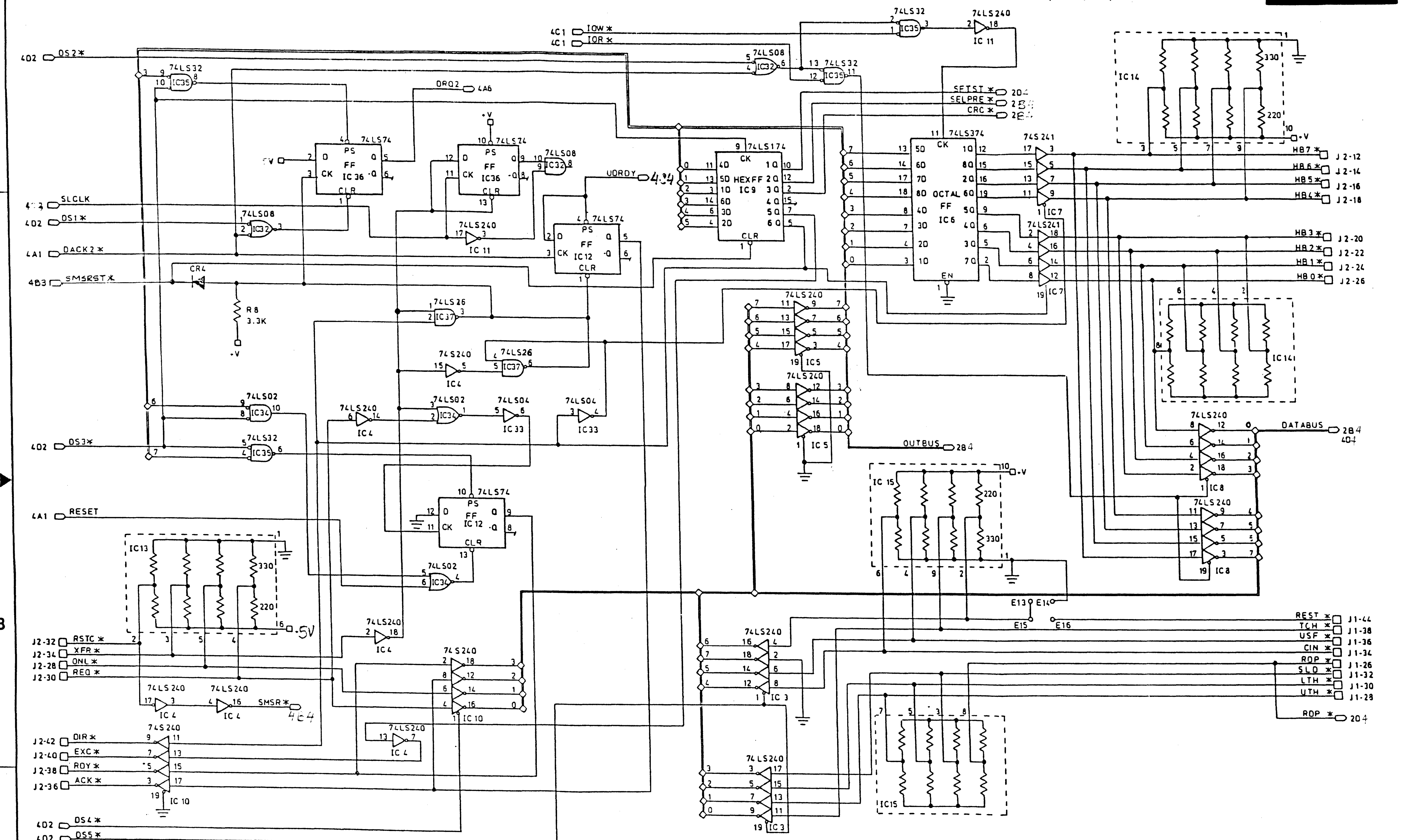


FIGURE 28
PAGE 89-1
REVISIONS
ZONE REV. DESCRIPTION DATE APPROVED
IC11 74LS240
74LS26 IC37
4070B IC20
4013B FF IC19
4013B FF IC18
4066B QUAD BI SW IC16 CONT
GCR READ IC23
GCR WRITE IC21
IC24
IC22
PLL IC17
74S374 OCTAL FF IC2
74S374 OCTAL FF IC1
THESE COMPONENTS NOT INSTALLED
NOT INSTALLED
C13 THRU C19, C21
PARTS LIST
QTY REQD
FSCM NO.
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
MATERIAL SPECIFICATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS
DECIMALS
ANGLES
CONTRACT NO.
APPROVALS
DATE
MATERIAL
DRAWN
CHECKED
FINISH
ISSUED
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
wangtek
SIMI VALLEY, CA 93065
SCHEMATIC, SINGLE BOARD FORMATTER (NT)
SIZE C
FSCM NO.
DWG. NO. 40018
REV.
SCALE
SHEET 2 OF 4
BISHOP GRAPHICS/ACCUPRESS REORDER NO. A26418

FIGURE 28
PAGE 89-2

REVISIONS

ZONE	REV.	DESCRIPTION



QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

CONTRACT NO.

APPROVALS	DATE
DRAWN	
CHECKED	
ISSUED	

wangtek
SIMI VALLEY, CA 93065

SCHEMATIC, SINGLE BOARD FORMATTER (NT)

SIZE	FSCM NO.	DWG. NO.	REV.
C		40018	J

SCALE SHEET 3 OF 4

NEXT ASSY	USED ON
APPLICATION	

DO NOT SCALE DRAWING

DWG. NO. 40018 SH 3 REV

BISHOP GRAPHICS/ACCUPRESS REORDER NO. A26418

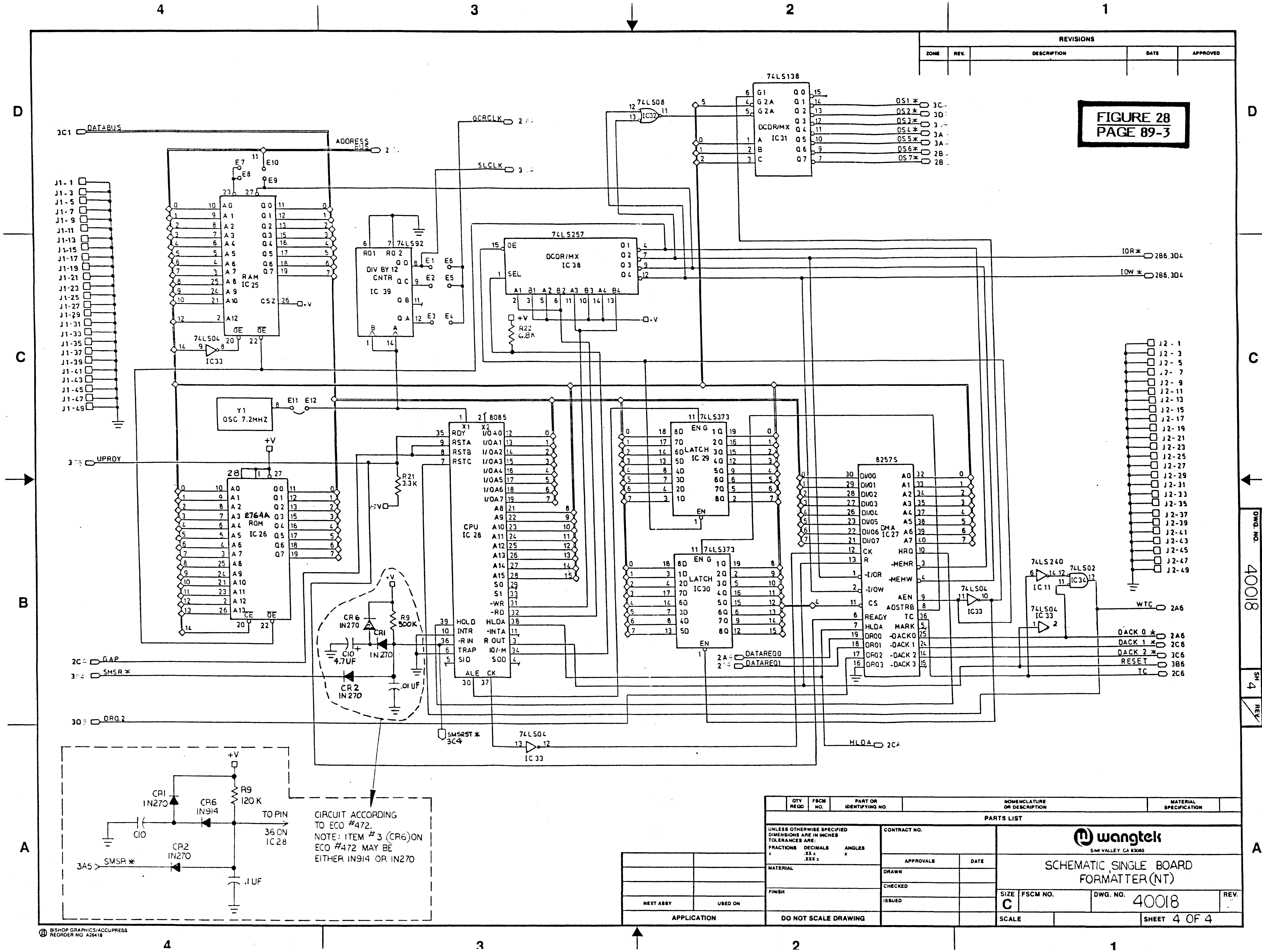


FIGURE 28
PAGE 89-3
REVISIONS
ZONE
REV.
DESCRIPTION
DATE
APPROVED
74LS138
DCDR/MX IC 31
74LS257
DCDR/MX IC 38
74LS92
DIV BY 12 CNTR IC 39
RAM IC 25
2764A ROM IC 26
8085
CPU IC 28
74LS373
LATCH IC 29
LATCH IC 30
8257S
DMA IC 27
Y1 OSC 7.2MHZ
DATABUS
ADDRESS BUS
GCRCLK
SLCLK
UPRDY
GAP
SMSR *
DRQ 2
IOR *
IOW *
WTC
DACK 0 *
DACK 1 *
DACK 2 *
RESET
TC
HLDA
DATAREQ0
DATAREQ1
SMSRST *
CIRCUIT ACCORDING TO ECO #472.
NOTE: ITEM #3 (CR6) ON ECO #472 MAY BE EITHER IN914 OR IN270
TO PIN 36 ON IC28
PARTS LIST
QTY REQD
FSCM NO.
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
MATERIAL SPECIFICATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS
DECIMALS
ANGLES
MATERIAL
FINISH
CONTRACT NO.
APPROVALS
DATE
DRAWN
CHECKED
ISSUED
wangtek
SIMI VALLEY, CA 93065
SCHEMATIC SINGLE BOARD FORMATTER (NT)
SIZE C
FSCM NO.
DWG. NO. 40018
REV.
SCALE
SHEET 4 OF 4
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
BISHOP GRAPHICS/ACCUPRESS REORDER NO. A26418

12.0 PLL ADJUSTMENT PROCEDURE FOR SBF-II

This procedure is designed to optimize the Phase Lock Loop operating points and test for acceptable limits. If a "Single-Board Formatter II" is adjusted per, and meets, the test limits of this specification, it will be able to function with a reasonable level of confidence.

