cipher 3000i

PRODUCT SPECIFICATION

3830 Series
Half-Inch Cartridge
Tape Drive

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Tape Drive

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April 1989

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Chapter 1 General Description

1.0 INTRODUCTION

This document provides information on the Cipher® 3830 Series Half-Inch Cartridge Tape Drives. The 3830 Series has two base models, the 3832 and the 3834, that are part of the 3000i™ family. These two models are available in a wide selection of interface and mounting configurations.

In this document the 3832 and the 3834 cartridge tape drives are referred to as the 3830 Series. The exact model number is used when specific model references are required. Detailed information on both models is covered in the following chapters.

1.1 CARTRIDGE DRIVE APPLICATIONS

The 3830 Series drives are designed to back up high-capacity disk drives for workstations, midrange and small mainframe computers and to provide reliable data interchange between computers ranging from low-end systems to small mainframes. Each drive contains a single tape drive with an Integrated Device Controller (interface).

1.2 CAPABILITIES

The 3830 Series drives use the industry standard, 3480-type half-inch cartridges to read and write data using the Multi-track Serpentine Recording (MSR) format. During handling all cartridge openings are closed and the tape cannot be damaged by accidental contact. The drives also feature automatic loading and self-threading of the tape. This ensures simple, rapid handling while protecting the tape from contaminants.

The 3480-type cartridge contains up to 600 feet of tape. Each cartridge can store up to 320 megabytes of formatted data and up to 3.4 megabytes of directory information. The model 3832 can transfer data to or from tape at 448 kilobytes per second (KB/s) and the 3834 can transfer 896 KB/s.

1.3 MIGRATION AND COMPATIBILITY

As previously mentioned, two base models of the 3830 Series are available. The 3832 has a 2-track Read/Write Head and writes data in the MSR-2 format. The 3834 has a 4-track R/W Head and writes data in either the MSR-2 or MSR-4 format. Both models have 512KB of cache memory.

The models are backward compatible. A model 3834 can read and write cartridges recorded by a 3834 or a 3832. The 3832 can only read a cartridge written by a 3834 if the MSR-2 format was used.

When a recorded cartridge tape from a 3832 is loaded into a 3834, the read/write operations automatically default to the MSR-2 format.

The model 3834 can record tapes that can be read by a 3832 when the 3834 is placed in the 2-track mode using the format switch on the front panel. The mode set at the front panel can also be changed by commands from the host computer.

1.4 MODEL DIFFERENCES

The major differences between the models are the number of tracks read or written in a group, instantaneous data rate at the R/W Head, maximum effective data transfer rate between cache and tape, and the sector size (without control characters) transferred between cache and tape. See Table 1-1.

Model	Group	Cache	R/W Head	Cache/Tape	Sector Size
3832	2-track	512 KB	487 KB/s	448 KB/s	4096 Bytes
3834	4-track	512 KB	975 KB/s	896 KB/s	8192 Bytes

Table 1-1. Model Differences

1.5 OPTIONS

Each Model has the following available options:

SCSI, IPI, or Cipher interface
AC with a power supply
DC with customer-supplied power
Stand-alone with enclosure
19-inch rack-mounted

1.6 GENERAL FUNCTIONAL DESCRIPTION

The 3830 Series is composed of four main functional assemblies: the interface, microprocessor controller, servo driver, and the drive mechanism.

1.6.1 Interfaces

The host communicates with the drive through one of three available interfaces: the Small Computer Systems Interface (SCSI), the Intelligent Peripheral Interface (IPI), or the Cipher Interface. The interface translates system bus commands into tape drive executable commands, as well as translating tape drive data and status signals into the correct system bus format.

1.6.2 Microprocessor Controller

The drive uses a microprocessor (MPU) to control all logic functions relating to read/write, tape motion, cache memory, and data/command transfers between the drive and the interface. The MPU interprets the command lines from the interface, accelerates and decelerates the tape, positions the Read/Write Head, detects tape position, controls format, and provides status to the host via the interface.

Using the cache memory for read and write operations significantly reduces timing constraints on the interface. During write operations the cache stores blocks of data until the tape is in position. During read operations the cache stores the blocks of data from the tape until the host is ready to accept them.

1.6.3 Servo/Driver

The Servo/Driver converts the binary control data from the MPU to dc signals, with the appropriate voltage and current, to drive the various motors.

