CalComp

Trident 1150 Formatter

Performance Specification
Bulletin No. 346

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CALCOMP

CONTENTS

ILLUSTRATIONS

SECTION 1
INTRODUCTION

1.1 PURPOSE

The purpose of this manual is to provide the OEM designer with the information required to integrate the 1150 formatter into his data storage system. This manual contains complete specifications, functional description, interface description and timing constraints.

1.2 GENERAL

The 1150 was designed to control the Trident family of disk drives ranging from 25 to 300 megabytes. For added flexibility, the 1150 offers the capability of mixing the various Trident models and can be configured to supply a total 2.4 billion bytes of on-line data.

The user is presented with a universal interface, requiring a user designed circuit, called a *Host Adapter* which should provide the necessary handshake logic to the chosen mini/micro computer. Space has been made available in the 1150 for this user-designed Host Adapter to reside and ample power is provided for its use.

1.3 OBJECTIVES

The Trident OEM Formatter will provide the OEM user with the capability of easily interfacing the CalComp Trident Disk Drive to his selected CPU. This is done by placing the majority of the formatting and controlling requirements in the formatter hardware and firmware and allowing the host CPU to communicate with the drive via minimum software overhead.

1.4 SUMMARY PRODUCT DESCRIPTION

The Trident OEM Formatter will handle the control and formatter tasks for up to eight CalComp Trident Drives. It is organized around a microprogrammable processor which provides flexibility to accommodate most computers, perform diagnostic tests and report or recover from errors during data transfer operations.

1.5 FEATURES

Some of the more significant capabilities of the Trident OEM Formatter are:

1.5.1 Drive Select

Each drive, up to eight maximum, is individually selectable.

1.5.2 Status

Sixteen bits of Formatter Status is presented on the data interface at the conclusion of an operation. Additional information is available through use of software requests.

1.5.3 Logical Record Size

The formatter allows data transfer from one 16 bit word to 65 thousand words, while crossing all internal pack boundaries. (Physical Records, Tracks and Cylinders)

1.5.4 Built In Test Exercise (BITE)

A test routine is executed by the formatter during power up sequencing, system initialize, or as called via a user command. The test routine checks selected formatter microprocessor functions utilizing the data path and, upon successful completion, rezeroes the disks to home track.

1.5.5 Formatting Capability

The Trident Formatter will provide formatting which conforms to the basic drive specification regarding gap lengths and address mark characteristics. The functional addressing increments on a disk are established with address marks during formatting operations. Sector pulses, established by the disk drive electronics, are available for use with the RPS option.

1.5.6 Variable Buffer Lengths

The standard formatter has a four byte buffered data bus to the user for direct data feedthrough. Options are available for a fully buffered formatter in 512 byte increments with a maximum of 4096 bytes.

1.5.7 Error Detection and Correction

ECC, error detecting and correcting polynomials are standard. Detection of single error bursts up to 12 bits long for physical data records and 4 bits long for I.D. areas is standard. I.D. areas are automatically corrected by the formatter. Automatic Data Correction for data records is an option. Without the option, the User is responsible for applying the correction mask delivered by the formatter.

1.5.7 Overlapping Seeks

The formatter will initiate a seek to a drive and disconnect for other task assignments. This allows up to the maximum number of drives to be seeking selected cylinder locations.

1.5.8 Power Requirements

The self contained dc power supplies provide two power levels, plus five volts (+5V DC) and minus five volts (−5V DC). Both are required by the formatter.

1.6 OPTIONS

The formatter logic is packaged on two PCB's. The PCB's are designed such that they can be sold without the power supplies.

1.6.1 Microdiagnostics

Additional microdiagnostics are a standard feature. These will test all basic functions in the formatter and present an error indication upon failure.

1.7 EXTRA COST OPTIONS

1.7.1 Hardware Data Buffers

Hardware data buffers can be added to achieve a fully buffered formatter so that effective data transfers may take place. Buffers are available in 512 byte increments up to 4096 bytes. When the buffered formatter is used the logical record size is restricted to the size of the hardware buffer installed.

1.7.2 Automatic Error Correction

Optional automatic ECC correction of data records is available. This option requires the installation of the hardware data buffer.

1.7.3 Rotational Positional Sensing (RPS)

As an option the formatter will sense and report to the user interface RPS events for up to eight drives. This allows the user to initiate disk activity to many drives and execute the remainder of the activity to the drive that is positioned nearest the desired physical record, thus eliminating delays for rotational latency.

1.7.4 Maintenance Panel

An optional maintenance panel is available. The panel will permit off line testing of the formatter.

1.7.5 Additional Four Drive Capability

The basic unit is capable of attaching to four Trident Drives. An extra cost option is available which will allow attachment to an additional four (making a total of eight) drives.

SECTION 2
PRODUCT DESCRIPTION

2.1 RELATED DOCUMENTS

Trident Disk Drives performance specification.

2.2 CONCEPTS

The Trident OEM Formatter architecture is based upon a microprocessor, which serves as a central control for operation initiation, data flow between disks and the host CPU Interface and status maintenance and presentation. The microprocessor is organized around a single clock cycle instruction format.

A high performance data assembly-disassembly section is located outside the microprocessor to provide the parallel-serial conversion and buffering required. ECC polynomial error checking and correcting codes are also automatically generated within this feature.

2.3 SYSTEM SPECIFICATIONS

2.3.1 System Performance

Drives on-line	8 maximum
Maximum storage (unformatted)	Dependant on the type of drive used.
Data Transfer Rates (unbuffered)	6.45 MHz (403K 16 bit words/sec) 9.67 MHz (600K 16 bit words/sec)
(buffered)	1.4 million 16 bit words/sec
Indicators (formatter)	READY
Interface Logic	TTL Compatible

2.3.2 Physical Dimensions

The CalComp OEM Trident Formatter is contained within a cabinet 17 inches wide, 26.5 inches deep and 5.25 inches high. These dimensions provide the capability to mount the unit within a standard 19 inch RETMA rack; used as a desk top unit, or mounted inside the drive cabinet base. The weight of the formatter including the power supply is 50 pounds.

2.3.3 Environmental Requirements

The Trident OEM Controller will provide satisfactory performance when operated within the following environmental parameters.

2.3.4 Temperature

Operating: 60°F to 100°F, (15°C to 38°C) max. gradient of 20°F (11°C) per hour.

Non-Operating: −40°F to 150°F (−40°C to 65°C)

2.3.5 Relative Humidity

Operating: 10% to 80%, max. wet bulb 75°F (24°F), no condensation

Non-Operating: 5% to 80%, no condensation

2.3.6 Power Requirements

The CalComp Trident OEM Formatter is sold as a self-contained unit, requiring only input AC power.

2.3.7 Power Sequencing

The OEM Formatter is designed so that all AC and DC voltages may be applied or removed in any sequence.

2.3.8 AC Power

Input AC power for the formatter is specified between line and neutral connection.

The formatter operates under the following five (5) AC input configurations with the proper connection of jumper wires.

AC Voltage	Connection	Frequency	Current
100 VAC +10%, −15%	Line to Neutral	50/60 Hz	3.4A
120 VAC +10%, −15%	Line to Neutral	50/60 Hz	2.9A
200 VAC +10%, −15%	Line to Neutral	50/60 Hz	1.9A
220 VAC +10%, −15%	Line to Neutral	50/60 Hz	1.7A
240 VAC +10%, −15%	Line to Neutral	50/60 Hz	1.6A

Input AC power is controlled by a front panel power switch. The power transformer provides 120V AC for the formatter system cooling fan.

2.3.9 AC Power Cord

A detachable power cord with NEMA 5-15P type plug is offered for 100/120 VAC operated unit and a power cord with CEE (7) type plug is offered for 200/220/240 VAC unit.

2.4 RELIABILITY

The formatter is designed and constructed to provide a useful service life of 10 years or 60,000 hours, whichever comes first, before replacement is required. Repair or replacement of parts will be permitted during the lifetime of the unit.

2.4.1 Mean Time Between Failure (MTBF)

Following an initial period of 200 hours, MTBF is expected to exceed 10,000 hours. The following expression defines MTBF:

$$MTBF = \frac{\text{Operating Hours}}{\text{Number of equipment failures}}$$

Operating hours mean total "Power-On" hours less any maintenance time. Equipment failures mean any stoppage or substandard performance of the unit because of equipment malfunction. Equipment failure shall exclude downtime or substandard performance due to operator error, adverse environment, power failure or other failures not caused by the formatter. To establish a meaningful MTBF, operating hours must be greater than 5,000 hours and shall include all sites where the units are used. Equipment failures are defined as those actions requiring repairs, adjustments or replacements on an unscheduled basis.

2.4.2 Mean Time to Repair (MTTR)

MTTR shall be less than 0.5 hours, and is defined as the time required for an adequately trained and competent serviceman to diagnose and correct a malfunction, by substitution of replaceable assemblies.

The host CPU formatter data interface will allow attachment to a wide variety of CPU's in either Program or Direct Memory access (DMA) modes. A printed wiring board location is provided in the formatter card cage to assist the OEM user in the building of his specialized interface functions.

The formatter is designed to Underwriters Laboratories specification. An application for Underwriters Laboratories listing will be made for the formatter.

2.5 FUNCTIONAL ORGANIZATION

The storage system block diagram is shown in Figure 2.1. The user connects his computer to the disk formatter by building a logic module which can adapt the specifics of his interface (DMA, Interrupt, or Programmed (I/O) to the generalized interface protocol of the User Bus.

The formatter connects to up to a maximum of eight disks via one common bus and eight individual radial cables. The common bus carries the low bandwidth command and status information, and the radials carry the high bandwidth read/write data. Sector/index pulses are returned continuously through the radials. This permits implementation of the RPS (Rotational Position Sensing) option.

Once the data transfer is operating in the burst mode, the operation is taken over by the specialized read/write and data buffer logic. The use of optional buffers permits the user to tailor the transfer rate of the disk storage system to his own needs.

The Data Buffer and RPS options are provided by the addition of component assemblies to the basic formatter.

2.5.1 User Tasks

The tasks which the user is required to perform are:

1. Provide a multiple user interface, if desired.
2. Do necessary storage space address conversions to UNIT, CYLINDER, HEAD, and RECORD level.
3. Provide logic necessary to transmit or receive data 16 bits at a time; e.g., address counter, data register, control logic.
4. Provide any authorization, privacy, or priority mechanisms.
5. Provide any service queueing which may be required (except for concurrent RPS, and overlapped seeks, the formatter performs only one task at a time).
6. Provide error recovery mechanisms if the formatter option described below is not selected. The formatter option uses a powerful error detection and correction scheme based on cyclic codes. The formatter also responds to commands by which the user may control head offset and read strobe positioning of the Trident disk.
7. IPL Bootstrapping Requirements
8. Logical Sector Interleaving Schemes — If this is implemented the formatter must restrict the logical record length to one physical recora.

2.5.2 Formatter Tasks

The tasks which the formatter will perform:

1. Receive, interpret, and execute the user commands . . . READ, WRITE, SEEK, VERIFY, etc.
2. Select and control disks.
3. Collect, maintain, and present system status.

4. Make data transfers between user (in 16-bit words) and disk, handling *all* formatting.

5. Format disk packs to user specifications.

6. Provide self test and built-in maintenance features.

7. Provide two words of data buffering (with optional increase to maximum of 4096 bytes).

8. (option) Automatic error correction on data fields up to the size of the available buffer.

9. (option) Complete RPS Sensing and Reporting.

2.5.3 Microprocessor Tasks

The microprocessor is used to handle the following formatter tasks:

1. Receive, interpret, and initiate execution of user commands.

2. Collect, maintain, and present status.

3. Select and control disks.

4. (option) Maintain eight concurrent sector counters for the RPS.