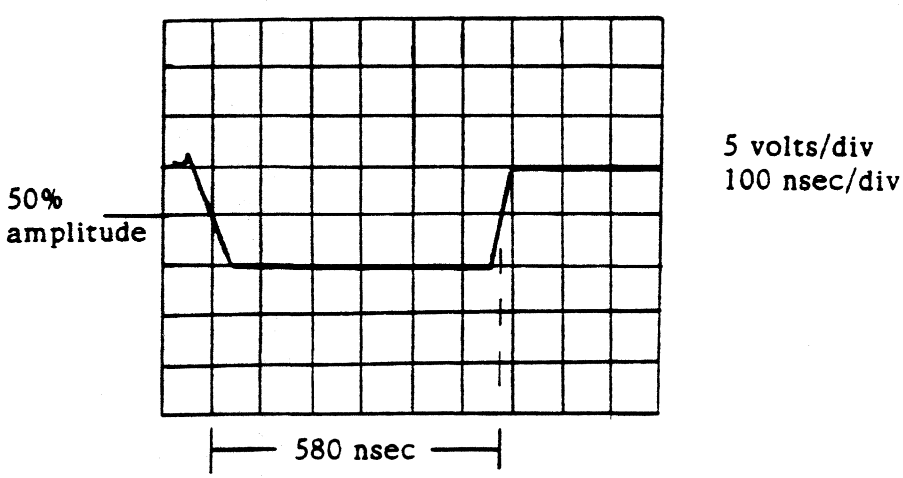
EQUIPMENT

- Oscilloscope and two (2) 10X probes.
- Digital frequency counter.
- Two (2) I.C. clips and a miniature clip lead.
- Digital voltmeter.
- Glyptol or equivalent sealer.

A. Install an I.C. clip on U2, then connect Pin 9 to Pin 7 (ground). This will supply a 900 KHZ signal to the Phase Lock Loop input circuitry.

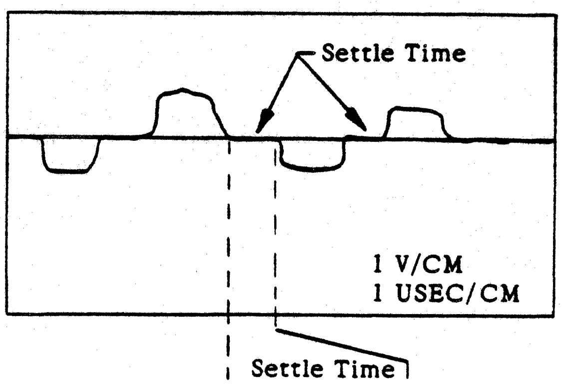
B. Connect one channel of the oscilloscope to TP1 (U33 Pin 12) and adjust the trim-pot R26 for a negative pulse width of 580 nsec. (Measure at the 50% amplitude points.)

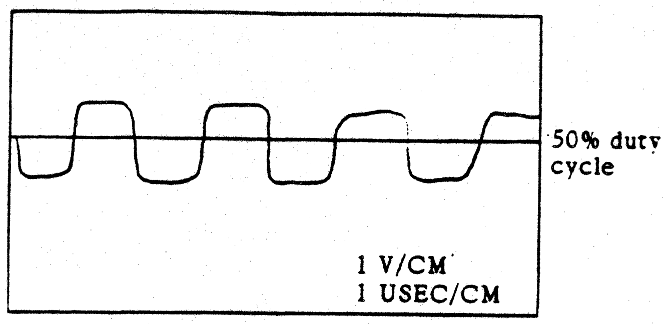
C. Apply glyptol to the trim-pot, insure that the pulse width does not change.



D. NOTE: Prior to starting this adjustment, insure your adjustment tool is made of plastic. No screwdrivers.

Connect the scope to TP3 (U41 Pin 9). Synchronize scope to obtain a steady, single trace display. Adjust the trimming capacitor (C11) for 5 volts at the settle time of the wave form or at the 50% duty cycle, according to the appropriate waveform. Apply glyptol to the capacitor. Insure that the voltage setting does not change.





(If 5 volts DC cannot be set, C22, C19, R29, or R30 may be the wrong value or defective.)

E. With the frequency counter on the VCO output TP2 (U32 Pin 8), measure the frequency range of the VCO.

F. Connect TP3 or U41 Pin 9 (VCO input) to ground and measure the frequency. Then connect TP3 or U41 Pin 9 to +10V (U42 Pin 1) and measure the frequency. (See the table for the frequency limits.)

VCO INPUT	FREQUENCY	
Ground 0V	650 KHZ or less	Range $\geq$370 KHz
U42 Pin 1 +10V	1.02 MHz or greater	

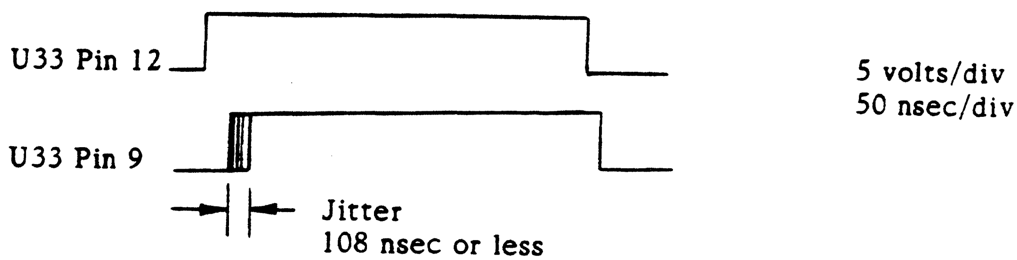
G. If the frequency limits are not met but the range of maximum - minimum is at least 370 KHZ, re-tweek trimming capacitor C22 to center the VCO frequencies to meet the frequency limits of "650 KHZ or less" to "1.02 MHZ or greater".

If the range of 370 KHZ minimum cannot be achieved, check R29 and R30 for proper value.

If the values are correct, suspect a low gain PLL chip (U41).

H. Check static jitter. Connect both scope probes, one to TPI (U33 Pin 12) and the other to U33 Pin 9.

I. Trigger the scope on the positive edge of the signal on U33 Pin 12 (TP1). Compare the positive-going edge of U33 Pin 9 as shown in the picture.



If jitter is excessive, suspect U41, U31, U33, or C20, C21, R31, R32.

13.0 WANGTEK SINGLE BOARD FORMATTER II (SBF-II) PARTS LIST

DESCRIPTION	REFERENCE DESIGNATOR
IC's	
74LS00U4	
74LS02	U26
74LS04	U27
74LS08	U1
74LS26	U2
74LS32	U5
7438	U37
74LS74	U3,35
74LS92	U40
74LS138	U38
74LS174	U17
74LS240	U6,7,8,19,25
74S240	U39
74S241	U24
74S244	U9,10
74LS257	U28
74LS373	U29,30
74LS374	U18
74S374	U15,16
4013B	U31,33
4046B, PLL	U41
4066B	U34
4070B	U32
8085A-2 MICROPROCESSOR	U23
8257-5, DMA CONTROLLER	U22
E-PROM, PROGRAMMED	U21
STATIC RAM (2K)	U20
GATE ARRAY - CRC/ECC	U11,12
GATE ARRAY - WRITE	U14
GATE ARRAY - READ	U13
LM311	U36
VOLTAGE REGULATOR, TL431CP	U42
OSCILLATOR	
7.2 MHZ	Y1
TRANSISTOR	
2N3904	Q1,2,3,4
DIODES	
1N914	CR1,2
1N270, GERMANIUM	CR3

13.0 WANGTEK SINGLE BOARD FORMATTER II (SBF-II) PARTS LIST

DESCRIPTION	REFERENCE DESIGNATOR
CAPACITORS	
0.1 MF RADIAL	C1-4,6-11,15,16
2.2 MF, 6V AXIAL	C5
4.7 MF, 6V AXIAL	C13
47 MF, 16V, RADIAL	C14
47 MF, 6.3V, AXIAL	C12
VAR, 15-60 PF	C22
27 PF, 1% AXIAL	C19
47 PF, 1%, AXIAL	C21
430 PF, 1%, AXIAL	C20
47 PF, +/-5%, AXIAL	C17,18
1 uf, 50V, +/-10%	C23-25
RESISTORS	
68, 5%, .5W	R19
150 OHM, 5%, 1/4W	R2
470 OHM, 5%, 1/4W	R1
750 OHM, 5%, 1/4W	R6
.499, 1%, 1/8W	R28
1K, 5%, 1/4W	R4,13,20,23
1.5K, 1%, 1/8W	R27
3.3K, 5%, 1/4W	R9,10,12,18,R21,24,25
3.9K, 5%, 1/4W	R11
4.7K, 5%, 1/4W	R3,5,8
6.8K, 5%, 1/4W	R17
9.1K, 5%, 1/4W	R22
10K, 1%, 1/8W	R31
VAR, 10K, 5%, 1/2W	R26
14.7K, 1%, 1/8W	R30
24.9K, 1%, 1/8W	R29
33K, 5%, 1/4W	R32
47K, 5%, 1/4W	R16
56K, 5%, 1/4W	R15
100K, 5%, 1/4W	R7
1 MEG, 5%, 1/4W	R14
220/330, 10-PIN, SIP	RP1,2
220/330, 6-PIN, SIP	RP3