1.6.4 Drive Mechanism

The drive mechanism provides the appropriate tape motion, records the data supplied by the interface, and reads back recorded information.

1.7 GENERAL HARDWARE DESCRIPTION

The standard configuration of each model of the 3830 Series includes an interface, cache memory, switches and indicators, read/write electronics, a fan for cooling, and a drive mechanism. The drive mechanism consists of a cartridge tape loader/threader, motors, and a head assembly.

1.7.1 Mounting

The drive can be mounted in a stand-alone enclosure or mounted horizontally, vertically, or side-by-side in a rack.

1.7.2 Front Panel

The front panel provides the operator with four indicator lights, a two-digit hexadecimal display, and two pushbuttons (UNLOAD and FORMAT).

The front panel of the 3830 Series performs the following functions:

Loads and unloads the cartridge tape.
Signals faults.
Allows format selection.

Initiates diagnostic tests.
Allows configuration options to be reviewed or changed.

1.7.3 Rear Panel

The rear panel has the ac power switch (if an ac model) and interface connectors.

1.7.4 Drive Mechanism

The drive mechanism consists of motor driven assemblies, under microprocessor direction, that precisely control insertion, positioning, and ejection of the cartridge tape, as well as tape and R/W Head motion.

Chapter 2 Functional Description

2.0 INTRODUCTION

This chapter provides a general understanding of the major functional capabilities of the 3830 Series drive. A more detailed description of the electronic circuits and hardware components, referenced by physical task and location, is provided in Chapter 3.

2.1 OPERATOR CONTROLS

The operator controls and indicators allow for manual operation and testing of the tape drive. They are described in detail in Chapter 7. There are no operator controls inside the tape drive.

2.2 CARTRIDGE LOADING AND UNLOADING

The shape of the cartridge and the opening in the Front Panel establish the correct orientation of the cartridge. During the loading process, the Loader automatically loads, aligns, and engages the cartridge. The Loader can also determine whether a Cleaning Cartridge has been inserted. When an unload function is initiated and the tape is fully rewound, the Loader disengages and partially ejects the cartridge.

2.3 RECORDING FORMAT

2.3.1 Track Format

The 3830 Series drives record data serially using a serpentine format on 24 parallel tracks. Two MSR formats, MSR-2 and MSR-4, are defined. With MSR-2, the drive records two tracks simultaneously; with MSR-4, four tracks are simultaneously written. All 3830 Series drives can read and write the MSR-2 format, providing a common format for interchanging data between MSR-compatible drives.

As tape passes the Read/Write Head, the drive reads or writes a track group of two or four tracks. Track groups are designated in ascending recording sequence with the first as "track group one," the second "track group two," etc. Odd-numbered track groups are written as the tape moves from the supply reel to the take-up reel; even-numbered track groups are written in the opposite direction. The head is stepped up and down to switch from one track group to another. Six or twelve passes (depending on which format is being used) of the tape are required to read or write a cartridge.

2.3.1.1 Format Definitions

Physical Beginning of Tape (PBOT) is where the Leader Block is fastened to the tape.

Physical End of Tape (PEOT) is where the tape connects with the supply reel hub.

Beginning Of Tape (BOT) is the "load point" of the tape with the write head positioned at track group 1. It is also referred to as Logical Beginning Of Tape (LBOT). The loading process positions the tape at the head at this point. A rewind operation also causes the tape to be positioned here. BOT is not less than 1.2 meters from PBOT.

Logical Beginning of Track (LBOTx). The first five sectors written in a track group are special sectors marking the beginning of a track group and are designated as such by placing the End of Track indicator in the sector control information. LBOTx is the point where the first sector of user data can be written in a track group.

End of Track. Write End Of Track (WEOTx) is the point following the last sector of user data written in a track group. The point beyond WEOTx where the drive controller can no longer read data is Read End Of Track (REOTx). A distinction is made between WEOT and REOT to allow for mechanical tolerances across drives. Writing in a track group is terminated before reading is terminated to ensure that a tape written on one drive can be read on another.

2.3.2 Tape Partitions

The tape is divided logically into two recording areas termed partitions. One partition, called Data Partition 1, has a minimum capacity of 3.4 megabytes and is located at the end of the last track group. The other partition, the Default Data Partition, contains most of the recording area and is located across all track group except the portion of the last track reserved for Data Partition 1. Each partition has four logical locations: Beginning of Partition, Logical End of Partition, Write End of Partition, and Read End of Partition. There is a void area between the end of the Default Data Partition and the Beginning of Data Partition 1 that is not less than 0.4 meters long.