5. Initiate, coordinate, and terminate read and write data transfers.

6. Provide format data and VFO timing gaps for the ID area and address marks.

7. Do disk address comparisons from the ID areas for data operations.

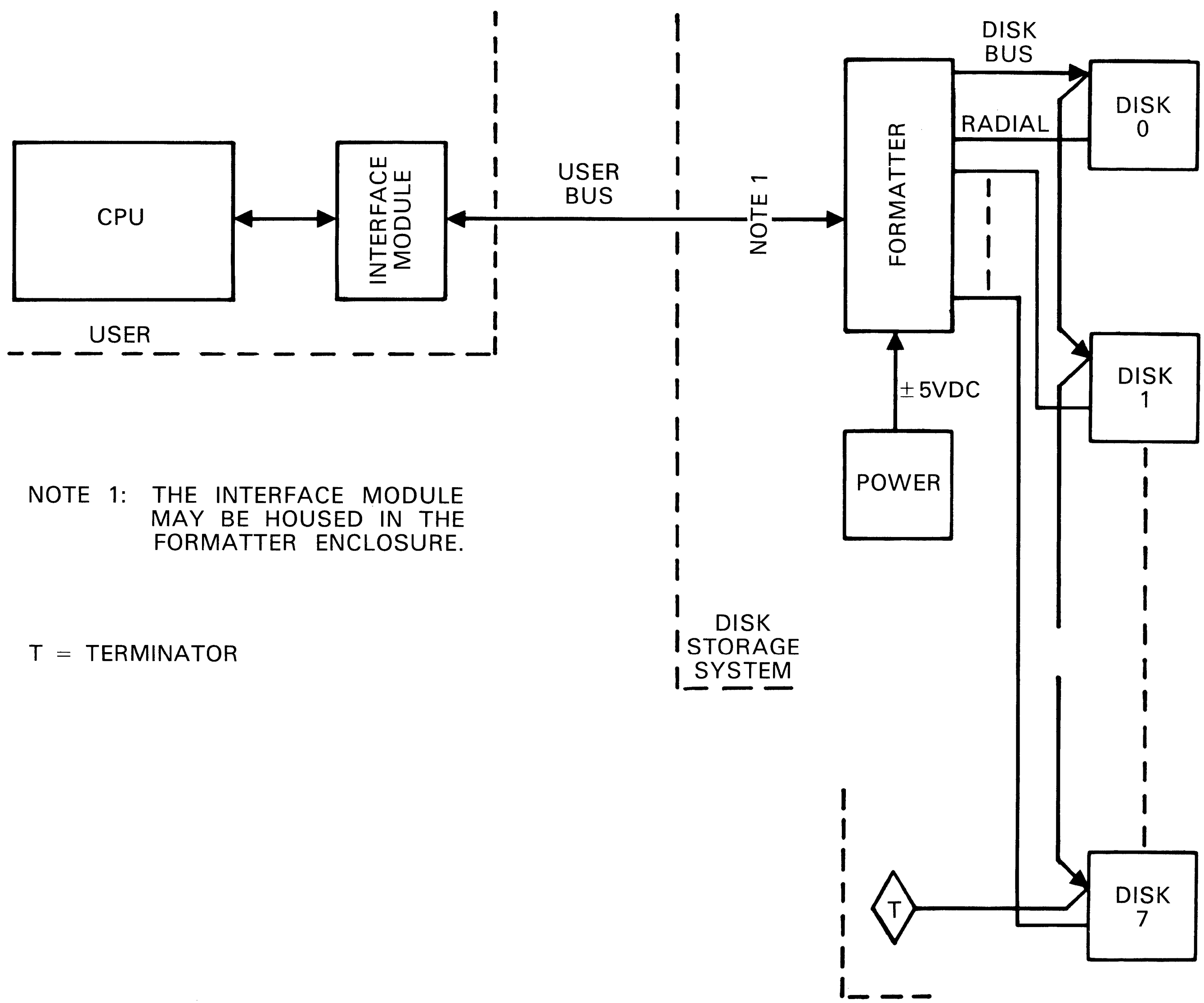


Figure 2.1. The Storage System Block Diagram

SECTION 3
FUNCTIONAL DESCRIPTION

3.1 MEDIA CONSIDERATIONS

The Trident OEM Formatter is designed to manage up to eight Trident Disk Drives, using CalComp Approved media. The formats allowable with the Trident Disk System covers a wide range of possibilities; however, the address mark format defined in the Trident Disk spec. must be used. The OEM Formatter is not equipped to manage data organized in hardsector formats.

3.2 TRACK FORMAT REQUIREMENTS

The format that is used in the standard Trident Formatter is as shown in Figure 3.1.

Address Mark sectoring relies on a special pattern written on the data track. This format is more efficient than conventional hardsector sensing since the tolerance between servo head and the data head is eliminated. Address Mark sectoring requires a start of track pad at the beginning of every track. The formula for the maximum possible number of records per track is as follows:

$$\text{Max Records Per Track} = \frac{\text{Track Length} - \text{Track Overhead}}{\text{Data Length} + \text{ID Length} + \text{RD Overhead}}$$

TRIDENT	4040 Density	6060 Density
Track Length	13,440 bytes	10,160 bytes
Track Overhead	39.69 bytes	31.63 bytes
Data Length	Variable	Variable
Record Overhead (Including ID FLD)	82.38 bytes	116.15 bytes

Examples:

$$\text{T50 Records Per Track} = \frac{13{,}440 - 39.69}{\text{D.L.} + 82.38}$$

$$\text{T80 Records Per Track} = \frac{20{,}160 - 31.63}{\text{D.L.} + 116.15}$$

NOTE: Above formula includes tolerances for worst case drive speed variations and for maximum cable lengths.

3.3 MICROPROCESSOR TASKS

3.3.1 Overall Control of Operations

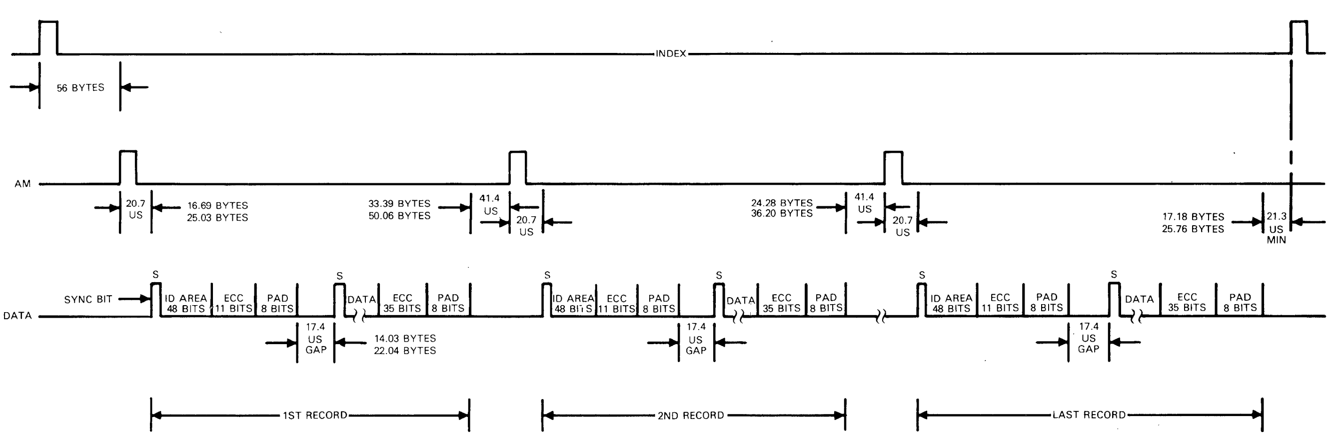
The microprocessor is assigned overall responsibility for what function the formatter is performing. It, in effect, decides what is to be done and allocates the available resources to accomplish this task. As such, it controls movement from one "state" to another.

The microprocessor controls all interface control lines for both the disk interface and user interface. The microprocessor is also responsible for command decoding and interrupt handling.

3.3.2 System Configuration Table

The formatter and its microprocessor require a unit configuration for each drive on the system. This table defines for the formatter the Logical Unit, the format of the pack, the User's logical record size, and error correcting factors.

The User is required to load the table using the LOAD TABLE command when the formatter is



NOTE: ALL GAP SIZES ARE NOMINAL AND SHOULD NOT BE USED TO CALCULATE TRACK CAPACITY. REFER TO PAGE 6 FOR CAPACITY FORMULA.

Figure 3.1. Track Format

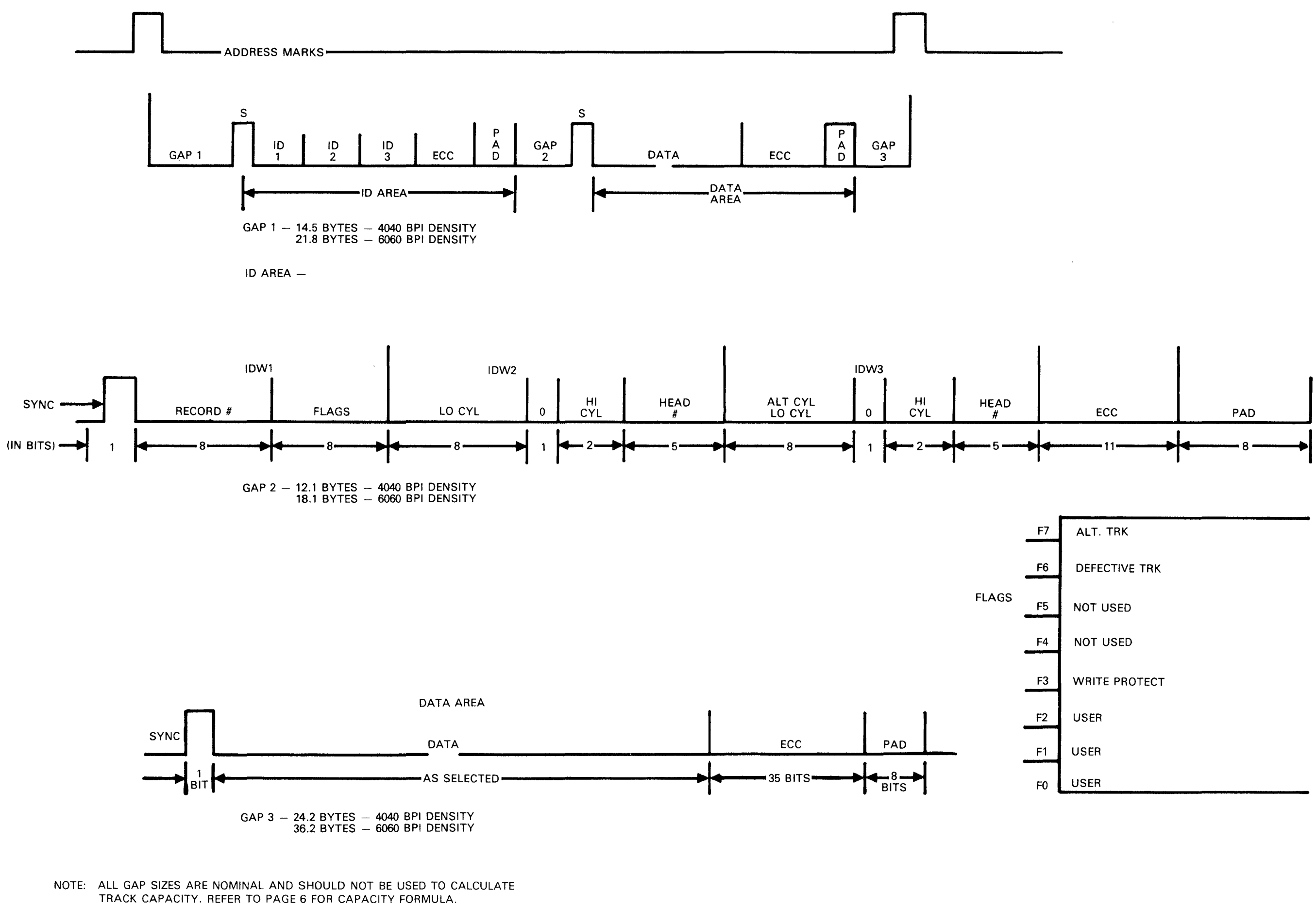


Figure 3.2. Record Format

powered up or after a power interrupt failure has occurred. The reason for this requirement is that the RAM memory that holds the table drops its logical data holding power when power is interrupted.

Figures 3.3 and 3.4 define and map the configuration table for User reference.

Configuration Table Definitions

Words 0-7 Not Used

Words 8-15 Record No. and Flags
When formatting, User must load flags for correct operation. (Figure 3.2) Record number will be current record number for any read/write operation.

Words 16-33 Cylinder/Head Count
Head and cylinder count will be current position of heads, when heads are loaded.

Words 24-31 Alternate Cylinder/Head Count
When formatting User must load alternate head and cylinder for defective track. Otherwise should be loaded with zeroes.

Words 32-39 Words Per Record
User must load with correct words per record before using any track.

Word 40-47 Read Strobe and Records Per Track
Read strobe should be initially loaded with zeroes, upon receiving a set/reset read strobe command Formatter will load strobe value. User must load with correct records per track before using any track.

Words 48-55 User Word Count
User must load to maintain correct word count for any read/write data transfer.

Words 56-63 Unit Status/Logical Unit
User must load logical address to be used for any device and each device should have a unique logical address.

3.3.3 Interrupts

Three types of interrupts are presented by the formatter. The first is the normal command completion status interrupt. This status interrupt will stay active on the User interface until acknowledged by the User interface.