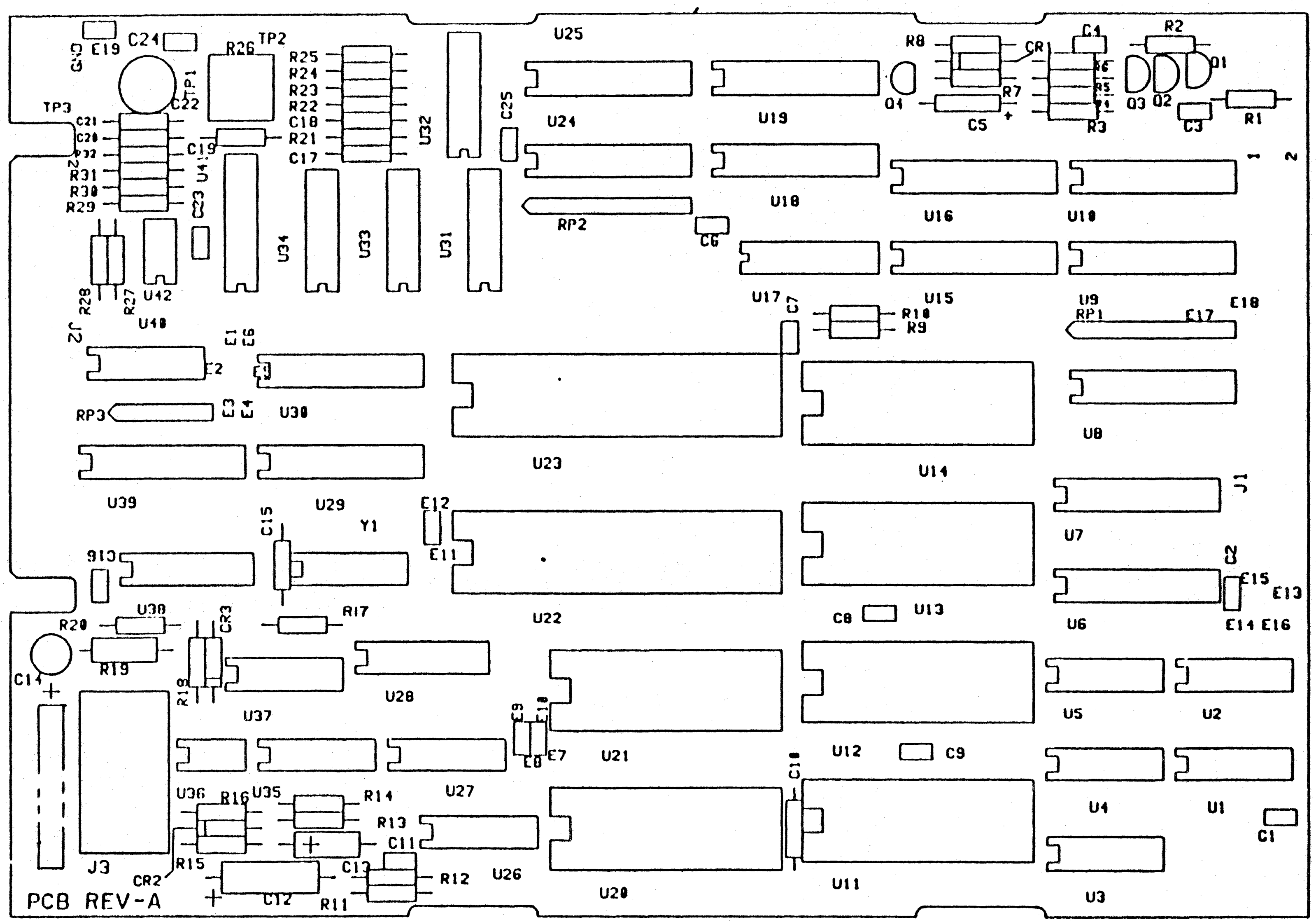


FIGURE 29.0 SBF-II LAYOUT

ZONE	REV.	DESCRIPTION	DATE	APPROVED
	N/C	UNRELEASED	4/17/85	
	A	ENGINEERING REL PER ECO 738	5/6/85	
	A1	SEE ECO 860	7/10/85	S.T.
	A2	SEE ECO 985	8/19/85	S.T.

FIGURE 30
PAGE 96

POWER & GROUND CHART

DESIGNATOR	GND	+5V	+10V
U1, U2, U3, U4, U5, U26, U27, U35, U37, Y1	7	14	—
U6, U7, U8, U9, U10, U15, U16, U18, U19, U24, U25, U29, U30, U39	10	20	—
U36	4	8	—
U42	6	1	—
U11, U12, U13, U14	7, 22	15, 28	—
U20, U21	14	28	—
U17, U28, U38	8	16	—
U22	20	31	—
U23	20	40	—
U40	10	5	—
RP1, RP2	1	10	—
RP3	1	6	—
U31, U32, U33	7	—	14
U34, U41	8	—	16

JUMPER CHART

FUNCTION		CONNECT	NO CONNECT
90 IPS		E3 TO E4	E1, E2, E5, E6
60 IPS		E2 TO E5	E1, E3, E4, E6
30 IPS		E1 TO E6	E2, E3, E4, E5
IPS OPERATION E1, E2, E3, E4, E5, E6			
2K RAM		E8 TO E9	E7, E10
4K RAM		E7 TO E10	E8, E9
8K RAM		E7 TO E10	E8, E9
2K, 4K, 8K RAM OPERATION E7, E8, E9, E10			
TEST JUMPER		E11 TO E12	
BASIC DRIVE INPUT AT J1-24		E17 TO E18	
TRACK FORMAT OPTION	9 TRK		E13, E14, E15, E16
	12 TRK	E13 TO E14	E15, E16
READ BASIC DRIVE		E15 TO E16	E13, E14
TRACK 9 STATUS JUMPER		E19 (OPTIONAL)	

3 FOR ASSEMBLY SEE 30423
2 ALL RESISTOR VALUES ARE IN OHMS, 1/4 W, 5 %
1 ALL CAPACITOR VALUES ARE IN MICROFARADS, 50 V
NOTE: UNLESS OTHERWISE SPECIFIED

QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

NEXT ASSY	USED ON
30423	5000

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

MATERIAL

FINISH

DO NOT SCALE DRAWING

CONTRACT NO.

APPROVALS		DATE
DRAWN	STROH	4/11/85
CHECKED	M. RAJA	5/6/85
ISSUED		

wangtek
SIMI VALLEY, CA 93065

SCHEMATIC
SINGLE BOARD
FORMATTER II (SBF II)