2.3.3 Block Format

Blocks of user data are recorded on tape in fixed-length sectors of 4096 (MSR-2) or 8192 (MSR-4) bytes. In order to maximize compatibility with existing system and applications software, the drive accepts from a host blocks of data that can vary from one byte to 64 kilobytes in length. Each block of data is formatted onto a sector, so that a sector can contain either one data block or a portion of one block; a sector can never contain more than one block regardless of the block's size. Maximum cartridge capacity is available only when the block size is an integer multiple of the size of the sector of the selected format. The data in Table 4-1 demonstrate this.

2.3.4 Sector Contents

During write operations data is recorded in each sector in the order received from the host. If a sector is filled before a complete block has been processed, the remaining data is written into the next contiguous sector. If the recording of data does not end on a sector boundary, the sector is padded to the correct length with hexadecimal zeroes at the beginning of the sector. Control information is added at the end of each sector before the sector is recorded on tape. A pattern designated the Intersector Gap (ISG) is written on tape following each sector.

During read operations one or more sectors are read (depending on the size of the user data blocks), control information is removed, and the block of data is transferred to the host.

2.3.5 Physical Data Address

Positioning commands allow the host to determine the physical location of a data block on the tape and to position the tape to the beginning of a block. A 32-bit physical address is used for each block and filemark: eight bits identify the track group containing the first sector of the block, 20 bits identify the relative position of the block within the partition, and four bits are reserved.

2.4 READ/WRITE OPERATIONS

The MPU monitors and controls data transfers from and to the tape. The MPU itself is not directly in the data path. Data is transferred to the media via the Cache Memory.

2.4.1 Cache Memory

The Cache Memory stores data, partitioned as blocks and sectors, until the host or the Read/Write circuits are ready to process it. Data is transferred one sector at a time. The sector size depends on the recording format (MSR-2 or MSR-4). The MPU controls all transfers via the Cache Memory to and from the tape. The interface transfers data between the cache and the host. The Read/Write circuitry transfers data between the tape and cache. Each data block is maintained in cache memory until it has been correctly written to tape or read by the host.

2.4.2 Read After Write

All written data is verified by the read head immediately after being written. This ensures that the R/W Head is performing correctly, the data block can be read, and the Error Correction Code (ECC) is within limits. Whenever the write head is operating, the read head is reading the data just written to tape and sending the signals to the read ECC circuitry to check for errors.

2.4.3 Cache Write Operation

In the cache write mode, Cache Memory stands logically between the interface and the tape. When the drive receives a write command, a data transfer is started. After at least one full block of data has been transferred to cache, tape motion is started. When the tape reaches recording speed, data is transferred from cache to the write data flow hardware for recording.

Once recording has started, the transfer of data between the interface and cache and between cache and the tape are allowed to overlap. This is permissible because the Cache Memory has an independent control system. In the time required to write a data sector to tape, the cache can often store additional blocks from the same or subsequent write commands. The drive can thus support high-efficiency continuous streaming.

During these operations, each data block is maintained in the cache until it has been written correctly to tape. This action allows the host to recover full data blocks from cache if a drive fails. Once all the data and the End Of Data (EOD) marker have been written, tape motion is braked and the drive repositioned for the next operation. If the next operation is also a write, the EOD marker is overwritten.

2.4.4 Non-Cache Write Operation

Writing to tape without using the Cache Memory seriously degrades the speed of the drive. Normally it is used only when it is necessary to ensure that critical non-recoverable data is written correctly to tape.
In the non-cache write mode, the Cache Memory is dedicated from the time a command is received until it has been completed. In addition, the interface cannot complete the operation with the host until the whole block has been written on tape. This means the interface cannot accept another command until the Cache Memory is empty, forcing the drive to decelerate and reposition the tape before the next write or read operation.

The non-cache write mode is used automatically when a write command is issued after the Logical End Of Tape (LEOT) has been reached.

2.4.5 Cache Read Operation

If the requested block of data has not already been read into Cache Memory when the read command is received, the controller signals the drive to begin forward or reverse motion. When the tape reaches the correct speed, the first data block is transferred into cache. Once the block is stored in the cache, the interface is instructed to transfer it to the host.