PHYSICAL UNIT CONFIGURATION WORDS

Word		Load Requirements
0	NOT USED (bits 15–8, 7–0)	Set to zero
1	Bit 15: 0; Bits 14–8: RECORD NO. R_6 — ; Bits 7–0: I.D. FLAGS F_7 — F_0	Set flags for FORMAT WRITE (Fig. 3-2)
2	Bits 15–8: CURRENT CYLINDER C_7 — C_0; Bits 7–6: C_9 C_8; Bit 5: 0; Bits 4–0: CURRENT HEAD H_4 — H_0	Set to zero's to initialize
3	Bits 15–8: ALT CYLINDER C_7 — C_0; Bits 7–6: C_9 C_8; Bit 5: 0; Bits 4–0: ALT HEAD H_4 — H_0	Set for format defective track
4	Bits 15–11: 0 — 0; Bits 10–0: WORDS PER PHYSICAL RD. W_{10} — W_0	Must always be loaded as pack was formatted
5	Bits 15–10: 0 — 0; Bits 9–8: RD STRB E L; Bit 7: 0; Bits 6–0: RECORDS/TRACK R_6 — R_0	Set RD Strobe to zero Records/Track must be correct
6	Bits 15–0: USER WORD COUNT OF LOGICAL RD LENGTH U_{15} — U_0	Set during read or write operations
7	UNIT STATUS/LOGICAL UNIT #: Bits 15–11: 0 — 0; Bits 10–8: P_2 — P_0; Bits 7–0: 0 — 0	Sets logical unit per physical unit

Figure 3.3. Configuration Table

PICTORIAL RAM LAYOUT CONFIGURATION TABLE

	Unit 0	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Not Used WD 0	00	01	02	03	04	05	06	07
Record # Flags WD 1	08	09	10	11	12	13	14	15
Current Address WD 2	16	17	18	19	20	21	22	23
ALT Address Wd 3	24	25	26	27	28	29	30	31
Words/Phy RD WD 4	32	33	34	35	36	37	38	39
RD/STRB-RDS/Track WD 5	40	41	42	43	44	45	46	47
User WD Count WD 6	48	49	50	51	52	53	54	55
Status/Logical Unit WD 7	56	57	58	59	60	61	62	63

**Table Addresses

LOAD TABLE COMMAND RULES

1. Load Table Word Sequence 00, 08, 16, 24, 32, 40, 48, 56, 01, etc.
2. Load One Word Sequence (Address From Map Above)
3. Load One Device Sequence 00, 08, 16, 24, 32, 40, 48, 56

Figure 3.4 Configuration Table

The second type is the ATTENTION interrupt which is caused by a delayed completion of a drive activity. This status interrupt will be presented to the User interface and stay active until acknowledged by the User interface. (Refer to the REZERO and SEEK commands.)

The third type of interrupt is the RPS interrupt. This interrupt is caused by an active target sector on a drive being satisfied. This condition will hold true for the period that the physical sector compares equal to the target. The interrupt will be presented to the User interface and stay active until it is acknowledged or until the target compare goes false. If this interrupt is acknowledged by the User interface the logical unit in the status word will be automatically selected on the next command delivered to the formatter. TO OVERRIDE THIS AUTOMATIC SELECTION THE USER INTERFACE WOULD HAVE TO DELIVER A SELECT COMMAND TO THE FORMATTER AS THE NEXT COMMAND TO ANOTHER LOGICAL UNIT.

3.3.4 System Timing

A crystal-controlled oscillator is used to operate a majority of the logic in a synchronous fashion. The only portion of the formatter logic which doesn't use the basic clock, or some derivative thereof, is the read and write logic. This logic is driven by a clock supplied by the selected disk.

3.4 SYSTEM OPERATIONS

3.4.1 Power On Sequence/System Reset

The formatter will, upon power turn on, execute a Built-In Test Exercise (BITE). This firmware routine, installed in the microprocessor ROM, tests the selected registers in the microprocessor utilizing the formatter data path. Upon completion of the sequence, a test is made to verify proper execution. If it is satisfactory, the READY lamp on the front panel indicates that the formatter has completed basic checks. If the tests fail, the READY lamp will remain off and the formatter will stay in the test loop until remedial action is taken. After satisfactory test completion, the controller firmware then de-selects all disk drives and enters a disk attention status/wait loop for an attention(s) or a command. This loop is executed until a user command is received or an RPS interrupt (option) occurs.

3.4.2 User Commands

Figure 3.5 represents a complete list of user commands that the formatter can execute.

3.4.3 Initialize

This is a separate input signal to the formatter called SYSINT/ and described in paragraph 4.2. Execution of the Initialize command places the formatter in the Built-In Test Exercise Loop (BITE).

3.4.4 Formatter Commands

These commands do not require previous device selection. In order for the formatter to accept commands, READY must be high. Formatter will return status to User for all commands except BITE.

3.4.4.1 BITE (Built)In Test Exercise) Command: Code 00

BITE is initiated at initial power up and by User command, at the initiation of BITE, READY will drop, BITE will be performed and upon successful completion, all devices will be rezeroed. After rezeroes are completed, Formatter will raise READY and return to WAIT LOOP. No status will be returned on this command.

3.4.4.2 Load Table Command: Code 2X

Allows User to load Configuration Table. Each On-line device must have a valid device table entry in the configuration table as described in paragraph 3.3.2. Load table command has three options for the User:

Code 20 Load Complete table up to a maximum of 64 words (8 words per device) by device.

Code 21 Load one word at specified address.

Code 22 Load one device table (8 words) for device specified (Physical Address).

NOTE: For option 1 above, the range of allowable words is 1-64. Numbers outside this range will cause indeterminate results.

3.4.4.3 Read Table: Code 3X

Allows User to read RAM configuration table. Read Table command has three options for the User:

Code 30 Read Complete table up to a maximum of 64 words (8 words per device). See Note, paragraph 3.4.4.2.

Code 31 Read one word at a specified address.

Code 32 Read device table for one device as specified in the command (Physical Address).

3.4.4.4 Select Command: Code 80

Allows User to select any on-line device. This command must be used prior to any control or read/write command. Also allows User to select formatter status or Unit Status for status returned.

3.4.4.5 Sequence Command: Code 81

Allows User to start or stop disk rotation. On initial formatter power up User must sequence devices up. Drives must be powered up one at a time. Power up sequence requires 25 sec per drive.

3.4.4.6 Diagnostic Command: Code 88 (Diagnostic Option)

Allows User to execute the resident diagnostics that check the internal hardware of the formatter. Reference paragraph 3.7 for the details of the diagnostic feature.

3.4.4.7 Control Commands

Requires valid device table for each on-line device. Requires prior device selection for command execution. Formatter status will be presented at the end of each command.

Devices must be on-line and ready.

3.4.4.8 Read Sector (RPS): Code 10 (RPS Option)

Allows User to read the physical rotational position of the selected drive. Hardware strapping of the drive can divide the unit into equal sectors ranging from 1 to 128 physical sectors.

3.4.4.9 Seek Command: Code 5X

Allows User to position heads to desired cylinder. Updates RAM device table for selected device. Also allows User to suppress attention interrupts if desired.

3.4.4.10 Rezero Command: Code 82

Allows User to re-position heads to cylinder zero and head zero.

Rezero will clear seek incomplete and error conditions caused by illegal cylinder and offset errors. Also allows User to suppress Attention interrupts if desired.

3.4.4.11 Clear Device Check: Code 83

Allows User to reset all error conditions in the selected device.

CODE	DESCRIPTION	FORMAT
00	BITE	0 | 0 | 0 | 0 15 — 0
10	READ SECTOR (RPS)	1 | 0 | 0 | 0 | C 15 — 1 — 0 C: 0 = CURRENT SECTOR 1 = FROZEN
20	LOAD TABLE	2 | 0 | 0 | WORD COUNT 1-64 15 — 8 7 6 — 0
21	LOAD ONE WORD	2 | 1 | 0 | RAM ADDR 0-63 15 — 8 7 6 — 0
22	LOAD PHYSICAL DEVICE	2 | 2 | 0 0 0 0 0 | Dev # 0-7 15 — 8 7 — 3 ·2 — 0
30	READ TABLE	3 | 0 | 0 | WORD COUNT 1-64 15 — 8 7 6 — 0
31	READ ONE WORD	3 | 1 | 0 | RAM ADDR 0-63 15 — 8 7 6 — 0
32	READ PHYSICAL DEVICE	3 | 2 | 0 0 0 0 0 | DEV # 0-7 15 — 8 7 — 3 2 — 0
4X	LOAD DATA BUFFER	4 | 0 | WD TRANSFER LENGTH 15 — 12 11 10 — 0
5X	SEEK CYLINDER	5 | A | 0 | CYLINDER NUMBER 15 — 12 11 10 9 — 0 A=1 INHIBIT ATTENTION INTERRUPT

Figure 3.5. User Commands

CODE	DESCRIPTION	FORMAT
6X	WRITE I.D & DATA	6 | FLAG 3-0 | B | RECORD # 0-127 15 — 12 11 — 8 7 6 — 0 B = WRITE DATA FROM BUFFER FLAGS (REF. FIGURE (3.2)
7X	READ DATA BUFFER	7 | 0 | WD TRANSFER LENGTH 15 — 12 11 10 — 0
80	SELECT LOGICAL DRIVE	8 | 0 | 0 0 0 0 | S | LOG. UNIT # 15 — 8 7 — 4 3 2 — 0 S = 0: FORMATTER STATUS 1: UNIT STATUS
81	POWER SEQUENCE	8 | 1 | 0 0 0 0 | S | LOG. UNIT # 15 — 8 7 — 4 3 2 — 0 S = 1: POWER UP 0: POWER DOWN
82	REZERO	8 | 2 | A | 0 0 0 0 0 0 0 15 — 8 7 6 — 0 A = 1: INHIBIT ATTENTION INTERRUPT
83	CLEAR DEV CHECK	8 | 3 | 0 | 0 15 — 8 7 — 0
84	RPS TARGET	8 | 4 | S | SECTOR NO. 0-127 15 — 8 7 6 — 0 S = 1: SET TARGET 0: RESET OFF
85	SET READ STROBE	8 | 5 | 0 0 0 0 0 | E | L 15 — 8 7 — 2 1 0 EL = 00: ONTIME 01: LATE 10: EARLY
86	LOAD USER WORD COUNT (LOGICAL RD LENGTH) (IN 16 BIT WORDS) (2 WD COMMAND)	8 | 6 | 0 | 0 15 — 8 7 — 0 WORD COUNT | MAX | 65536 | WORDS 15 — 8 7 — 0

Figure 3.5. User Commands (cont.)

CODE	DESCRIPTION	FORMAT
87	CLEAR ATTENTION	8 | 7 | 0 | 0 15 — 8 7 — 0
88	DIAGNOSTIC TEST	8 | 8 | 0 0 0 0 | Test # 15 — 8 7 — 4 3 — 0
C0	FORMAT TRACK	C | 0 | FLAGS (FIG. 3-2) 15 — 8 7 — 0
C1	WRITE DATA	C | 1 | B | RECORD # 0-127 15 — 8 7 6 — 0 B = 1 = WRITE FROM BUFFER
C2	READ ID	C | 2 | 0 | RECORD # 0-127 15 — 8 7 6 — 0
C3	VERIFY I.D.	C | 3 | 0 | RECORD # 0-127 15 — 8 7 6 — 0
C4	READ DATA	C | 4 | B | RECORD # 0-127 15 — 8 7 6 — 0 B = 1: READ INTO BUFFER
C5	VERIFY DATA	C | 5 | 0 | RECORDS # 0-127 15 — 8 7 6 — 0
C6	REQUEST ECC	C | 6 | 0 | 0 15 — 8 7 — 0
C7	HEAD ADVANCE	C | 7 | 0 | 0 15 — 8 7 — 0

Figure 3.5. User Commands (cont.)

CODE	DESCRIPTION	FORMAT
C8	CLEAR HEAD	C | 8 | 0 | 0 15 ——— 8 7 ——— 0
C9	SELECT HEAD & OFFSET	C | 9 | S | D | 0 | HEAD ADDR. 15 ——— 8 7 6 5 4 ——— 0 S D = 10 = REVERSE OFFSET 11 = FORWARD OFFSET 00 = 01 = NO OFFSET

Figure 3.5. User Commands (cont.)

3.4.4.12 RPS Target: Code 84 (RPS Option)

Allows User to load target value in device table for selected device. When the target value and sector count compare equal a RPS interrupt is generated and presented to the User. The reset function disables RPS.

3.4.4.13 Set/Reset Read Strobe Command: Code 85

Allows User during User error recovery to change read strobe timing in the device data separator to recover marginal data. Error code 02 will be generated if both early and late bits are on.

3.4.4.14 Load User Word Count Command: Code 86

Allows User to change User Word Count value in the selected device, device table. For all read or write data transfers, User word count must match the actual word transfer count.

3.4.4.15 Clear Attention Command: Code 87

Allows User to reset all interrupts in the selected device.

3.4.4.16 Advance Head Command: Code C7

Allows User to increment head address by one in the selected device.

3.4.4.17 Clear Head Command: Code C8

Allows User to reset head register in the selected device to zero.

3.4.4.18 Select/Head/and Offset Command: Code C9

Allows User to set head register to desired head in the selected drive.

Also allows User to Offset heads during error recovery to recover marginal read data.

3.4.4.19 Read/Write Commands

Requires valid device table and prior device selection for proper operation. All read commands will test ECC for any data errors and report status.

For all correctable ECC errors in the ID field formatter will correct these errors and continue operation.

Formatter status will be presented after every command.

User Word Count in device table must equal words transferred.

3.4.4.20 Format Command: Code C0

Allows User to format one complete track based on device table information. All data fields will be written with ones, i.e., HEX FF, with ECC data appended. Formatter will write ID fields and data fields of equal lengths as specified in the device table (word/record, records/track) on the selected track with the remainder padded with zeroes. If no ALT., TRK. is specified (configuration table entry for ALT. TRK. is zeroes) the formatter will fill ID word 3 with all ones i.e., HEX FFFF.

3.4.4.21 Write Data Command: Code C1

Causes formatter to search for a specified record number, upon successful search, write the data received from User and at the end of each physical data field append ECC data. If write from buffer is specified, data from the buffer will be written.

User word count in device table must equal words transferred, and can not exceed buffer length.

3.4.4.22 Write ID and DATA Command: Code 6X

Causes formatter to search for a specified record minus one, upon successful search creates the ID record within the formatter using the User flags sent in the command and writes a new ID record and then writes the data record with the data received from the User.