SIZE D | FSCM NO. | DWG. NO. 40048-001 | REV. A2

SCALE — | SHEET 1 OF 4

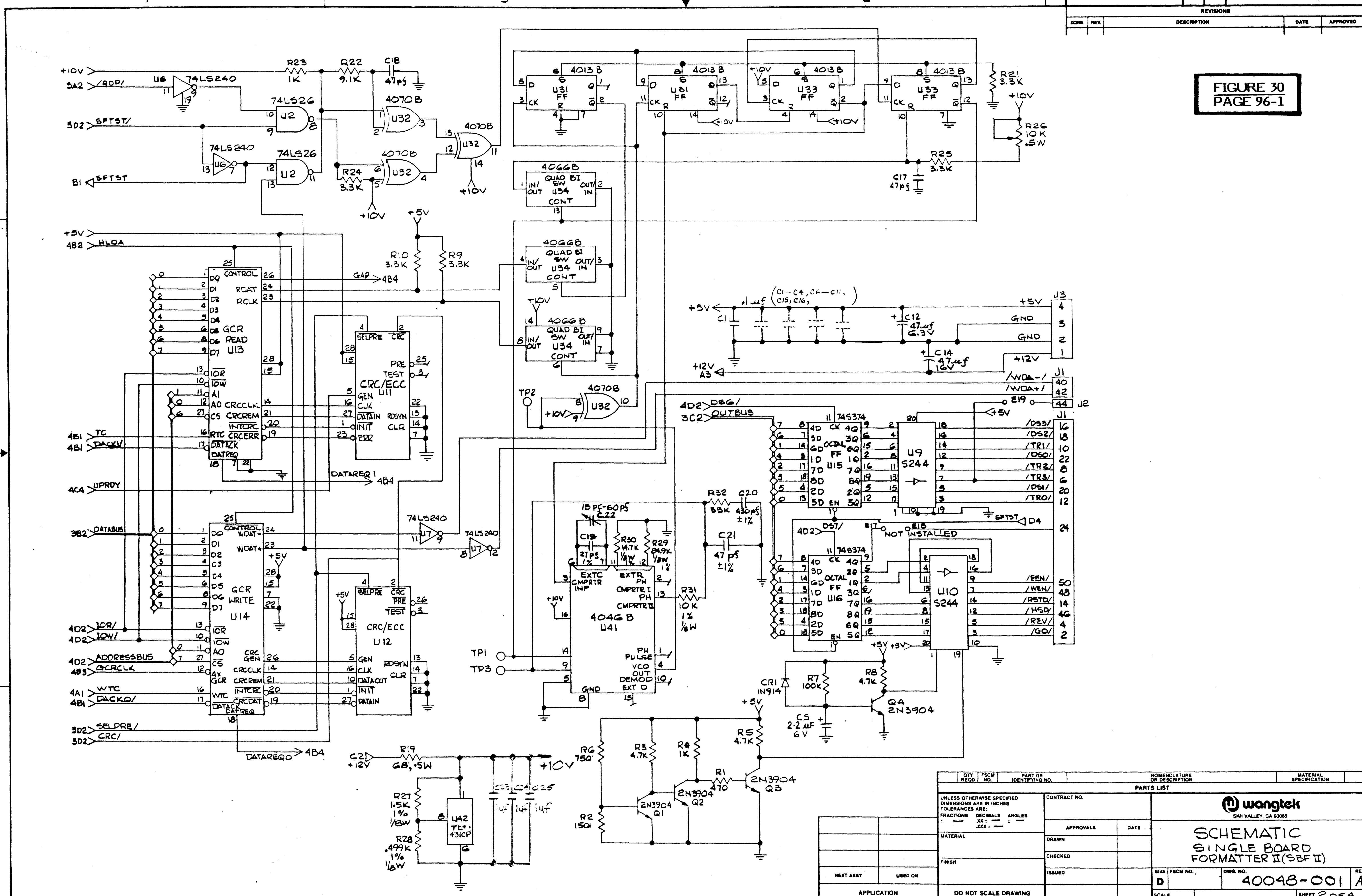


FIGURE 30
PAGE 96-1
REVISIONS
ZONE
REV.
DESCRIPTION
DATE
APPROVED
+10V
3A2 /RDP/
U6 74LS240
R23 1K
R22 9.1K
C18 47pf
3D2 SFTST/
74LS26 U2
4070B U32
B1 SFTST
74LS240 U6
74LS26 U2
R24 3.3K
4013B U31 FF
4013B U31 FF
4013B U33 FF
4013B U33 FF
R21 3.3K
R26 10K .5W
R25 3.3K
C17 47pf
4066B QUAD BI SW U34 CONT
+5V
4B2 HLDA
R10 3.3K
R9 3.3K
CONTROL
RDAT
RCLK
GAP 4B4
GCR READ U13
CRC/ECC U11
SELPRE
CRC
PRE
TEST
GEN
CLK
DATAIN
RDSYN
CLR
INIT
ERR
4B1 TC
4B1 DACK1/
4C4 UPRDY
DATAREQ1 4B4
3B2 DATABUS
GCR WRITE U14
WDAT-
WDAT+
74LS240 U7
CRC/ECC U12
4D2 IOR/
4D2 IOW/
4D2 ADDRESSBUS
4B3 GCRCLK
4A1 WTC
4B1 DACK0/
3D2 SELPRE/
3D2 CRC/
DATAREQ0 4B4
TP2
4070B U32
TP1
TP3
4046B U41
R32 33K
C20 430pf ±1%
C21 47pf ±1%
C22 15pf-60pf
C19 27pf 1%
R30 14.7K 1/8W
R29 84.9K 1/8W 1%
R31 10K 1% 1/8W
(C1-C4, C6-C11, C15, C16)
.1uf
C12 47uf 6.3V
C14 47uf 16V
+12V A3
J3
GND
J1 /WDA-/ /WDA+/
E19
J2
4D2 DEG/
3C2 OUTBUS
74S374 OCTAL FF U15
U9 S244
/DS3/ /DS2/ /TR1/ /DS0/ /TR2/ /TR3/ /DS1/ /TR0/
SFTST D4
4D2 DS7/
E17 E18 NOT INSTALLED
74S374 OCTAL FF U16
U10 S244
/EEN/ /WEN/ /RSTD/ /HSD/ /REV/ /GO/
CR1 1N914
R7 100K
R8 4.7K
Q4 2N3904
C5 2.2uF 6V
R5 4.7K
R6 750
R3 4.7K
R4 1K
R1 470
R2 150
2N3904 Q1
2N3904 Q2
2N3904 Q3
C2 +12V
R19 68, .5W
+10V
R27 1.5K 1% 1/8W
R28 .499K 1% 1/8W
U42 TL431CP
C23 C24 C25 1uf
QTY REQD
FSCM NO.
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
MATERIAL SPECIFICATION
PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS DECIMALS ANGLES
MATERIAL
FINISH
CONTRACT NO.
APPROVALS
DATE
DRAWN
CHECKED
ISSUED
wangtek
SIMI VALLEY, CA 93065
SCHEMATIC
SINGLE BOARD
FORMATTER II (SBF II)
SIZE D
FSCM NO.
DWG. NO. 40048-001
REV. A2
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
SCALE
SHEET 2 OF 4

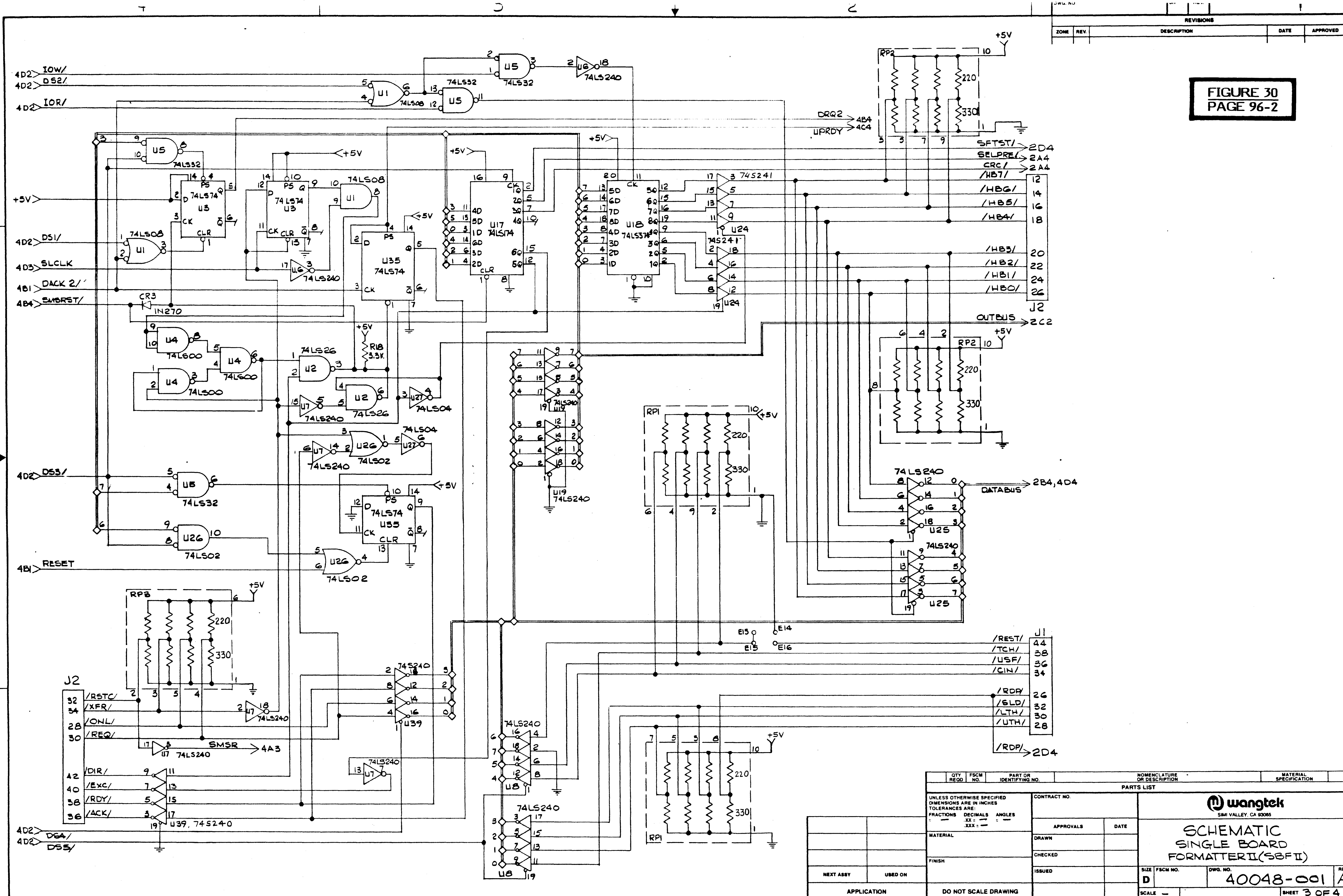


FIGURE 30
PAGE 96-2
REVISIONS
ZONE
REV.
DESCRIPTION
DATE
APPROVED
IOW/
DS2/
IOR/
DS1/
SLCLK
DACK 2/
SMBRST/
DS3/
RESET
DS4/
DS5/
DRQ2
UPRDY
SFTST/
SELPRE/
CRC/
/HB7/
/HB6/
/HB5/
/HB4/
/HB3/
/HB2/
/HB1/
/HB0/
OUTBUS
DATABUS
/REST/
/TCH/
/USF/
/CIN/
/RDY/
/SLD/
/LTH/
/UTH/
/RDP/
/RSTC/
/XFR/
/ONL/
/REQ/
SMSR
/DIR/
/EXC/
/RDY/
/ACK/
J1
J2
74LS32
74LS08
74LS74
74LS240
74S241
74LS374
74LS00
74LS26
74LS04
74LS02
74S240
CR3
1N270
R18
3.3K
RP1
RP2
RP3
220
330
PARTS LIST
QTY REQD
FSCM NO.
PART OR IDENTIFYING NO.
NOMENCLATURE OR DESCRIPTION
MATERIAL SPECIFICATION
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS
DECIMALS
ANGLES
CONTRACT NO.
APPROVALS
DATE
DRAWN
CHECKED
ISSUED
MATERIAL
FINISH
NEXT ASSY
USED ON
APPLICATION
DO NOT SCALE DRAWING
wangtek
SIMI VALLEY, CA 93065
SCHEMATIC
SINGLE BOARD
FORMATTER II (SBF II)
SIZE
D
FSCM NO.
DWG. NO.
40048-001
REV
A2
SCALE
SHEET 3 OF 4