While the interface is transferring the first block of data, the drive reads subsequent blocks into cache in preparation for the next read request. The process keeps Cache Memory full until a command, other than a sequential read, is received. At that time, cache is cleared before the new command is executed.

2.4.6 Write Error Recovery

When the drive is unable to write data from the Cache Memory to tape, it skips over that area of tape (sector) and attempts to write the data in the next sector. The read-after-write (read back) circuitry provides the capability of detecting an erroneously written sector. The drive attempts to rewrite the sector four times (for a total of five tries). This feature is designated "write skipping." If the data cannot be written within five tries, the drive repositions and again tries to write the sector five times. If the data cannot be written within 23 repositions of five write attempts each, a permanent error is posted to the host. If the data is written successfully during one of the retries, statistics on the retries are posted in the Buffered Error Log and the host is not notified of the write error(s).

Two consequences result from write skipping bad sectors:

1. Failed sectors are left as written with error(s) and the correctly recorded duplicates are recorded elsewhere.

2. When the drive is in the streaming mode, multiple sectors may be duplicated for a single sector error.

2.4.7 Read Error Recovery

When the drive is reading data from tape, it is always reading ahead to ensure that a duplicate sector has not been written using write-skipping. The process of identifying an alternate sector and bypassing write-skipped sectors is not defined as an error during a read. Therefore, it is not reported to the host or posted in the Buffered Error Log. Failing to read a previously written sector results in a series of read and read backward retries that are interspersed with head stepping. These multiple retries in each direction and at each head setting are designed to ensure that recoverable data is indeed recovered. If the data cannot be recovered, a permanent read error is reported to the host and posted in the Buffered Error Log.

2.5 TAPE POSITIONING

The tape is always positioned relative to recorded elements or to the Beginning of Partition.

When a cartridge is loaded, or following a rewind, the tape is positioned at the beginning of the Default Data Partition (Logical Beginning Of Tape) so that the Format ID information can be written or read.

After completing a read or space operation, the tape is positioned to process the next recorded element in the same direction. If a command is terminated because Logical Beginning Of Tape (LBOT) was encountered in the reverse direction, the tape remains positioned at LBOT.

After completing a write operation, the tape is positioned to record the next element in the forward direction.

If an error is detected during a read, the tape is positioned to read the erroneous record in the direction opposite to that in which it was moving when the error was detected. If a Format ID error is detected, the tape is positioned after the Format ID sectors. For Control Field errors, the tape is positioned at the gap before the erroneous block. If an unrecoverable error is detected while writing, the tape is stopped and its position is indeterminate.

If the drive reaches Write or Read End of Partition, an error is reported to the host indicating Physical End of Tape. The tape remains at Write or Read End of Partition until the host issues a command that causes reverse motion.

Chapter 3 Physical Description

3.0 INTRODUCTION

This chapter provides a detailed physical description of the major assemblies, modules, and tasks.

The 3830 Series drive is built on a cast aluminum structural Deck Plate with the major modules designed as Field Replaceable Units (FRUs). The drives conform with the 8-inch disk drive form factor.