If the buffer option is specified the data for the data record only is taken from the buffer. Only a single physical record can be written with this command.

3.4.4.22 Read ID Command: Code C2

Causes formatter to search for a specified record and upon successful search, transfers complete ID (3 words) to User.

3.4.4.23 Verify ID Command: Code C3

Causes formatter to search for a specified record and upon successful search and ECC check status is presented to User.

Command is used to verify no ECC error has occurred.

3.4.4.24 Read Data Command: Code C4

Causes formatter to search for a specified record and upon successful search transfers data read to User. Number of words transferred must equal User word Count in device table and can not exceed buffer length.

3.4.4.25 Verify Data Command: Code C5

Causes formatter to search for a specified record upon successful search, read data field and report status.

Command is used to verify no ECC error has occurred in data field.

3.4.4.26 Request ECC: Code C6

Allows User to interrogate ECC logic to determine correctable or uncorrectable error of previous read data error, if correctable formatter will transfer ECC displacement and error pattern mask.

Words Returned to User

WD.0	Shift Count	Word Count
	15 14 13 12	11 10 9 8 7 6 5 4 3 2 1 0
WD.1	0 0 0 0	Error Pattern
	15 14 13 12	11 10 9 8 7 6 5 4 3 2 1 0

Use of the correction factor words on the data read in error.

• SHIFT Count — from 0—15, this indicates the number of times to shift the error correction mask left. When shifting the mask left two 16 bit words will be created if the shift count is greater than four and the word count is off by one (one must be added to word count).

Example: 1

Zeroed Word	Error Pattern WD
0 0 0 0 0 0 0 0 0 0	0 0 0 0 xxxxxxxxxxxx
15 — 0	15 — 0

A. Shift 4 WORD COUNT = 50

0 0 0 0 0 0 0 0	xxxxxxxxxxxx 0 0 0 0
15 — 0	15 — 0
	Start WD 50

B. Apply pattern using only ERROR pattern Word.

Example: 2

Zeroed Word	Error Pattern WD
0 0 0 0 0 0 0 0	0 0 0 0 xxxxxxxxxxxx
15 — 0	15 — 0

A. Shift 6 WORD COUNT 50

000 0 0 00 00xx	xxxxxxxxxx 0 0 0 0 0 0
15 — 0	15 — 0
Start — 51	

B. Apply pattern starting with zeroes word and then the ERROR pattern word.

• Word Count: This indicates the actual word to apply the shifted pattern from the END of THE RECORD. If the record is 120 words long and the word count is 120, then the pattern is applied to the 120th word from the end of the record or the first word.

Therefore:

(PHYSICAL RECORD LENGTH) — (WORD COUNT) = (WORD IN ERROR FROM START OF RECORD).

NOTES:

A. If the word count is all one bits and the shift count is less than four, then the error pattern is totally applied to the ECC check bits.

B. If the word count is all one bits and the shift count is more than four the error pattern is partially applied to the last word of data and a part of the ECC bits.

C. If the word count is equal to the physical record length and the shift count is greater than four the error pattern is applied to the first word of the record −1 and the first word of the record.

• ERROR CORRECTION PATTERN — Once the user has shifted the pattern and found the starting data word in error the pattern is then used to correct the error. The user must "exclusive or" the pattern to the data. CPU's without this logical capability must remember that a 1 bit in the pattern will reverse the state of the corresponding bit in the data, all others remain as is.

3.4.4.27 Load Buffer Command: Code 4X (Buffer Option)

Allows User to load data buffer (4096 bytes max.) with write data. On subsequent write command, write data from buffer to specified device.

3.4.4.28 Read Buffer Command: Code 7X (Buffer Option)

Allows User to transfer data from buffer to user (4096 bytes max.).

3.5 STATUS REPORTING

The formatter has two major types of status, solicited or unsolicited.

The solicited type of status is a direct result of the User issuing a command to the Formatter and the command completion status being presented.

The unsolicited type of status is the result of a delayed completion of a SEEK or REZERO where the User specified an attention interrupt or an RPS target interrupt.

3.5.1 Unsolicited Status Presentation

In all cases the status word presented will be the Formatter Status. Figure 3.6 details the unsolicited Status word formats.

3.5.2 Solicited Status Presentation

All commands except "BITE" will return a Status to the User. BITE will execute the micro code test routine and enter the WAIT STATE. Three unique type of Status words can be presented to the User. Two of these types are Formatter Status words as shown in Figure 3.7 The third type is a UNIT Status word shown in Figure 3.8. UNIT Status is presented to the User when a SELECT command requests the Unit Status in lieu of the Formatter Status.

3.6 ERROR CODES

The formatter, when an error condition is reported by the drive or encountered in its operations, generates an error code consisting of 2 hex digits and subsequently places it in bits 8-15 of the unit status word. These codes and their meaning are shown in Figure 3.9.

3.7 INTERNAL DIAGNOSTIC FEATURE

The microcode diagnostics test the internal hardware of the formatter to verify the operational state of the

RPS TARGET INTERRUPT

BIT	USE	DETAILS
15	"One"	Denotes Unsolicited
14	"One"	Denotes RPS
13	Zero	
12	Zero	
11	Zero	
10	Logical Unit (4)	Interrupting Unit, will be
9	Logical Unit (2)	automatically selected for
8	Logical Unit (1)	next command.
7	RPS Active 7	Expressed as logical unit.
6	RPS Active 6	
5	RPS Active 5	1 = Target Compare
4	RPS Active 4	0 = No Target Compare
3	RPS Active 3	
2	RPS Active 2	
1	RPS Active 1	
0	RPS Active 0	

ATTENTION INTERRUPT

BIT	USE	DETAILS
15	"One"	Denoted Unsolicited
14	Zero	Denotes Attention
13	Zero	
12	Zero	
11	Zero	
10	Logical Unit (4)	
9	Logical Unit (2)	
8	Logical Unit (1)	
7	Attention Unit 7	Expressed as logical unit.
6	Attention Unit 6	
5	Attention Unit 5	
4	Attention Unit 4	1 = Attention Complete
3	Attention Unit 3	
2	Attention Unit 2	0 = Inactive
1	Attention Unit 1	
0	Attention Unit 0	

Figure 3.6. Unsolicited Status Types

READ RPS SECTOR INTERRUPT

BIT	USE	DETAILS
15	Zero	
14	Zero	
13	Zero	
12	One	Denotes RPS Sector
11	Zero	
10	Logical Unit (4)	Selected Unit
9	Logical Unit (2)	
8	Logical Unit (1)	
7	Valid Bit	1 = Valid Sector Count 0 = Not
6	Sector Count 64	RPS
5	Sector Count 32	Sector Count from selected
4	Sector Count 16	drive.
3	Sector Count 8	
2	Sector Count 4	
1	Sector Count 2	
0	Sector Count 1	

STANDARD COMMAND COMPLETION

BIT	USE	DETAILS
15	Zero	
14	Busy	Device Busy
13	Error	Operation in Error
12	Zero	
11	Zero	
10	Logical Unit (4)	Selected Unit
9	Logical Unit (2)	
8	Logical Unit (1)	
7	Attention Unit 7	Expressed as logical units.
6	Attention Unit 6	
5	Attention Unit 5	
4	Attention Unit 4	1 = Attention Complete
3	Attention Unit 3	
2	Attention Unit 2	0 = Inactive
1	Attention Unit 1	
0	Attention Unit 0	

Figure 3.7. Solicited Formatter Status Words

UNIT STATUS

BIT / FIELD	DESCRIPTION
15 14 HEX ERROR 13 CODE 12 DEFINES DETAIL 11 OPERATION IN 10 ERROR 9 FIGURE 3.9 8	Unit STATUS is only presented, if selected during a SELECT command and bit 3 in the command is a 1, and is the result of the previous operation.
7 READY	• **Ready** — When on, indicates device is on-line and heads are not in motion.
6 ON-LINE	• **On-Line** — Indicates the heads are loaded.
5 END OF CYLINDER	• **End of Cylinder** — When on, indicates head address register is greater than last head.
4 OFFSET — ON	• **Offset** — When on, indicates heads are offset.
3 READ ONLY	• **Read Only** — When on, indicates Read Only switch is on.
2 SEEK INCOMPLETE	• **Seek Incomplete** — When on, indicates last motion was not completed within .7 sec.
1 DEVICE CHECK	• **Device Check** — When on, device detected an error condition.
0 ADDRESS MARK FOUND	• **Address Mark Detected** — When on, indicates AM found and will stay up for 17 usec.

Figure 3.8. Unit Status Word

formatter. These diagnostics do not check the drives or the drive buses to the formatter.

The diagnostics may be accessed by the User using Diagnostic Command Code 88 or through the optional maintenance panel in an offline mode. In both modes the diagnostics are broken up into major test segments called major loops. The test number submitted by the User in the diagnostic command refer to these major loops. When the user submits a diagnostic command the selected major loop will be executed and only that major loop. At the completion of the test or an error situation the diagnostic will return status to the User and exit to the functional microcode wait state.

3.7.1 Status Presentation

The User will receive a normal completion status or an error status.

NORMAL COMPLETION

Test	No.	F	F
15	8	7	0

The all ones in the lower byte indicate normal completion. The upper byte indicates the last subtest that was executed.

ERROR COMPLETION

Failing	Sequence	Test	in error
15	8	7	0

The lower byte identifies the subtest that failed and the upper bit gives the failing sequence or qualifier so that detail isolation can take place.

3.7.2 Major Test Loops

There are 7 major tests performed defined as follows:

- — TEST 00 — ALU BUS TEST
- — TEST 01 — ALU REGISTER TEST
- — TEST 02 — OPTIONS TEST
- — TEST 03 — INTERFACE BUS TEST
- — TEST 04 — RAM TEST
- — TEST 05 — RPS TEST
- — TEST 06 — DATA BUFFER TEST

HEX CODE	DESCRIPTION
01	**Load Table Count Error** — A data word was detected to be in the input buffer after a data transfer operation was completed.
02	**Read Strobe Error** — Both read early and late strobe bits are on in the command word.
03	**No Logical Device Found** — During a select or a sequence command, the search for the logical device failed. Logical device number was not located in the configuration table.
04	**Takeful Error** — During a format operation, the takeful micro branch condition should have been off, but was found to be on; or it should have been on and was off.
05	**Command Reject** — Command code received from host is not one of the defined command codes.
06	**Format Index Error** — During a format operation, Index was detected before the end of the operation.
07	**Format Gap Error** — During a format operation, the last gap before Index was found to be less than 18 microseconds.
08	**Write Protect Error** — During a write data command, the write protect flag bit was found to be on.
09	**Cylinder Miscompare** — During an ID search, the cylinder address read miscompared with the cylinder address in the configuration table for the selected device.
0A	**Head Miscompare** — During an ID search, the head address or the high cylinder bits miscompared with the current head word in the configuration table for the selected device.
11	**Data Transfer Error** — During a read or write data operation, the Index was detected before the end of the physical record.
12	**Re-Orientation Error** — While attempting to re-orient on an ID field after an ECC correction on the ID field, Index was passed twice which indicates the correct address mark was not found.
13	**No Record Found** — During an ID search for record number compare, no compare occurred. This error can also be caused by failure to detect an address mark.
14	**Overrun Error** — During a read or write data operation, a data overrun condition was detected at the end of a physical record.
15	**Write ID/Data Count Error** — During a write ID/Data command, the User word count in the configuration table was greater than the physical record length.

Figure 3.9. Unit Status Error Codes

HEX CODE	DESCRIPTION
16	**Defective Track** — During an ID search, the defective track bit was found to be on.
17	**Alternate Track** — During a multiple track operation, the alternate track bit was found to be on. An attempt was made to overflow from 1 alternate track to another alternate track.
18	**Data Buffer Overflow** — Number of words directed to the data buffer exceeds its capacity.
21	**ID ECC Error** — During a Verify ID operation, a correctable ECC error was detected.
23	**Uncorrectable ECC Error in ID Field** — While attempting to correct an error in the ID field, the error was found to be uncorrectable.
24	**Uncorrectable ECC Error in Data Field** — While attempting to determine a correctable or uncorrectable ECC, the error was found to be uncorrectable.
25	**Correctable ECC Error in the ECC correction bits** — The data is correct.
26	**Correctable ECC Error in the data record** — If you do not have the automatic data correction option do a request ECC, and do the correction based on the ECC correction mask.
40	**Device Error** — After completion of an operation, device status check indicated unexpected device status condition.
41	**Device Status Error** — A device check or a seek incomplete was detected during the initial device status check.
42	**Device Offline** — The selected device was found to be off line during initial status check.
43	**Auto Seek Timeout Error** — During a long read or write the seek to the next cylinder failed.
46	Same as 06 except unexpected device status was also detected.
47	Same as 07 except unexpected device status was also detected.
48	**Auto Seek Error** — A device error occurred during an auto-seek operation.
49	**Read Only** — A write command was issued to a disk drive that has the Read-Only switch on the front panel of the drive set to the "ON" position.
51	Same as 11 except unexpected device status was also detected.
52	Same as 12 except unexpected device status was also detected.
53	Same as 13 except unexpected device status was also detected.
54	Same as 14 except unexpected device status was also detected.
61	Same as 21 except unexpected device status was also detected.
63	Same as 23 except unexpected device status was also detected.
64	Same as 24 except unexpected device status was also detected.
65	Same as 25 except unexpected device status was also detected.
66	Same as 26 except unexpected device status was also detected.