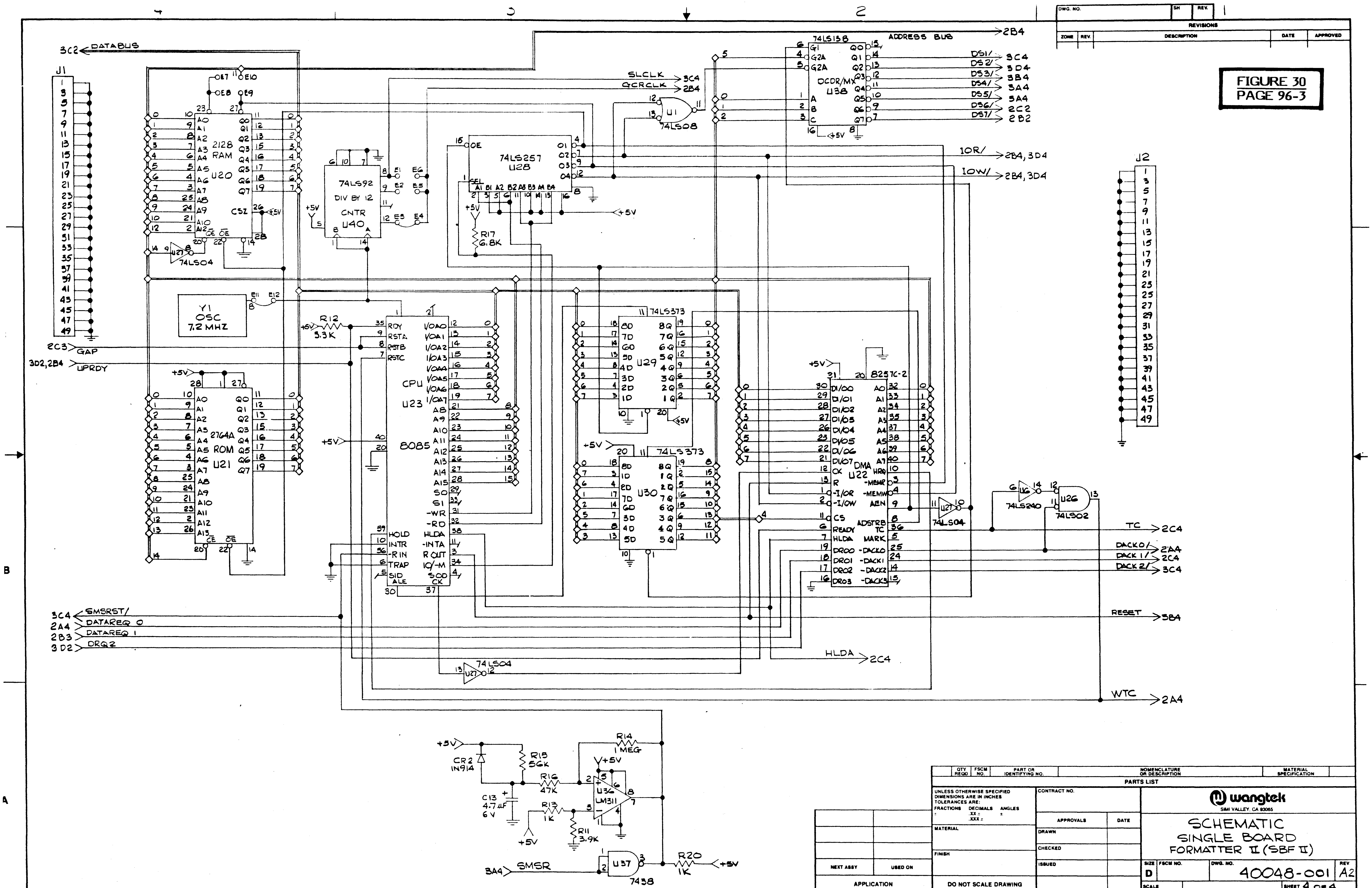


FIGURE 30
PAGE 96-3

14.0 WANGTEK SINGLE BOARD FORMATTER III (SBF-III)

14.1 INTRODUCTION

The Wangtek SBF-III is an enhanced version of the Wangtek Single Board Formatter. Some of the improvements include the following. Major portions of the logic have been consolidated into one gate array chip. Also the four gate arrays comprising of the write, read and CRC gate array have been combined into one gate array. The ground layouts have been reinforced for better PLL performance. A jumper has been added to provide optional status of the ninth track (or the last track) to the QIC-02 interface.

14.2 PLL ADJUSTMENTS AND JUMPER CONFIGURATION - SBF-III

This procedure is designed to optimize the Phase Lock Loop operating points and test for acceptable limits. If a "Single Board Formatter III" is adjusted per and meets the test limits of this specification, it will be able to function with a reasonable level of confidence.

14.2.1 EQUIPMENT ADJUSTMENT

a. Remove the jumper from E2-3.

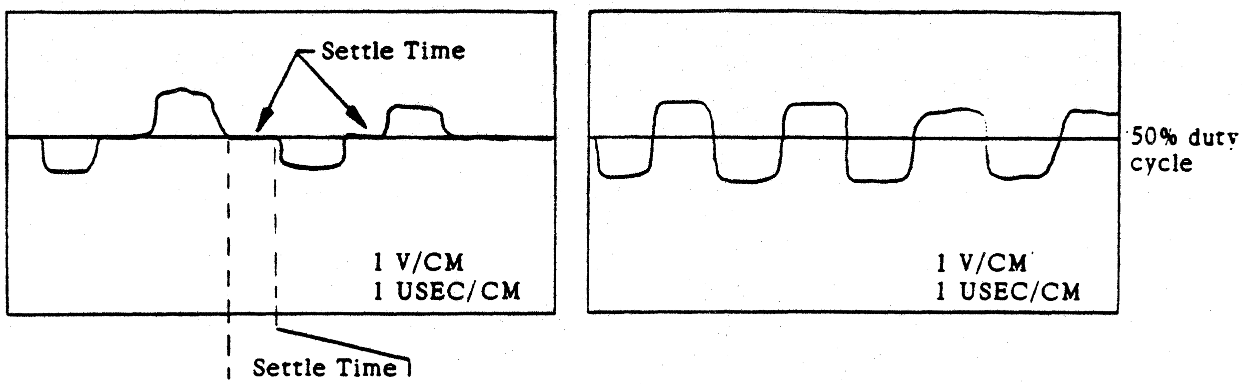
b. Install a jumper on E1-2. This will supply a 900 KHz signal to the Phase Lock Loop input circuitry.

c. Connect one channel of the oscilloscope to TP1 (U14 Pin 12) and adjust the trim-pot R20 for a negative pulse width of 580 nsec. (Measure at the 50% amplitude points).

d. Apply glyptol to the trim-pot, insure that the pulse width does not change.

Note: Prior to starting this adjustment, insure your adjustment tool is made of plastic. No screw drivers.

Connect the scope to TP3 (U16 Pin 9). Synchronize scope to obtain a steady, single trace display. Adjust the trimming capacitor (C16) for 5 volts at the settle time of the waveform or at the 50% duty cycle, according to the appropriate waveform. Apply glyptol to the capacitor. Insure that the voltage setting does not change.



(If 5 volts DC cannot be set, C22, C19, R29, or R30 may be the wrong value or defective).

14.3 FINAL FREQUENCY ADJUSTMENT

a. With frequency counter on the VCO output TP2 (U12 Pin 8), measure the frequency range of the VCO.

b. Connect TP3 or U16 Pin 9 (VCO input) to ground and measure the frequency. Then connect TP3 or U16 Pin 9 to +10V (U17 Pin 1) and measure the frequency. (See table for the frequency limits.)

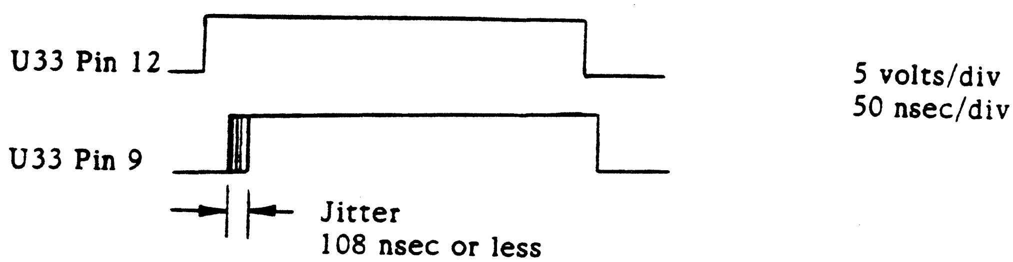
VCO INPUT	FREQUENCY	
Ground 0V	650 KHZ or less	Range $\geq$370 KHz
(CR3 cathode) +10V	1.02 MHz or greater	

c. If the frequency limits are not met, but the range of maximum-minimum is at least 370 KHz, re-tweek trimming capacitor C22 to center the VCO frequencies to meet the frequency limits of "650 KHz or less" to "1.02 MHz or greater".

If the range of 370 KHz minimum cannot be achieved, check R23 and R24 for the proper value. If the values are correct, suspect a low gain PLL chip (U16).

d. Check static jitter. Connect both scope probes, one to TP1 (U14 Pin 12) and the other to U14 Pin 9.

e. Trigger the scope on the positive edge of the signal on U14 Pin 12 (TP1). Compare the positive going edge of U14 Pin 9 as shown in the picture.



If jitter is excessive, suspect U16, U13, U14 or C18, C17, R21, R22.

f. Remove the jumper from E1-2 and install it on E2-3.

14.4 WANGTEK SINGLE BOARD FORMATTER-III (SBF-III)

Wangtek is pleased to release the Single Board Formatter-III (Assembly No. 30425-XXX), an enhanced version of the Wangtek Single Board Formatter. This application note defines some of its features. Section I enumerates enhancements, Section II gives the jumper definitions and Section III shows the board layout with standard jumper configurations.

ENHANCEMENTS

Higher output driver current for QIC-36 interface to increase noise immunity.

Improved regulator circuitry for higher regulation tolerance insuring better PLL tracking.

Improvement on the VCO referenced voltage and reinforced ground layouts enhancing PLL performance.

An optional status to provide the ninth track (or last track) to the QIC-02 interface (Jumper E4 to E5).

Consolidation of major portions of logic into gate arrays.

14.4 JUMPER DEFINITIONS

14.4.1 PLL ADJUSTMENT JUMPERS

Jumpers E1 through E3 are used for PLL adjustment on the board.

Jumper	Setting
E1 to E2	Connect E1 to E2 and disconnect E2 to E3 for PLL adjustment.
E2 to E3	Connect E2 to E3 and disconnect E1 to E2 (standard).

14.4.2 TRACK NINE STATUS JUMPER

Jumpers E4 and E5 allows a track nine status input signal at the QIC-02 host interface.

Jumper	Setting
E4 to E5	Not installed - standard. Installed - optional (provides the status of the ninth track at pin 44 of the QIC-02 interface).

14.4.3 RAM SELECTION JUMPERS

Jumpers E7 through E10 are used for addressing the different RAMs that can be used on the formatter.

Jumper	RAM Size
E8 to E9	2 Kbyte RAM - standard
E7 to E10	4 Kbyte or 8 Kbyte RAM

14.4.4 8085 CPU CLOCK INPUT JUMPER

Jumper E11 to E12 allows an external clock input to the micro-processor on the formatter for test purposes.

Jumper	Setting
E11 to E12	Installed - normal mode. Not Installed - test mode (always external clock input).

14.4.5 TRACK FORMAT OPTION JUMPER

Jumper E13 to E14 allows the formatter firmware to use bit 6 of the drive status port as a track format option bit for 12 track drives. This jumper is for Wangtek internal use only. Normally it is not installed.

14.4.6 THRESHOLD SELECTION JUMPER

Jumper E15 and E16 allows an external control for the threshold selection in the drive electronics. This jumper is for Wangtek internal use only. Normally it is not installed.

14.4.7 HIGH COERCIVITY SELECT JUMPER

Jumper E17 and E18 allows an externally generated high coercivity signal input at pin 24 of the QIC-36 basic drive interface.

Jumper	Setting
E17 to E18	Not installed - standard. Installed - optional (requires special firmware).

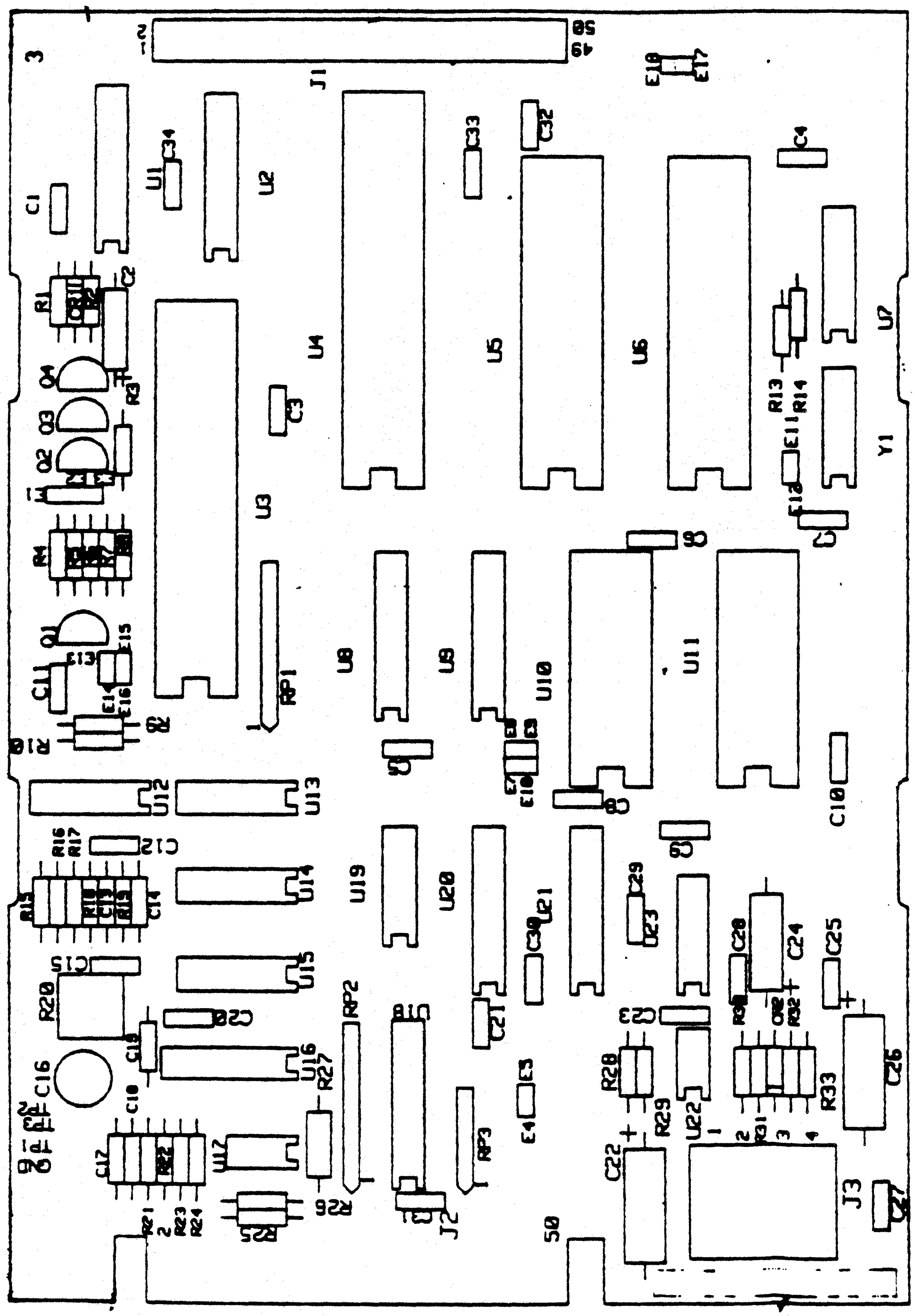
15.0 WANGTEK SBF-III PARTS LIST

DESCRIPTION	REFERENCE DESIGNATOR
Socket, Dip-Solder Tail (28 Pin)	U10, 11
Header, Right Angle	J3
Header, Single Row, 1 Pin	TP1, TP2, TP3, GND
Header, Double Row (50 Pin)	J1
Header, Double Row (2 Pin)	E4-5, E11-12, E8-9, E7-10, E13-14, E15-16, E17-18
Header, Single Row, 3 Pin	E1, E2, E3
Socket, Dip, Solder Tail (48 Pin)	U3, U4 (Optional)
IC, Gate Array, Read/Write	U4
IC, Gate Array, Glue Logic	U3
IC, 8085A Microprocessor	U6
IC, 8257-5 DMA Controller	U5
IC, Static RAM, 2K	U10
IC, EPROM-Programmed	U11
IC, TL431CP Voltage Regulator	U17
IC, 4070B	U12
IC, 4066B	U15
IC, 4013B	U13, U14
IC, 4046B, PLL	U16
IC, 74LS373	U8, U9
IC, 74LS240	U20, U21
IC, 74LS257	U7
IC, 74LS26	U19
IC, 74S244	U1, U2
IC, 74LS02	U23
IC, 74LS245	U18
IC, LM311	U22
Oscillator, 7.2 MHz	Y1
Transistor, 2N3904	Q1, Q2, Q3, Q4
Diode, 1N914, Switching	CR1, CR2
Capacitor, 0.1 MF Radial Lead	C1, C3-11, C21, C23, C25
Capacitor, 2.2 MF, 6V, Axial	C2
Capacitor, 4.7 MF, 6V Axial	C24
Capacitor, 47 MF, 25V, Axial	C22
Capacitor, 47 MF, 6.3V, Axial	C26
Capacitor, Variable, 15-60 PF	C16
Capacitor, 27 PF, ±5% Axial	C19
Capacitor, 47 PF, ±5% Axial	C13, C14, C17
Capacitor, 430 PF, ±5% Axial	C18
Capacitor, 1 MF, 50V, ±10%, Radial	C12, C15, C20
Resistor, 5%, 1/2W (68 Ohm)	R27
Resistor, ±5%, 1/4W (150 Ohm)	R4

15.0 WANGTEK SBF-III PARTS LIST

DESCRIPTION	REFERENCE DESIGNATOR
Resistor, ±5%, 1/4W (470 Ohm)	R3
Resistor, ±5%, 1/4W (750 Ohm)	R5
Resistor, 1%, 1/8W (0.499K Ohm)	R25
Resistor, ±5%, 1/4W (1K Ohm)	R8, R17, R32, R28
Resistor, 1%, 1/8W (1.5K Ohm)	R26
Resistor, ±5%, 1/4W (3.3K Ohm)	R9, R10, R14, R15, R16, R19
Resistor, ±5%, 1/4W (3.9K Ohm)	R33
Resistor, ±5%, 1/4W (4.7K Ohm)	R2, R6, R7
Resistor, ±5%, 1/4W (6.8K Ohm)	R13
Resistor, ±5%, 1/4W (9.1K Ohm)	R18
Resistor, 1%, 1/8W (10K Ohm)	R22
Resistor, Var, 1/2W (10K Ohm)	R20
Resistor, 1%, 1/8W (14.7K Ohm)	R23
Resistor, 1%, 1/8W (24.9 Ohm)	R24
Resistor, ±5%, 1/4W (33K Ohm)	R21
Resistor, ±5%, 1/4W (47K Ohm)	R30
Resistor, ±5%, 1/4W (56K Ohm)	R31
Resistor, ±5%, 1/4W (100K Ohm)	R1
Resistor, ±5%, 1/4W (1M Ohm)	R29
Resistor, 220/330 Ohms, 10 Pin, SIP	RP1, RP2
Resistor, 220/330 Ohms, 6 Pin, SIP	RP3