Figure 3.9. Unit Status Error Codes (Cont.)

SECTION 4
INTERFACE DESCRIPTION

4.1 USER INTERFACE

This interface has been designed to be general in that it consists of a bidirectional bus and handshaking for the movement of commands, status, and data between user and storage system. The bus is 16 bits wide. Data transfers are made 16 bits at a time and the word transfer rate may vary from 0 to 2 million words per second.

4.2 INTERFACE LINES

Figure 4.1 shows the 23 interface lines. A description of each line follows: (/ = Low Signal)

SYSINT/ — System Initialize — A low active signal whose minimum pulse width should be 500 nanoseconds. When the signal goes low it causes a general reset of the 1150. When it goes high, the microprocessor begins execution at location 000, the beginning of BITE. A power turn-on for the 1150 has the same effect.

RETURNS/ — These are the twisted pair return lines for each of the active signals.

READY — When high, this signal means that the 1150 is ready to receive and execute a command. When low, this signal means a) power is not turned on, or b) the 1150 is executing a command, or c) the 1150 is in its initialization cycle. Source of signal is 1150.

INPUT/ — When this signal is low it means that the 1150 is the source of data on the user bus. When this signal is high, the user is permitted to place data on the user bus. Source of signal is 1150.

LSTWD/ — Last Word — a low active signal generated by the 1150 which will be low during the time that the last word is being sent to or received from the disk drive.

STATUS/ — A low active signal generated by the 1150. It indicates that the data being sent to the user with the next REQ/ is a status word.

REQ/ — Request — a low active, bidirectional signal which is used by the source of data to signal the receiving unit that some data has been placed on the user bus.

ACK/ — Acknowledge — a low active, bidirectional signal which is used by the receiver of data to acknowledge receipt.

USBUS 15-00/ — User bus — a low active, bidirectional, 16 bit wide bus used to transfer commands, data, and status between user and the 1150.

USER BUS CONNECTORS 17800-XXX J-106	SIGNAL NAME	DIRECTION USER 1150
13	USBUS 0 Low Order	←→
9	1	←→
7	2	←→
11	3	←→
21	4	←→
05	5	←→
25	6	←→
03	7	←→
19	8	←→
23	9	←→
15	10	←→
17	11	←→
35	USBUS 12	←→
39	USBUS 13	←→
33	USBUS 14	←→
37	USBUS 15 High Order	←→
45	READY	←
01	SYSINT	→
31	ACK	←→
49	REQ	←→
43	STATUS	←
41	INPUT	←
47	LSTWD	←

NOTE:
Mating connector for J106 is available from ITT Cannon Elec.
Connector P/N 121-7367-002
Strain Relief P/N 317-7305-000
Maximum cable length for host adapter cable is 25 ft.

Figure 4.1. User-Formatter Interface Signals

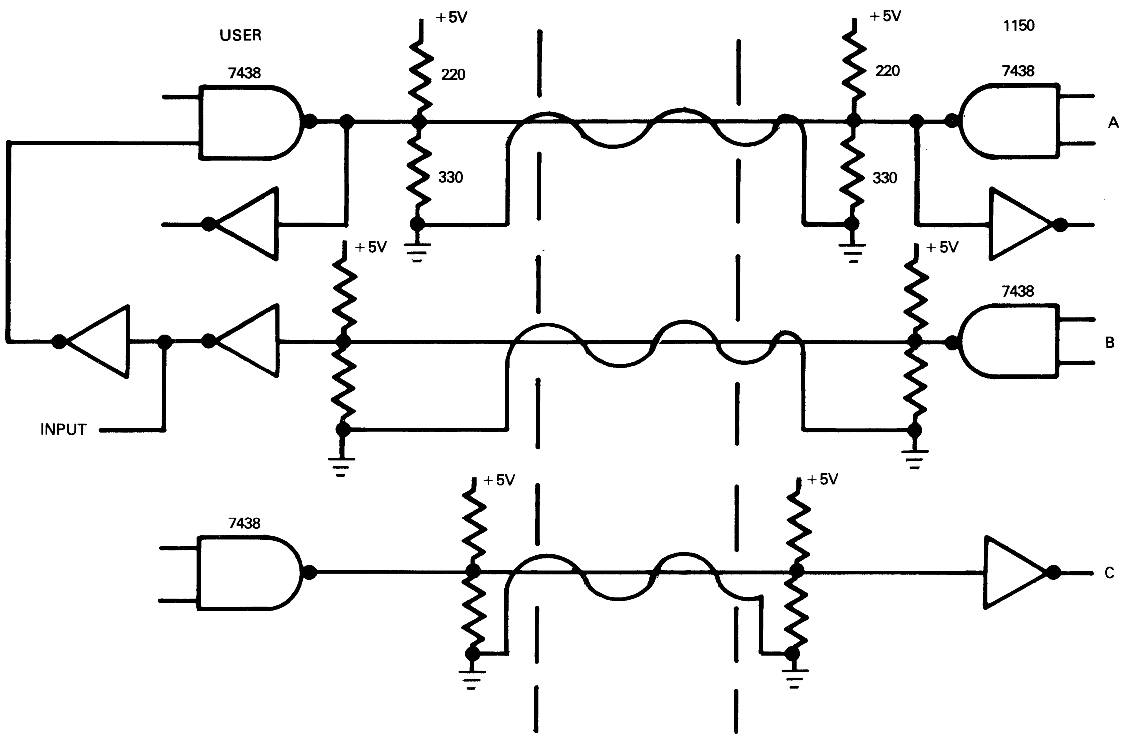


Figure 4.2. Interface

4.3 ELECTRICAL INTERFACE BETWEEN USER AND FORMATTER

General Rules:

a. Bidirectional outputs should be gated with INPUT/ at the user end so that 1150 can control access to the bus. Lines to be gated in this manner are: REQ/, ACK/, USBUS 15-00/. (Ex. A in Figure 4.2.)

b. Unidirectional outputs from the formatter to the user are the following: READY, INPUT/, LSTWD/, STATUS/. (Ex. B in Figure 4.2.)

c. The only unidirectional output for the user, is SYSINT/ which should be handled as shown in Ex. C.

Recommended Drivers:	7438 or equivalent
Recommended Receivers:	Any DTL, or TTL circuit
Recommended Termination:	220 ½W to +5VDC 330 ¼W to +5VDC return

4.4 DISK INTERFACE

There are connectors for attaching up to a maximum of eight disks to the formatter. Each disk may be attached to any of the connectors, the logical unit (plug) number being established by the user controlled configuration table. (Formatter RAM Memory)

4.4.1 Status and Control Functions

Refer to the Trident Performance Spec.

4.4.2 Read/Write Functions

Refer to the Trident Performance Spec.

4.4.3 RPS and Sectoring

When the RPS function is mechanized, the sector counters in each disk are strapped to produce from 1 to 128 sector pulses per revolution. (Angular Addresses) These are transferred to the formatter via the radial cables. "Data Sectoring" is the division of each track into a number of equal length blocks called Physical Records. This action is accomplished using the Address Mark Recording technique. The number of blocks and length of all blocks is determined by values in the RAM configuration table. The mention of some limits is appropriate. All records on a given track are of equal length. A maximum of 128 physical records may be formatted on any track. Physical records may be as large as 4,098 bytes. The user can define LOGICAL Records sizes up to 131,072 bytes. This LOGICAL record will span many physical records.

SECTION 5
INTERFACE TIMING

5.1 TIMING CONSTRAINTS

The timing constraints are:

- Data must be gated onto the user bus lines at least 100 nanoseconds before REQ/ becomes active.
- The data must remain stable throughout the time that REQ/ is low and may be removed at the same instant as REQ/ is made to go high.
- Control lines such as INPUT/, LSTWD/, STATUS/ will become active at least 100 nanoseconds before REQ/ goes low and will remain active at least up to the time at which REQ/ goes high.
- REQ/ may only be made to go low when ACK/ is high.
  REQ/ may only be made to go high when ACK/ is low.
  ACK/ may only be made to go low when REQ/ is LOW.
  ACK/ may only be made to go high when REQ/ is high.
- LSTWD/ will go low at least 100 nanoseconds before ACK/ goes high.

NOTE: User should not attempt to place write data on the bus until READY goes low.

Figures 5.1, 5.2 and 5.3 illustrate the timing relationships required between TAG and DATA lines during command, data and status transfers respectively.

5.2 INTERFACE RULES FOR STATUS HANDLING

Three types of Status can be generated by the Formatter:

- Normal Completion Status: This will set the status signal and will remain on until the interface acknowledges receipt.
- Attention Status: This will set the status signal and will remain on until the interface acknowledges receipt.
- RPS Status: This will set the status signal and will remain on until RPS compare goes false or the interface acknowledges receipt.

NOTE: An RPS interrupt can be identified on the interface by sampling USBUS 15 and 14 for one's (low active). If the RPS interrupt is acknowledged the formatter will do an automatic select of the interrupting drive for the next function delivered to the formatter.

5.3 SAMPLE USER INTERFACE LOGIC

The following information constitutes the basic logic required for the User interface in relationship to Figures 5.1, 5.2 and 5.3. Examples are given in Appendix E.

5.3.1 Command Sequence (Figure 5.1)

During the time that the interface is waiting for a command from the host CPU the interface should be checking the "READY" signal to drop. If this occurs the formatter is entering the "STATUS" mode to present an un-solicited status response due to an ATTENTION or RPS interrupt. The interface should revert to its STATUS logic.

Once a command is accepted by the interface the following steps should occur:

- Put the command word on the bus.
- Set "REQ" low to formatter.
- Wait for a low "ACK" from the formatter.
- Wait for READY to go low before reverting to data transfer logic.

5.3.2 Data Transfer Sequence (Figure 5.2)

When in the data transfer logic sequence with the formatter the direction of the transfer is determined by the state of the "INPUT" signal generated by the formatter.

- Low signal = formatter is the source of data.
- High signal = Host CPU is the source of data.

During data transfer the following rules apply:

- "READY" will stay low
- "INPUT" will remain constant

- Each data word transferred requires a "REQ"/ "ACK" sequence.

Detection of the end of data transfer is accomplished by checking the following conditions after each data word transfer:

- "STATUS", generated by the formatter, will drop to a low state. This indicates that the formatter is trying to present "STATUS".
- "LSTWD", generated by the formatter, will drop to a low state when the next to last word is being processed. This only happens when the transfer is directly related to a disk READ or WRITE operation.

5.3.3 Status Presentation (Figure 5.3)

On all status presentation, the formatter is in the following conditions:

- "READY" is low
- Status word is on the bus
- "STATUS" is dropped to a low state

The interface should take the status word from the formatter bus and "ACK" the formatter.

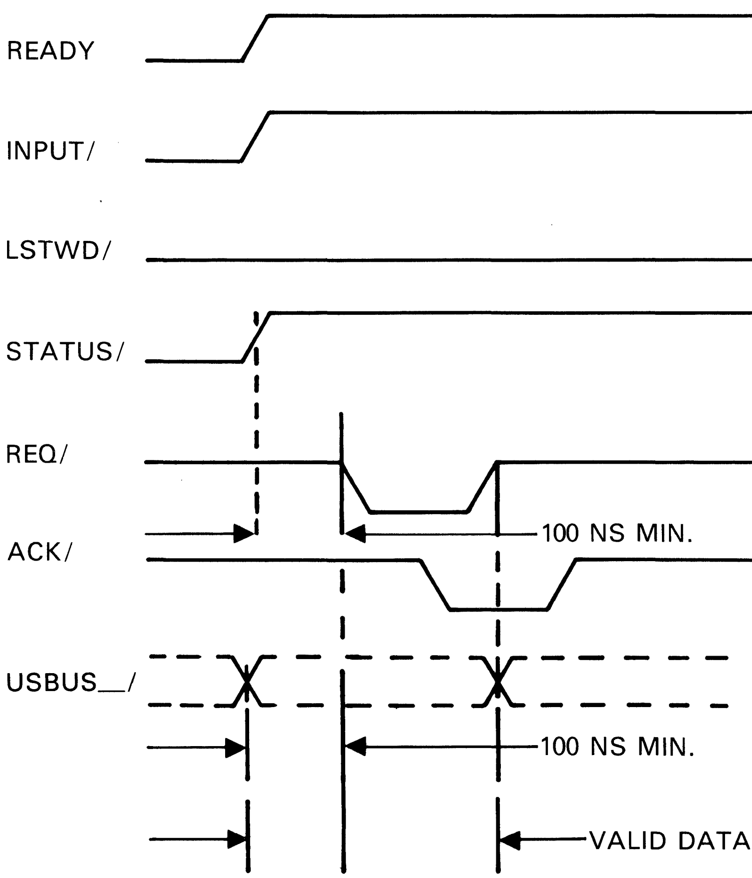
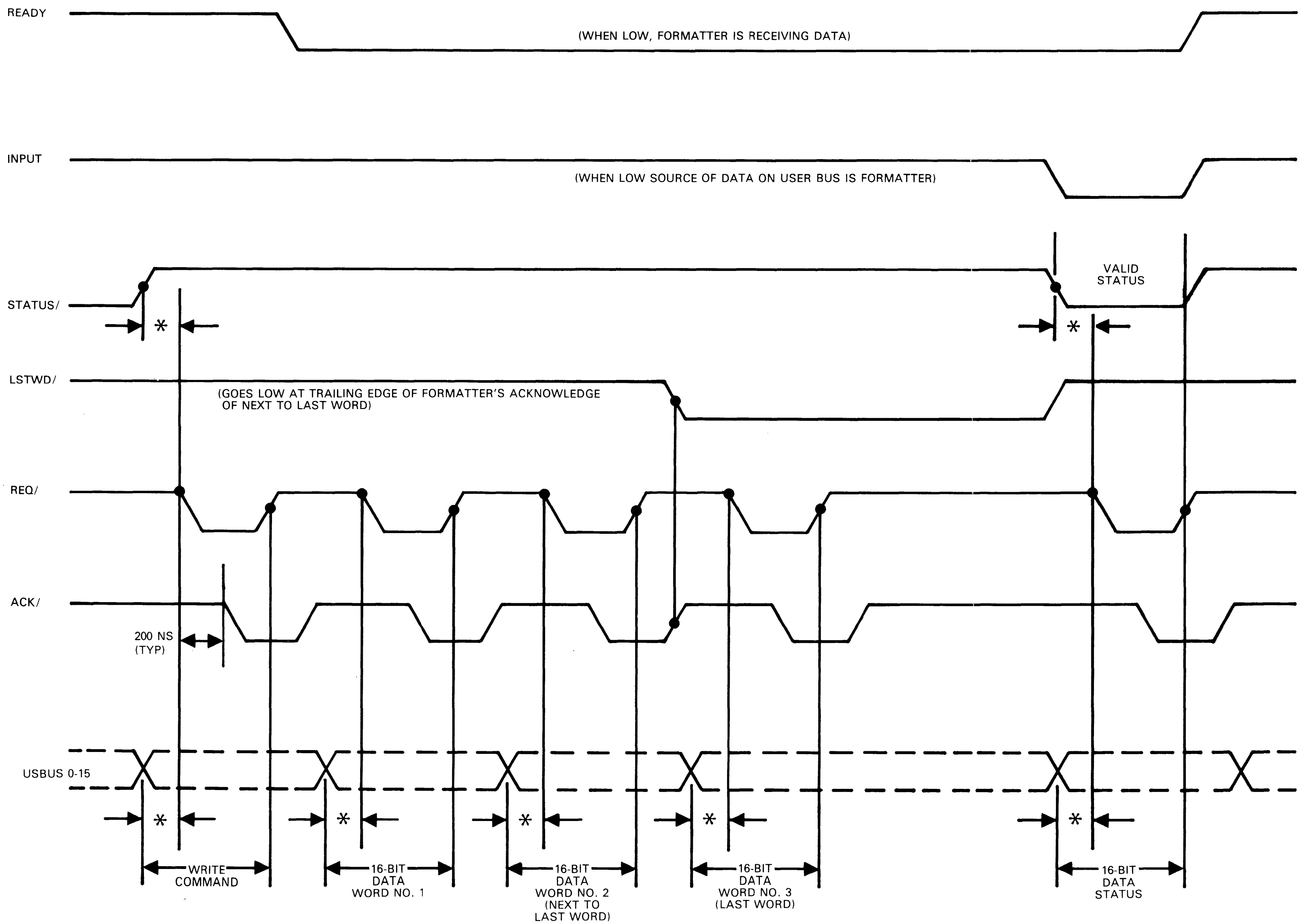


Figure 5.1. User Sending a Command to the Formatter



* 100 NS MIN.

Figure 5.2. Three Word Transfer from User to Formatter

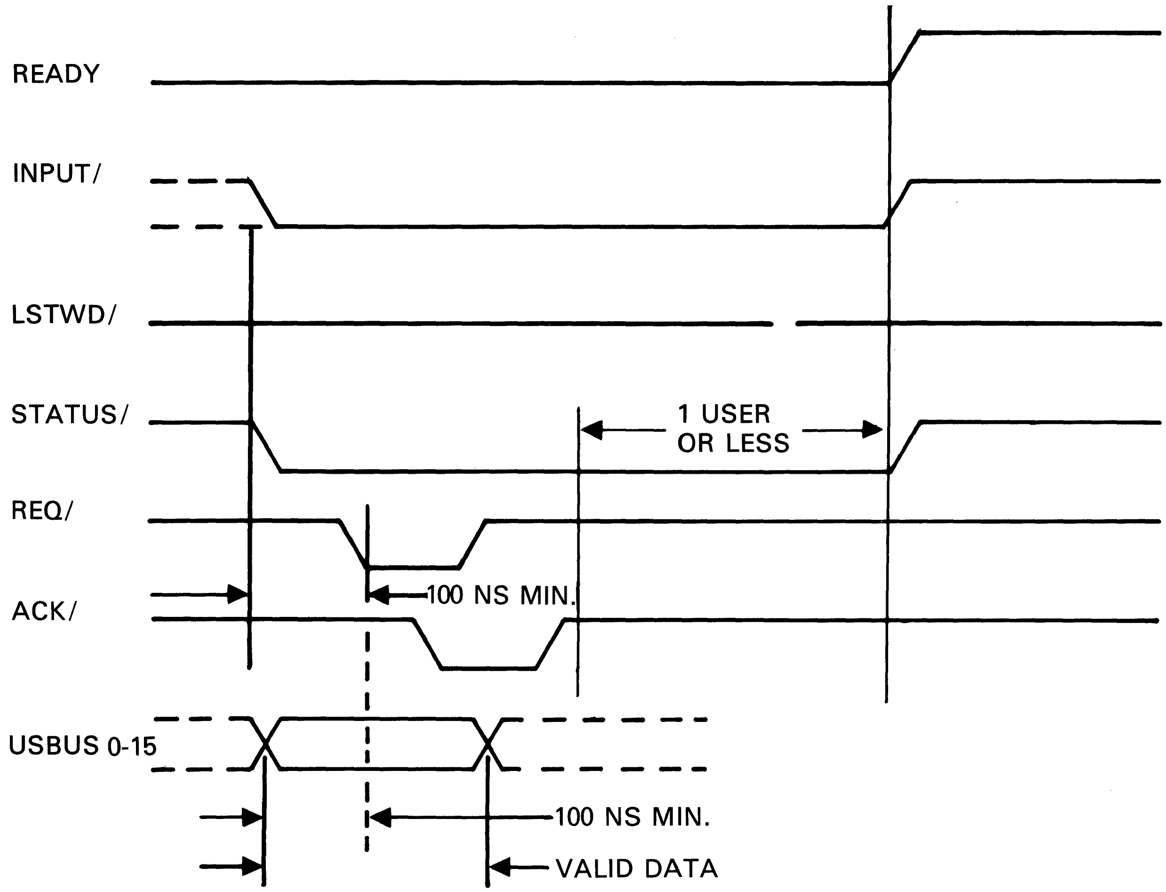


Figure 5.3. Formatter Presents Status to User

SECTION 6
OPTIONS

6.1 RPS FIRMWARE – SETTING TARGET SECTORS

Each time the User decides to activate or de-ativate an RPS search on any disk drive, he is *solely* responsible for the performance of each of the following steps:

First, the User must determine that the formatter is not busy.

Second, the User must select the disk drive of interest (command code 80) and determine that it is available.

Finally, the User must set or reset the target sector (command code 84). The most significant bit of the low significance byte must be a logical one to set the target or a logical zero to reset it. When resetting a target, the seven least significant bits are irrelevant; when setting a target, the seven least significant bits are the (positive) sector of interest.

IT IS ALSO THE USER'S SOLE RESPONSIBILITY TO SUBTRACT ENOUGH FROM THE SECTOR OF INTEREST TO ALLOW FOR HIS OWN PROCESSING OVERHEAD AND TO INCLUDE IN HIS CALCULATIONS 50 MICROSECONDS FOR FIRMWARE OVERHEAD.

If the disk drive is set for 128 sectors, (maximum) each sector is 130 microseconds in duration. If the drive is set for 64 sectors, each sector is 260 microseconds in duration.

6.2 RPS INTERRUPTS

Assuming the formatter to be idle, the occurrence of a sector count/target sector equality causes the following sequence:

Firmware reads the equality latches and (using the configuration table) translates from physical unit to logical unit. The resulting byte becomes the low significance byte of the forthcoming status word.

Firmware finds the highest priority active equality (logical drive zero has the highest priority and logical drive seven has the lowest) and automatically selects that drive. It also resets the target sector associated with the highest priority drive.

Firmware encodes the logical drive number of the highest priority drive and places it in the three least significant bits of the high significance byte of the forthcoming status word, sets the two most significant bits to ones and asserts INPUT/, STATUS/ and REQ/.

Firmware expects ACK/ in response to REQ/. If it does not receive ACK/ in a reasonable time, it will remove the request and return to the Idle Loop.

THE STATUS REQUEST IS THE ONLY NOTIFICATION THE USER MAY EXPECT THAT THE RPS HAS FOUND THE TARGET, THAT THE HIGHEST PRIORITY DRIVE HAS BEEN SELECTED, AND THAT THE ASSOCIATED TARGET IS NOT RESET.

APPENDIX A
COMMONLY ASKED QUESTIONS CONCERNING 1150 OPERATIONS

1. Q. *Is the RAM table contents in the 1150 valid after completion of a power up of the system?*

   A. No. the RAM data is lost on power down. The host system must set up the necessary parameters in the RAM configuration table via the LOAD TABLE COMMAND to the 1150 prior to any other commands being issued to either the 1150 or an attached drive.

2. Q. *If I must IPL my system from a disk to get rudimentary intelligence into my system how can I load the RAM table in order to read in the disk IPL record?*

   A. A hardware state counter could be implemented in the host adapter which would issue commands to the 1150 to load the table and read in the IPL record.

3. Q. *Can I interlace sectors on the media?*

   A. The 1150 will format the Trident disk with absolute contiguous record numbers in the ID fields. All of the formatting information will come from the RAM configuration table during the pack format command. If logical sector interlacing is required, the user must do a physical to logical mapping function either in his software or his host adapter.

4. Q. *How much Data is transferred to the system on Read ID command?*

   A. All six (6) Data Bytes of the ID area will be transferred to the system on a READ ID command.

5. Q. *If I am executing a multi-sector transfer operation and an ECC error is detected on a sector prior to the last one what happens on the interface and how can I tell where I am?*

   A. On a multi-sector command, one in which the user word count is greater than the physical sector size, an ECC check is performed at the end of each physical record. When an error is encountered at the end of a physical record, the data transfer handshake terminates and the 1150 will raise *status/* flag with an error condition indicated. The word in RAM table location word 96 will contain the record number of the failing sector in the low order eight (8) bits. The user can read out this word via the *Read Table* command in order to locate his error position.

6. Q. *How are multiple pending attention interrupts handled by the* clear attention *command?*

   The *clear attention* command must be preceeded by a *select* command in the users command sequence. Therefore, only the attention status bit for the selected unit will be reset.

7. Q. *Will the 1150 cause a system interrupt when a pack is changed or a drive comes ready due to a* sequence *command?*

   A. No. The system will always present a *select* command to the 1150 before any operational type of command. The status presented will indicate any attention conditions pending. The operating system is responsible for storing this status and flagging which units have generated an attention to the 1150 since their previous selection by the system.

8. Q. *Does a* Seek *command interrupt the system?*

   A. Yes, but the interrupt may be suppressed by the user via bit 11 in the Seek command word. In this case, the status word will reflect an attention bit pending but the 1150 will not attempt to force an interrupt into the system via the *status* line.

9. Q. *Can I do a buffer command simultaneously with a read or write command?*

   A. No. Only one (1) command can be performed at a time. For example, while the 1150 is performing a non-buffered Read command it could not accept data from the host into the buffer for a subsequent write out of buffer command.

10. *Q. Must I set up the user word count in the RAM table prior to an ID command?*

A. No. The ID commands always work on a six (6) byte basis. The user word count in the RAM only applies to reading and writing of the data fields.

11. *Q. What Data must I send to the 1150 during a write ID command?*

A. Only the flags must be sent to the 1150. All of the other data will come from that which resides in the RAM table during the command execution.

APPENDIX B
COMMAND EXECUTION SEQUENCE
EXAMPLE

The following describes the logical flow of events which take place in a typical disk operation:

1. Power is applied to the system. The 1150 executes the Bite routine and goes into the system wait loop. The LED on the front panel lights indicating the Formatter is operational. The READY line goes high active telling the Host System that the 1150 can accept a command.

2. A load table command is issued to the 1150 to establish the necessary system parameters.

   The user places the command word on the Bus lines and waits 100 ns. He then raises REQ/. The 1150 wait loop sees REQ/ and strobes the bus into a register and raises ACK/ to indicate to the Host Adapter that the command word has been accepted.

   NOTE: When the 1150 is in the wait loop it assumes the first word presented on the bus with REQ/ is always a command word. When ACK/ goes active, the Host resets REQ/ which causes the 1150 to reset ACK/. When the Host sees ACK/ go inactive he places the first word of the table values on the Bus, waits 100 ns and activates REQ/.

   The 1150 activates ACK/ when it accepts the word. REQ/ is then reset by the Host which causes the 1150 to reset ACK/. This sequence continues until the last word has been transferred to the table. The status presentation is then performed.