FIGURE 31.0 - SBF-III LAYOUT

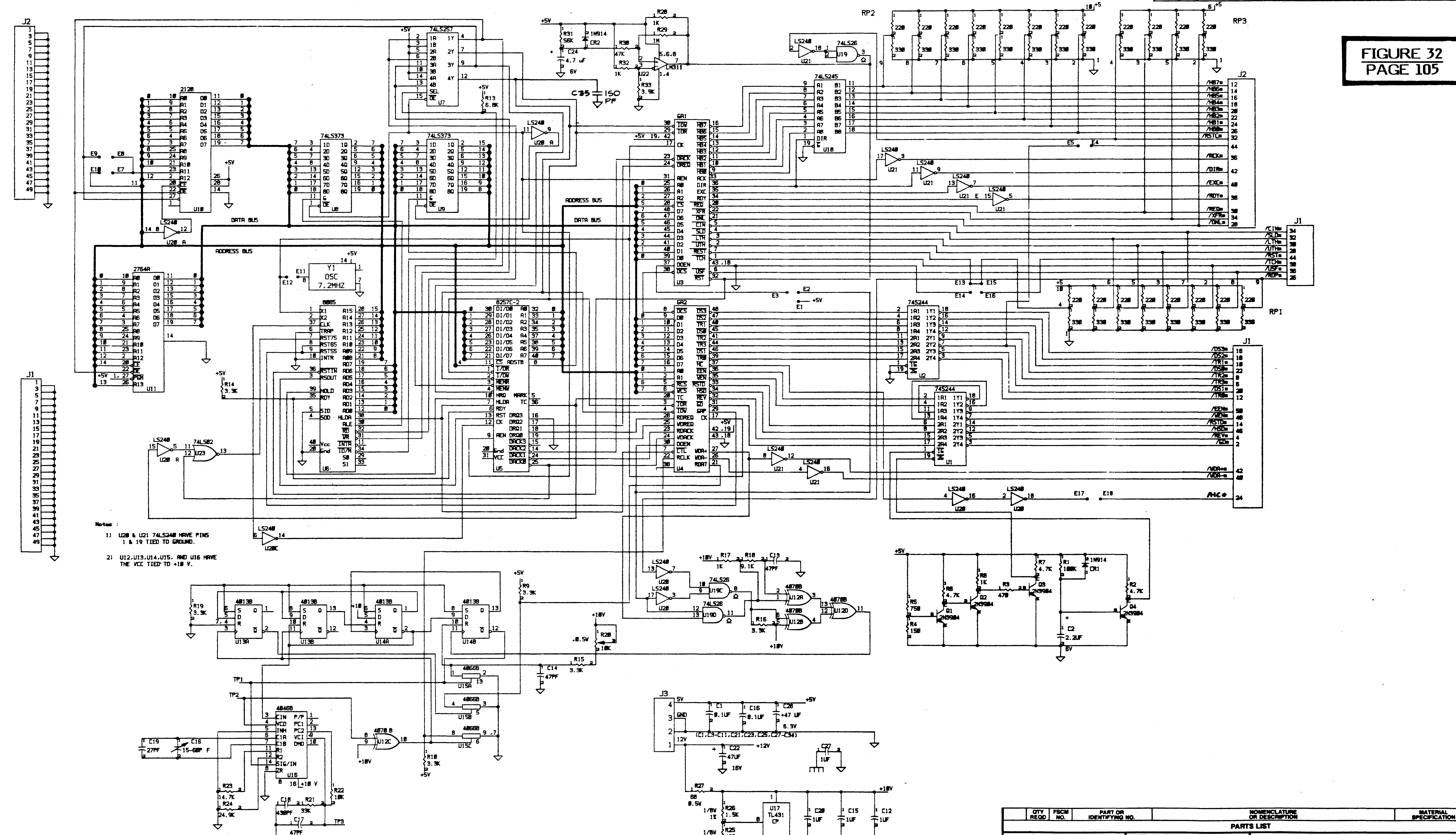


DWG. NO.	SH	REV.
40103-001	-	B

REV	DESCRIPTION	DATE	APPROVED
C1	PROD REL PER EO 10151	3/19/87	MR RL

REVISIONS

ZONE	REV.	DESCRIPTION	DATE	APPROVED
	B	REVISED & REDRAWN PER ECO 2079	6/25/86	S.T 6/25
	B1	SEE ECO 2467	10/7/86	MR RL
	C	SEE ECO 2861	2 FEB87	DG MR
	C	~~SEE~~ ECO 2861 A	3 FEB87	DG S.T



QTY REQD	FSCM NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL SPECIFICATION

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE:
FRACTIONS ± DECIMALS .XX ± .XXX ± ANGLES ±

CONTRACT NO.

wangtek
SIMI VALLEY, CA 93065

APPROVALS		DATE
DRAWN		
CHECKED	S. Taheri	6/11/86
ISSUED	S. Taheri	6/11/86

MATERIAL

FINISH

SCHEMATIC,
SINGLE BOARD FORMATTER III
(SBF III)

NEXT ASSY	USED ON

APPLICATION

DO NOT SCALE DRAWING

SIZE	FSCM NO.	DWG. NO.	REV.
D		40103-001	C1

SCALE —— SHEET 1 of 2

BISHOP GRAPHICS/ACCUPRESS

4C1E3

3 | 2

FIGURE 32
PAGE 105-1

REVISIONS			
ZONE	REV.	DESCRIPTION	DA
		SEE SHEET 1	

JUMPER CHART		
FUNCTION	CONNECTION	NO CONNECTION
2K RAM	E8-E9	E7-E10
4K RAM	E7-E10	E8-E9
8K RAM	E7-E10	E8-E9
JUMPER TEST	E11-E12	-
9 TRK FORMAT		E13,E14,E15,E16
12 TRK FORMAT	E13-E14	E15-E16
TRACK 9 STATUS JUMPER	E4-E5	
PLL ADJUSTMENT	E1-E2	E2-E3
HIGH COERCIVITY (HC)	E17-E18	

POWER AND GROUND CHART			
DESIGNATOR	GROUND	+5 VOLTS	+10 VOLTS
U19,U23	7	14	
U7	8	16	
U1,U2,U8,U9,U18,U20,U21	10	20	
U17	6		1
U12,U13,U14,U15	7		14
U16	8		16
U10,U11	14	28	
U6	20	40	
U5	20	31	
U3,U4	18,43	19,42	
U22	4	8	
RP1,RP2	1	10	
RP3	1	6	

APPENDIX "A"

The following describes signals and their definitions for the Wangtek Series 5125E, 125 Megabyte Tape Drive Interface.

INPUT SIGNAL DESCRIPTION. The input signals to the drive are as follows:

PIN 2 - GO. The GO line is used to start and stop the tape drive. A low signal level at this line will initiate tape motion. A High level signal will terminate tape motion.

PIN 4 - REV. The REV line is used to determine tape direction. A low level at this line will cause tape motion in the reverse (EOT to BOT) direction. A high level at this line will cause tape motion in the forward (BOT to EOT) direction.

PIN 6 - TR3.
PIN 8 - TR2.
PIN 10 - TR1.
PIN 12 - TR0.
PIN 18 - TR4. These lines are used to determine the head positioning with the respect to the track location. TR4 is the Most Significant Bit while TRO is the Least Significant Bit. TR1 through TR3 signal lines are used to determine head positioning. TRO is used to switch between the two write/read heads on the head assembly. TR4 is used for off track seek and is defined as shown in the following table.

Track Location	TR4	TR3	TR2	TR1	TR0
0	H	H	H	H	H
1	H	H	H	H	L
2	H	H	H	L	H
3	H	H	H	L	L
4	H	H	L	H	H
5	H	H	L	H	L
6	H	H	L	L	H
7	H	H	L	L	L
8	H	L	H	H	H
9	H	L	H	H	L
10	H	L	H	L	H
11	H	L	H	L	L
12	H	L	L	H	H
13	H	L	L	H	L
14	H	L	L	L	H
OFF TK (UP)	L	L	L	L	H
OFF TK (DN)	L	L	L	H	H

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PIN 14 - RST. The RST line initiates a Reset pulse to the microprocessor. A low level signal to this line will initiate a reset to the microprocessor, which positions the head to the recalibration position and terminates any operation being performed.

PIN 20 - DS1. The DS1 line is used to select drive #1 when the drive is jumpered for Select #1. A low level signal at this line selects drive #1.

PIN 22 - DS0. The DS0 line is used to select drive #0. This is the standard select configuration for the drive. A low level signal at this line will select the drive for operation.

PIN 24 - HC. The HC line is used to select high write current for use with the high coercivity tapes. A low signal at this line selects the high write current to the write amplifier. This function is normally performed with the basic drive microrprocessor.

PIN 40 - WDA-. The WDA- line is used to supply digital write data information to the write amplifier circuitry.

PIN 42 - WDA+. The WDA+ line is used to supply digital write data information to the write amplifier circuitry. This signal is the inverse of the WDA- signal.

PIN 44 - THD. The THD line is used to select either the read or write threshold level. A low signal at this line will select the write threshold level, which is 25% higher than the read level. This function is normally carried out in the basic drive microprocessor.

PIN 46 - HSD. The HSD line is used to select high speed (90 IPS) rewind and fast forward operations. A low level signal at this line enables the high speed operation. This function is normally carried out in the basic drive microrprocessor.

PIN 48 - WEN. The WEN line is used to enable the drive to write data to the tape. Alow level signal to this line enables the drive to write data to the tape.

PIN 50 - EEN. The EEN line is used to enable the drive to erase data from the tape. A low level signal to this line enables the drive to erase the tape cartridge, but only if the drive is selecting Track 0 and moving forward from BOT.

OUTPUT SIGNAL DESCRIPTION. The output signal descriptions are as follows:

PIN 16 - RDP. The RDP signal line is used to transmit the read data pulse information to the formatter. This line will be at a low signal level when the read data level is true.

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PIN 28 - UTH. The UTH line is used to transmit tape position status information regarding the upper tape hole status to the formatter.

PIN 30 - LTH. The LTH line is used to transmit tape position information to the formatter regarding the lower tape hole status. A low signal level at this line indicates that the lower tape hole has been detected.

PIN 32 - SLD. The SLD line is used to inform the formatter that the tape drive has been selected. A low level signal at this line indicates that the drive is selected.

PIN 34 - CIN. The CIN line is used to inform the formatter that a cartridge has been inserted in the drive. A low level signal at this line indicates that a cartridge is inserted in the drive.

PIN 36 - USF. The USF line is used to inform the formatter that the tape cartridge inserted in the drive is not write protected. A low level signal at this line indicates that it is safe to write data to the cartridge.

PIN 38 - TCH. The TCH line is used to transmit the tachometer information to the formatter.