   The 1150 activates the input/ line followed by status/. The status bits are placed on the bus at least 100 ns prior to activating status/. At least 100 ns after status/ goes active the 1150 activates REQ/ to inform the Host of the presence of the status word. The Host will strobe the bus into his Adapter and activate ACK//. Upon seeing ACK/ the 1150 will reset REQ/, status/ and input/ simultaneously. The Host will reset ACK/ when he sees REQ/ go inactive.

   This completes the command handshake execution. This sequence is typical of all the command sequences.

3. After the load table function is completed, a sequence command is issued to the needed drives.

4. A delay of at least 9 seconds should be provided by the Host system between successive sequence commands to prevent AC current overloading during initial drive high start current surge.

5. A Select command is issued to logically select the appropriate drive and the appropriate status word.

6. A Read command is issued to the drive to read in the required data.

7. Operations will continue to be executed on the same drive until another select command is issued to a different drive.

APPENDIX C
INTERFACE DESCRIPTION FOR THE 1150 DIAGNOSTIC MODULE

C.1 SELECTABLE DISPLAY — 8 LED's (see Figure C.1)

Used to monitor instruction address of the microprogram as well as the status of several busses in the formatter.

C.2 CLOCK CONTROL LOGIC — Four Modes

Free Run

Address Stop — Per address compare shown below.

Single Instruction

Single Clock

C.3 ADDRESS COMPARE CAPABILITY — Ability to:

Store a 12-bit reference address.

Display the 12-bit reference address.

Give either a pulsed or a latched indication of a compare between the present (actual) instruction address and the reference address stored as in C.3. above.

Stop the clock upon compare if enabled as in C.2 above.

C.4 ADDRESS TRACE CAPABILITY

An automatic recording of instruction addresses so that whenever the clock is stopped in T2 or T3, the operator can see, in addition to the present address, the previous 15 addresses.

C.5

Allowance for the operator to enter 1150 — type user commands and transfer data and status.

C.6

Ability to *invoke* the *internal* 1150 *diagnostic routines* by telling it to force high-order address lines then giving it a master reset. Three additional bits; LOCAL, LOOP-ALL, and LOOP-ERR are tri-stated onto one of the low-true busses mentioned in C.1 above. This enabling is per a strobe from the 1150.

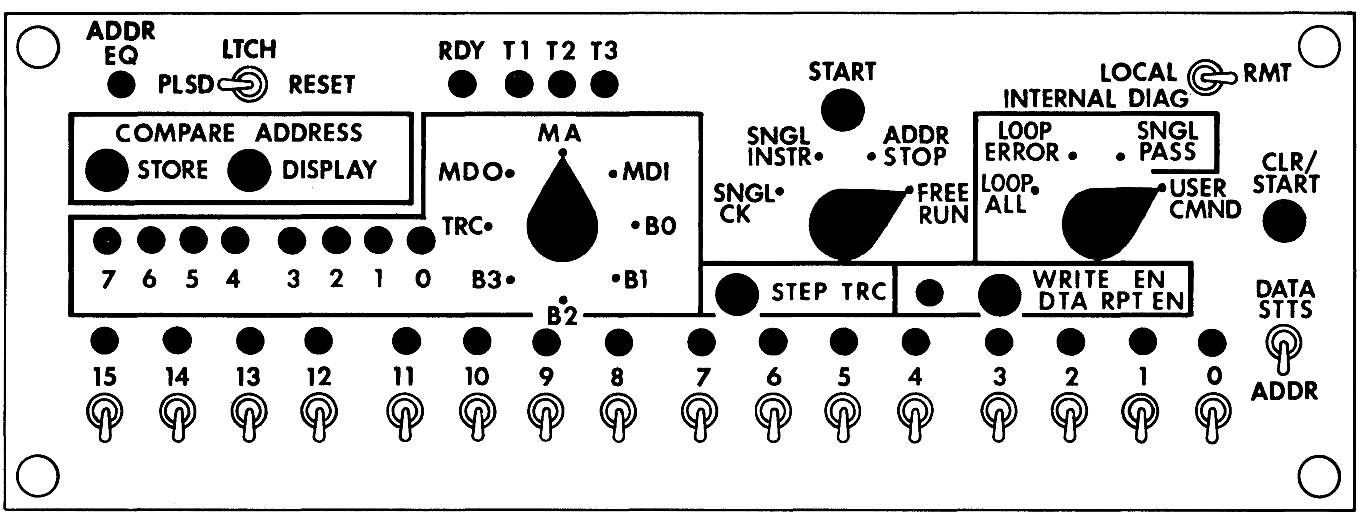


Figure C.1. 1150 Maintenance Panel

APPENDIX D
USEFUL STORAGE CAPACITY

SECTOR SIZE (BYTES)	TRIDENT DRIVES														
	T-25 27.4 MBytes			T-50 54.7 MBytes			T-80 82.1 MBytes			T-200 208.1 MBytes			T-300 312.1 MBytes		
	SEC	CAP	%	SEC	CAP	%	SEC	CAP	%	SEC	CAP	%	SEC	CAP	%
256	39	20.4	74	39	40.7	74	54	56.3	69	39	154.6	74	54	214.0	69
512	22	23.0	84	22	45.9	84	32	66.8	81	22	174.4	84	32	253.6	81
768	15	23.5	86	15	46.9	86	22	68.9	84	15	178.3	86	22	261.6	84
1024	12	25.1	92	12	50.1	92	17	70.9	86	12	190.3	91	17	269.5	86
2048	6	25.1	92	6	50.1	92	9	75.1	91	6	190.3	91	9	285.4	91

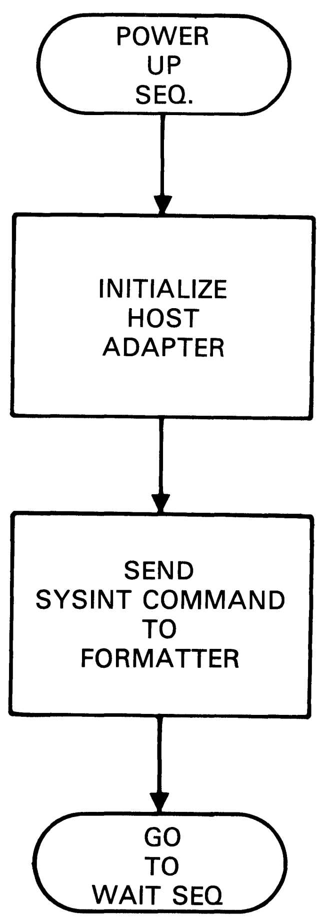
SEC = Number of sectors per track
CAP = Net capacity in megabytes
% = Efficiency

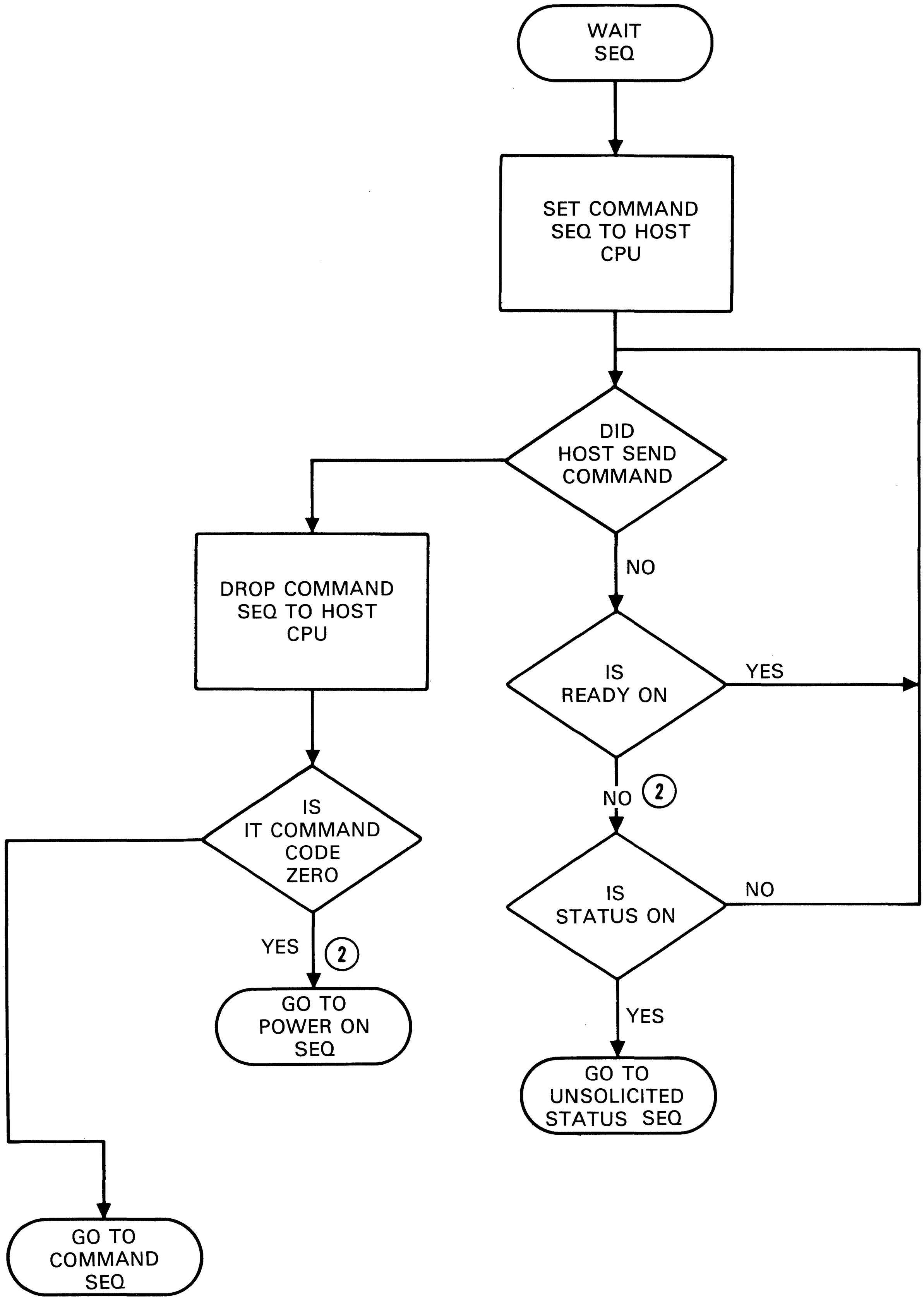
APPENDIX E
SAMPLE USER INTERFACE LOGIC EXAMPLES

E.1 GENERAL

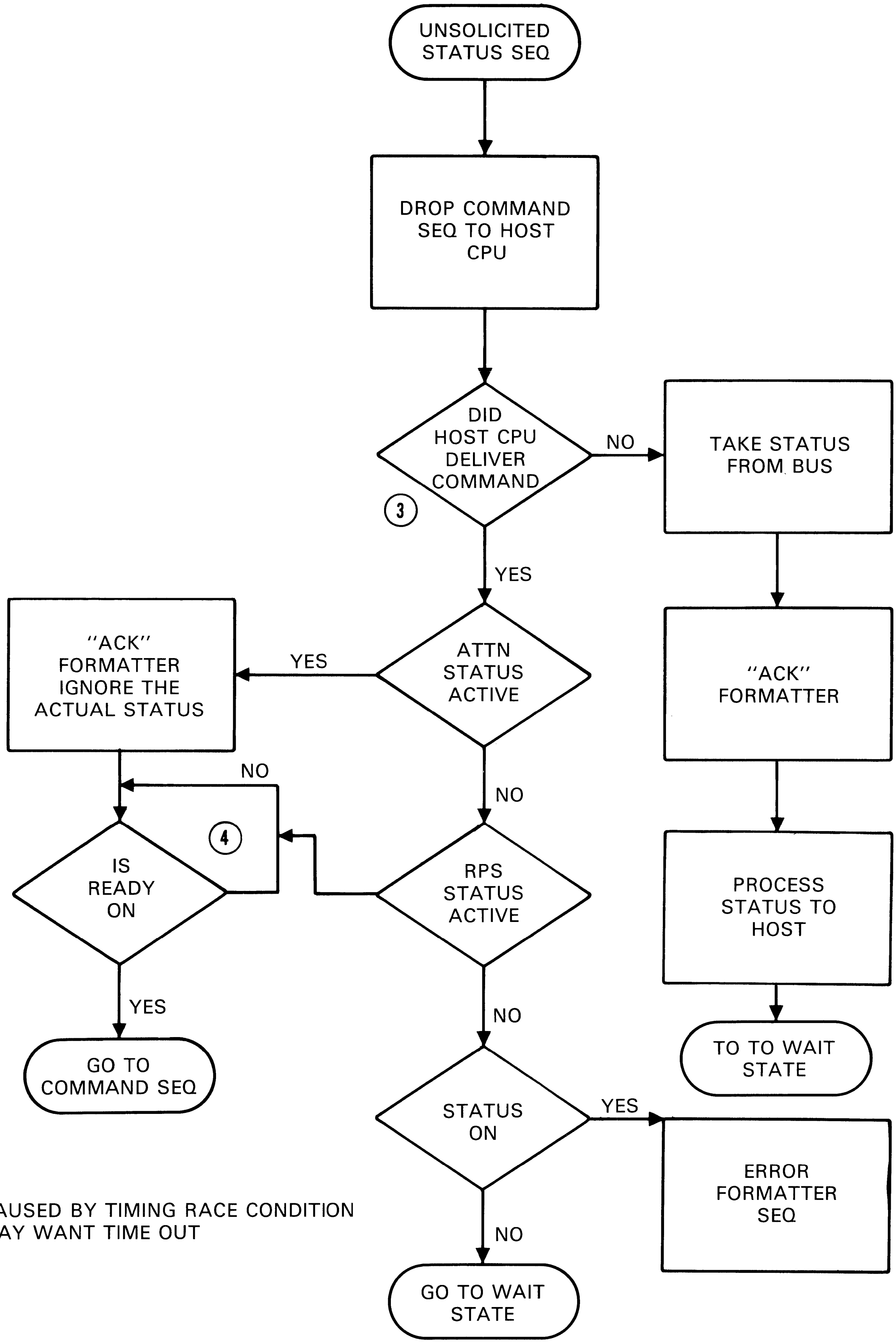
The following flows give the steps required by a Host Adapter to interface the Host CPU to the Formatter. The example includes the logic required for the RPS option, which if not required can be ignored.

THE FLOWS ARE PROVIDED AS AN EXAMPLE ONLY. CALCOMP IS NOT RESPONSIBLE FOR THEIR IMPLEMENTATION FOR A HOST ADAPTER TO THE 1150 FORMATTER.



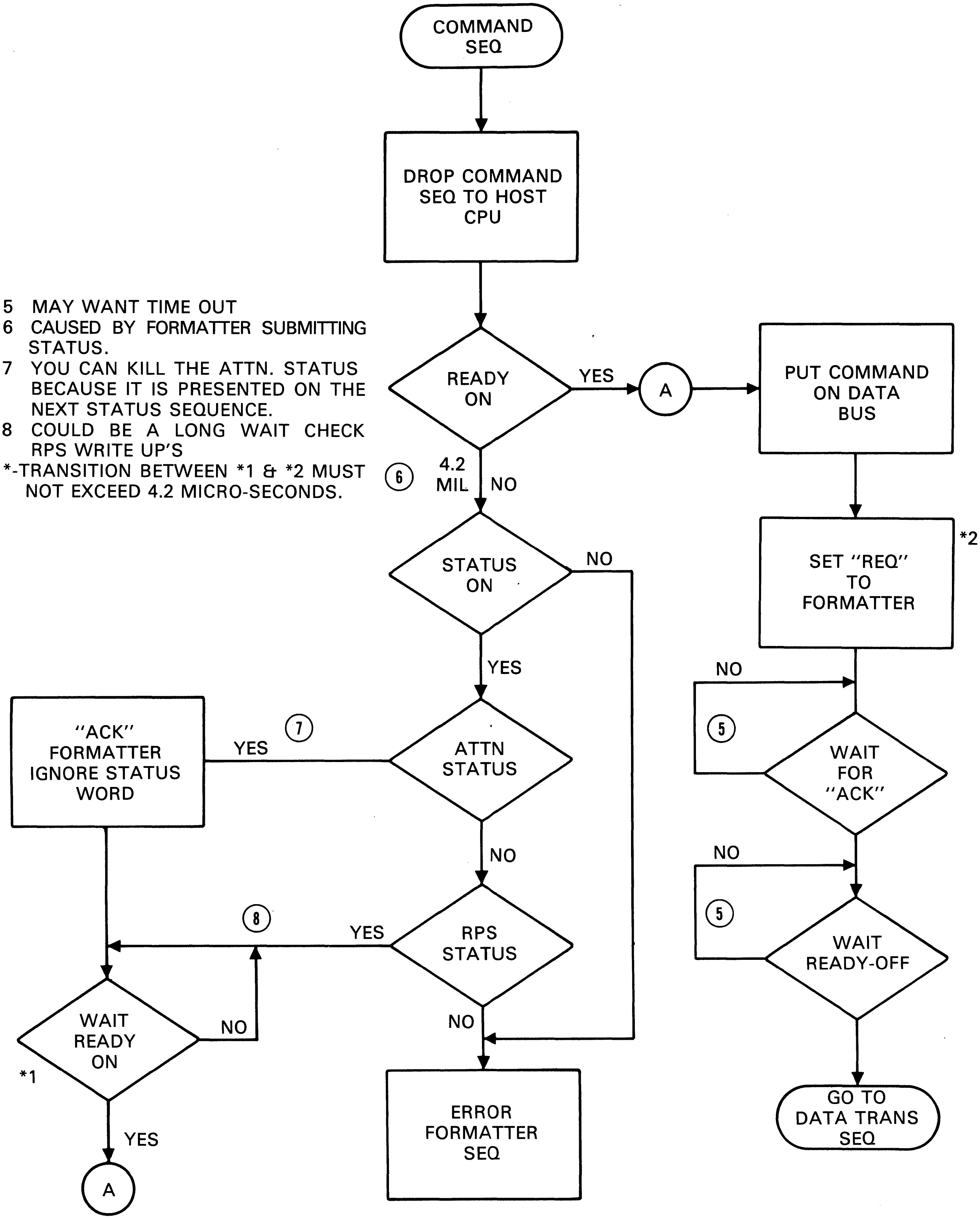


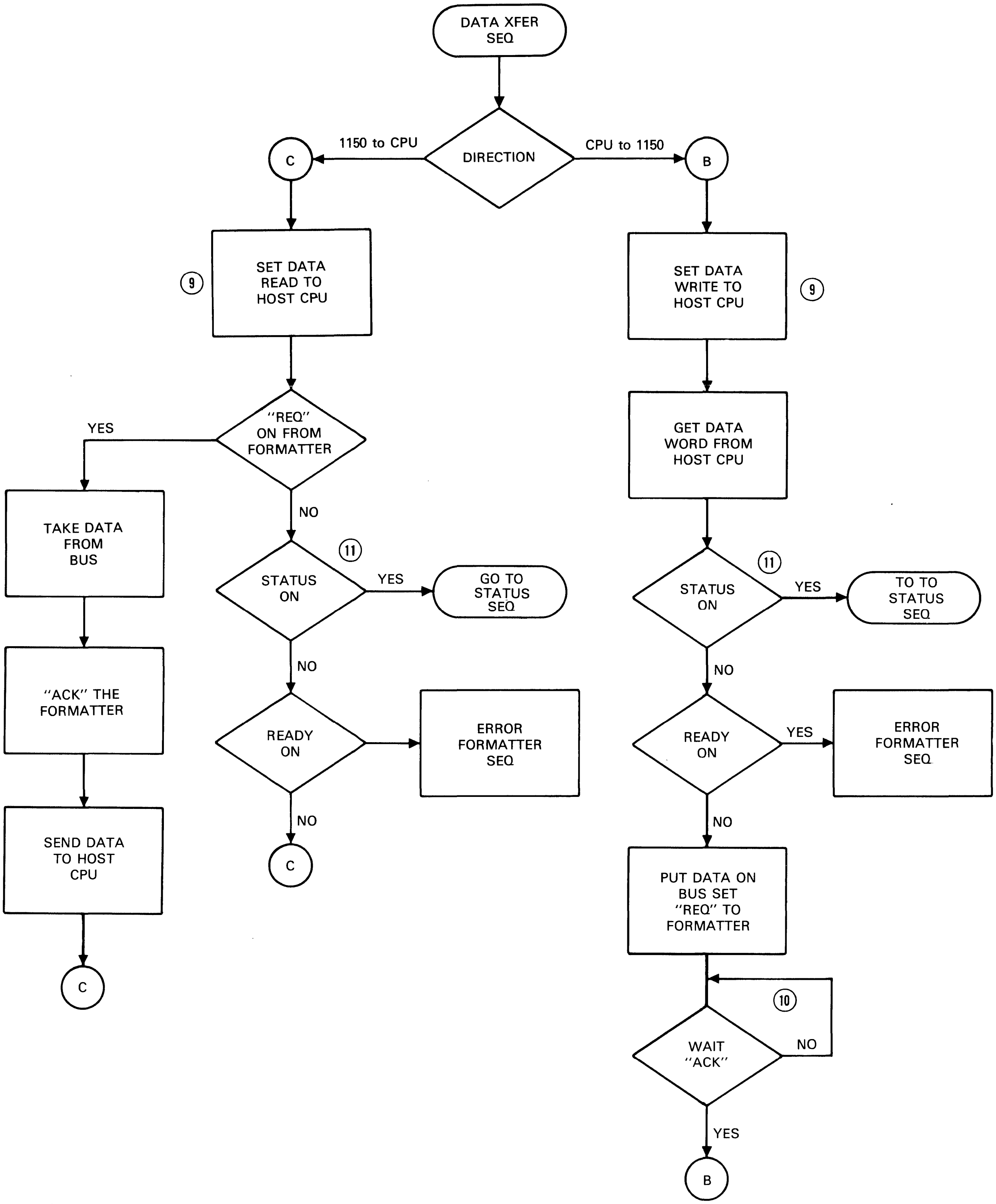
1= MAY WANT TIME OUT OF 10 MSEC.
2= ALTERNATE SEQ = EXECUTE COMMAND BUT REMEMBER STATUS IS NOT RETURNED. THE FINAL ACTION BY THE FORMATTER IS THAT READY COMES BACK ON.



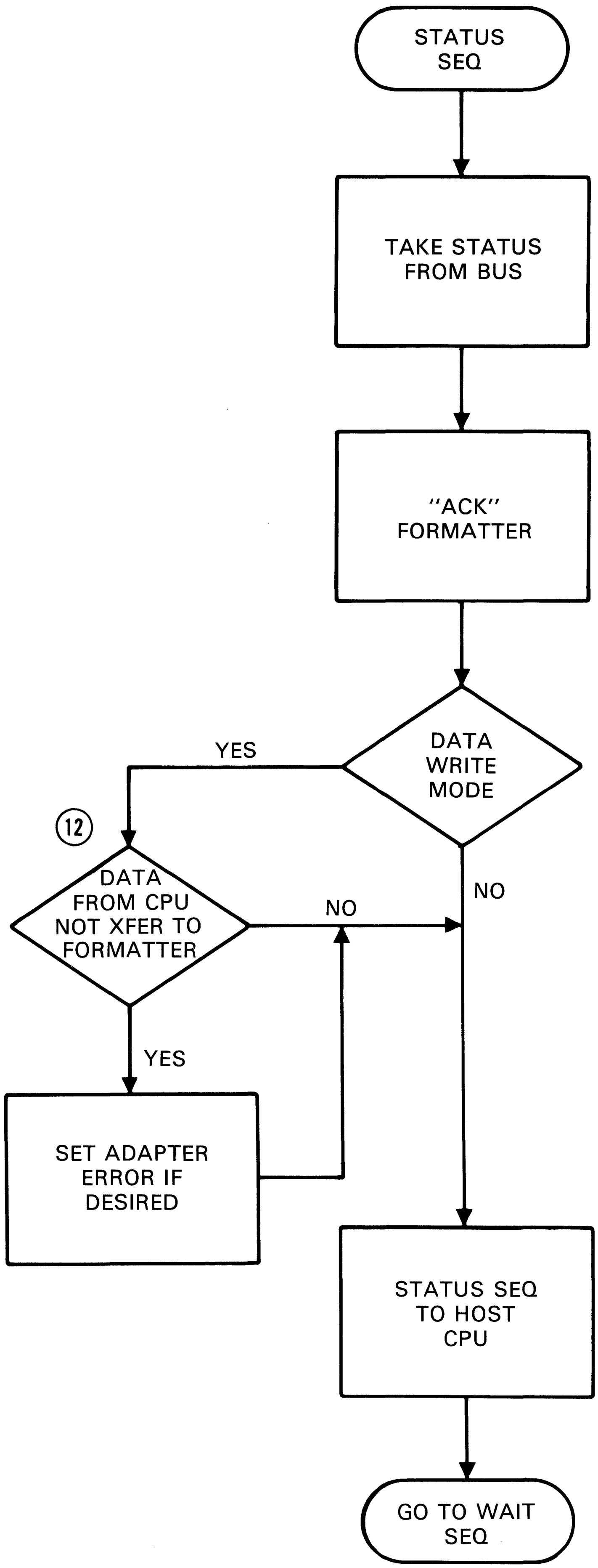
3 CAUSED BY TIMING RACE CONDITION
4 MAY WANT TIME OUT

5 MAY WANT TIME OUT
6 CAUSED BY FORMATTER SUBMITTING STATUS.
7 YOU CAN KILL THE ATTN. STATUS BECAUSE IT IS PRESENTED ON THE NEXT STATUS SEQUENCE.
8 COULD BE A LONG WAIT CHECK RPS WRITE UP'S
*-TRANSITION BETWEEN *1 & *2 MUST NOT EXCEED 4.2 MICRO-SECONDS.





9 OPTION TO USERS
10 MAY WANT TIME OUT
11 THE ADAPTOR MAY ALSO WANT TO CHECK "LASTWORD" TO ALLOW FOR A PRENOTICE OF STATUS PRESENTATION


STATUS SEQ
TAKE STATUS FROM BUS
"ACK" FORMATTER
DATA WRITE MODE
YES
NO
12
DATA FROM CPU NOT XFER TO FORMATTER
NO
YES
SET ADAPTER ERROR IF DESIRED
STATUS SEQ TO HOST CPU
GO TO WAIT SEQ

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