APPENDIX "B"

OPTIONAL COMMAND SET - 125 MEGABYTE DRIVES

Section 1 gives a brief introduction of the optional command set for the Wangtek 125 Megabyte Tape Drives.

Section 2 deals with the Media Format Commands.

Section 3 deals with the Enhanced Write Commands.

Section 4 describes the Enhanced Read Commands.

Section 5 deals with the Self Test Commands.

SECTION 1 - INTRODUCTION

This document describes the OPTIONAL COMMAND SET for the WANGTEK 125 MB Cartridge Tape Drives, Model 5125EG and 5125EK. The Optional Command Set is designed to enhance the drive performance by combining commands, and providing features that improve the hosts' ability to store data or recover data from the media.

The optional commands are divided into four (4) different categories. These are the Media Format Commands, Enhanced Write Commands, Enhanced Read Commands and the Self Test Commands.

The Media Format Commands allow the host to read the different tape formats. There are currently three formats, QIC-11, QIC-24 and QIC-120, with the latter as default.

The Enhanced Write Commands allow the host to write without the drive underrunning or to combine the writing of a filemark and a write command.

The Enhanced Read Command gives the host the ability to space forward and backwards over blocks, read multiple filemarks, find the end of data and to read without underruns.

The Self Test Commands allow the device to determine its' operational status and to inform the host of that status. There is also a command that will permit the host to read the firmware identification.

The Optional Commands provide the host with an enhanced set of commands which give it more control over the device, and improved access to the data.

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SECTION 2 - MEDIA FORMAT COMMANDS

SET QIC-11 FORMAT (26H)

The SET QIC-11 FORMAT command shall instruct the device to enable the proper tape format. The default is QIC-120.

Notes: This command will enable the device to read the QIC-11 tape format. The device will not write in the QIC-11 format.

A format change must be performed before tape motion commands are sent to the device.

SET QIC-24 FORMAT (27H)

The SET QIC-24 FORMAT command shall instruct the device to enable the proper tape format. The default FORMAT is QIC-120.

Notes: The device will not write in the QIC-11 format.

SECTION III - ENHANCED WRITE COMMAND

WRITE WITHOUT UNDERRUNS COMMAND (41H)

The WRITE WITHOUT UNDERRUNS (WU) command shall instruct the device to perform all functions of a WRITE command and shall continue tape movement when an underrun occurs. Tape movement shall stop when the end of track is reached, or at the completion of a normal write command.

Notes: This command is used if the host cannot provide another block within 6mS after the READY that requests the next block. By not meeting this time requirement, the device will underrun. WU command continues to write by rewriting the last block until end of track or another write command is issued.

WRITE FILEMARK/WRITE COMMAND (62H)

The WRITE FILEMARK/WRITE command instructs the device to combine the WRITE FILEMARK command and a WRITE command to achieve streaming operation when writing file marks. When executing this command, the device shall first complete the writing of the remaining data block in the buffer, if applicable. It shall then write a file mark and, thereafter, the device shall proceed with a normal write operation. To maintain streaming operation, the controller shall transfer a complete data block prior to the device committing to an underrun.

Notes: None.

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WRITE FILEMARK/WRITE WITHOUT UNDERRUNS COMMAND (63H)

The WRITE FILEMARK/WRITE WITHOUT UNDERRUNS command instructs the device to combine the WRITE FILEMARK command and a WRITE command to achieve streaming operation when writing filemarks. When executing this command, the device shall first complete the writing of the remaining data block in the buffer, if applicable. It shall then write a file mark and, thereafter, the device shall proceed with a normal write without underruns operation. Tape movement shall stop when the end of track is reached, or at the completion of a normal write command.

Notes: See WRITE WITHOUT UNDERRUNS Command.

SECTION 4 - ENHANCED READ COMMANDS

SPACE FORWARD COMMAND (81H)

The SPACE FORWARD command shall instruct the device to logically move the tape forward over the subsequent data block or filemark. No data shall be transferred. The normal completion of this command shall cause READY to be asserted. If the command is issued at End of Recorded Media (ERM) or spacing over a filemark occurs, EXCEPTION shall result.

Notes: None.

READ CONTINUOUS COMMAND (82H)

This command shall instruct the drive to begin (or continue) a read operation. During the execution of the standard READ command, it is permissible to stop tape motion when a filemark is encountered. However, during execution of the READ CONTINUOUS command, tape motion shall ot stop when a filemark is encountered. The device shall continue reading the following blocks, while simultaneously altering the controller by asserting the EXCEPTION signal. To maintain streaming, the controller shall complete the READ STATUS sequence and issue a new READ or READ CONTINUOUS command prior to the device committing to an underrun.

Notes: None.

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SPACE REVERSE COMMAND (89H)

The SPACE REVERSE command shall instruct the device to logically move the tape in reverse over the previous data block or filemark. No data shall be transferred. The normal completion of this command shall cause READY to be asserted. If the command is issued at Beginning of Media (BOM) or spacing over a file mark occurs, EXCEPTION shall be asserted and BOM status set.

Notes: None.

READ N FILEMARKS COMMAND (B1H - BFH)

The READ N FILEMARKS command shall be identical in function to the READ FILE MARK command except that the number of file marks read shall be equal to the binary value of NNNN. For example 1011 0001 shall cause one filemark to be read and 1011 0010 shall cause two file marks to be read. In the case where NNNN is zero (0011 0000), the device shall return illegal command status.

Notes: None.

SEARCH TO END OF RECORDED MEDIA COMMAND (A3H)

The SEARCH FOR END OF DATA command shall instruct the device to search for the end of recorded media. The normal completion of this command shall cause EXCEPTION to be asserted with ERM (Byte 1, Bit 1) set. New data may then be recorded following the existing recording by issuing a WRITE command. Should there be no data on the tape, then normal completion shall cause EXCEPTION to be asserted with the NDD (Byte 1, Bit 5) set.

Notes: The drive will search the even tracks (0, 2, 4, 6, 8, A, C, E in this order) until it finds a track without data. It then returns to the previous track and positions itself to the end of recorded media on that track or the next odd track. EXCEPTION is asserted with the RM bit set. In the case of NDD on track zero (0), EXCEPTION is asserted with the NDD bit set. Track 14 (OEH) cannot step to the next even track, thus the device starts reading immediately.

This command is necessary to reduce the positioning time in an append operation. Thus within six minutes (on a 600 foot cartridge) the tape could be positioned at the end of track 15. If this was accomplished by streaming (approximately two minutes per track with 15 tracks) it would require almost thirty minutes.

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SECTION 5 - SELF TEST COMMANDS

RUN SELF-TEST 1 COMMAND (C2H)

The RUN SELF-TEST 1 command shall instruct the device to perform the self-test operations. This command shall not allow writing on the media. Following transfer of the command byte, the device will deassert READY and commence with the self-test. At the completion of the self-test, READY shall be asserted indicating that response information is available. The controller shall receive six bytes of response information using the REQUEST/READY handshake protocol. The first two bytes of response information shall conform to the Standard Status Description. Information bytes 2, 3, 4 and 5 are described in Figure 1. The normal completion of this command shall cause READY to be asserted.

Notes: This test checks the following: Tape Holes, Tape Speed (72 and 90 ips), and the 2k(8k) RAM test.

The running time is dependent upon tape length. This test requires four minutes with a 600 foot tape. Subtract one minute of time for each decrease in length of 150 feet.

RUN SELF-TEST 2 COMMAND (CAH)

The RUN SELF-TEST 2 command shall instruct the device to perform vendor unique self-test operations. This command allows reading and writing on the media. This command may destroy user data if executed on a device with media containing user data installed. Following transfer of the command byte, the device shall deassert READY and commence with the self-test. At the completion of the self-test, READY shall be asserted indicating that status information is available. The controller shall transfer six bytes of status information using the REQUEST/READY handshake protocol. The first two bytes of response information shall conform to the standard status description. Information bytes 2, 3, 4 and 5 are described in Figure 1. The normal completion of this command shall cause READY to be asserted.

Notes: This test checks the following: Write Operation, Read Operation, Erase and the drive stepper motor.

The running time is dependent upon tape length. This test requires 5:15 minutes with a 600 foot tape. Subtract one minute of time for each decrease in length of 150 feet.

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RUN SELF-TEST 3 COMMAND (CBH)

The RUN SELF-TEST 3 command shall instruct the device to perform the self-test operations. The cartridge will be write protected. Following transfer of the command byte, the device will deassert READY and commence with the self-test. At the completion of the self-test, READY shall be asserted indicating that response information is available. The controller shall receive six bytes of response information using the REQUEST/READY handshake protocol. The first two bytes of response information shall conform to the Standard Status Description. Information bytes 2, 3, 4 and 5 are described in Figure 1. The normal completion of this command shall cause READY to be asserted.

Notes: This test checks the drive write protect switch.

The tape must be write protected. Status information is shown in Figure 1. The running time is not dependent upon tape length. This test requires 1:10 minutes.

READ FIRMWARE IDENTIFICATION COMMAND (CFH)

The READ FIRMWARE IDENTIFICATION command shall instruct the device to transfer to the controller six bytes of firmware identification. The device shall transfer the bytes using the REQUET/READY handshake protocol. Normal completion of this command shall cause READY to be asserted.

Notes: The identification shall contain a letter and two digits of revised information.

FIGURE 1. DEFINITION OF SELF TEST ERROR BYTES

Byte 0	=	not used		
Byte 1	=	not used		
Byte 2	=	not used		
Byte 3	=	000H	Test not performed	
		011H	Test performed, no failures	
		024H	Test Failed, see Byte 3	
Byte 4	=			
Bit	0	Hole Sensors	Bit	1 0
	1			0 0 No Failure
				0 1 1th Failure
				1 0 uth Failure
	2	Drive Speed Control (tach)		
	3	Stepper Motor		
	4	Write/Read	Bit	5 4
	5			0 0 No Failure
				0 1 Write Failure
				1 0 Read Failure
				1 1 crc Failure
	6	Erase		
	7	RAM		
Byte 4	=	not used		
Byte 5	=	not used		