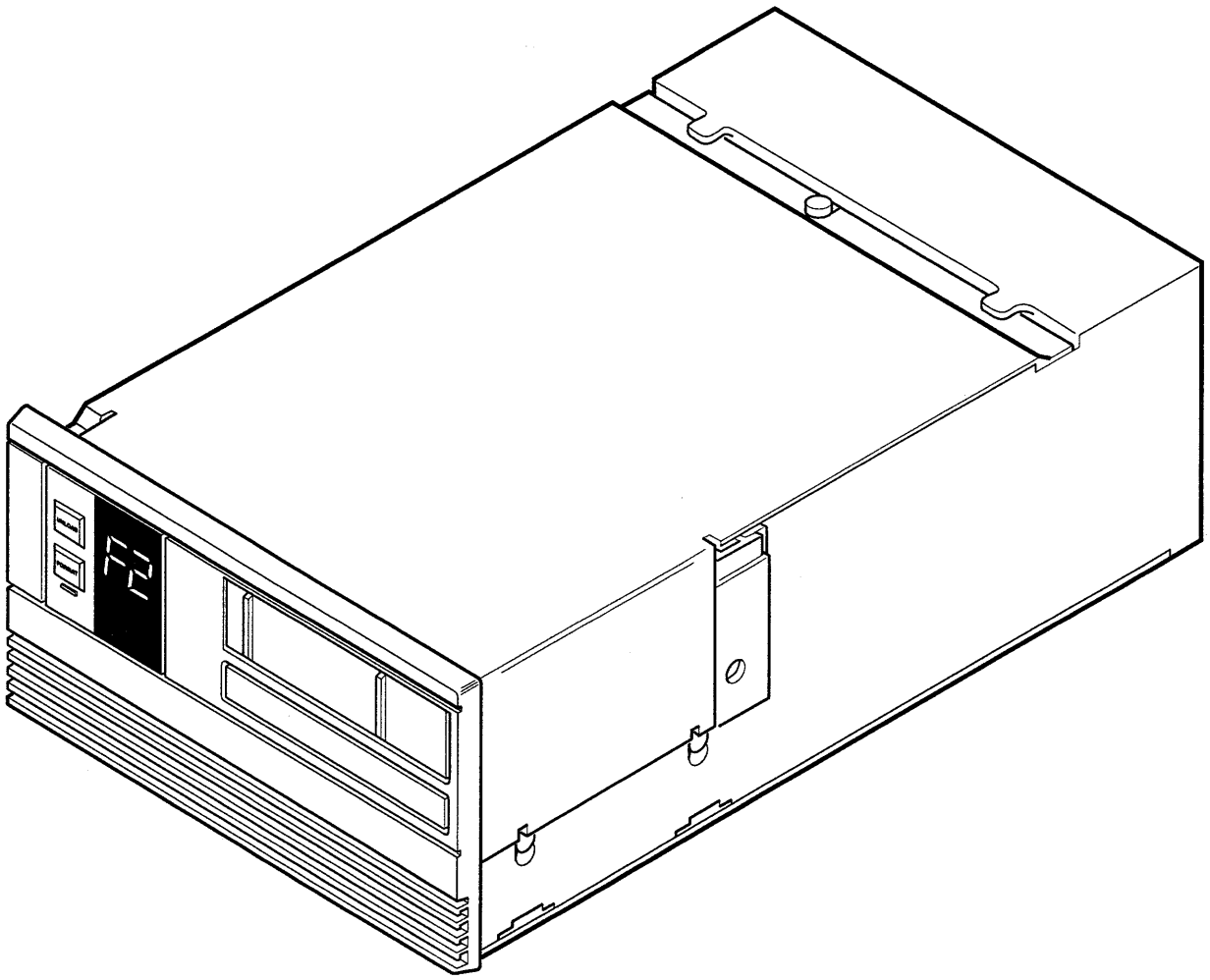


Figure 3-1. 3830 Series Tape Drive

3.1 FIELD REPLACEABLE UNITS

The 3830 Series drive has been designed to maximize uptime and minimize the Mean Time To Repair (MTTR). It is built from assemblies and components that are easily disconnected and removed as established under the Field Replaceable Unit (FRU) concept. All ten FRUs in the drive are provided with the appropriate mechanical self-locators and multi-pin connectors to simplify field replacement. The ten FRUs of the drive are:

Front Panel
Control Unit Electronics (CUE) Circuit Board
Head Positioner
Supply Motor
Take-up Motor
Servo/Driver Circuit Board
Loader
Threader
Read/Write Circuit Board
Power Supply

Interconnection of the FRUs and major assemblies is illustrated in Figure 3-2 and explained in the following paragraphs.

3.2 FRONT PANEL

The Front Panel consists of the following (see Figure 3-3):

Pushbutton Controls (two)
Indicator Lights (four)
Two-digit Hexadecimal Display
Plastic Housing
Printed Circuit Board

The Front Panel is connected mechanically to the cast aluminum base and electrically to the CUE Board. The Front Panel indicators are listed in Table 3-1.

Label	Purpose
Power	Indicates power is on
FAULT	Indicates fault has occurred
ACTIVE	Indicates drive is active
WRT EN	Indicates cartridge is write enabled

Table 3-1. Front Panel Indicators

3.2.1 UNLOAD Pushbutton

When a cartridge is inserted the drive enters the ready state. When the drive is in the ready state and the UNLOAD pushbutton is pressed, it notifies the MPU to rewind and eject the cartridge. Any write data in cache is first written to tape. The tape is then rewound and unloaded

If a cartridge is not completely loaded, UNLOAD button is ignored unless it is being used in conjunction with the FORMAT button to activate a test or review configuration parameters.

3.2.2 FORMAT Pushbutton

When the FORMAT pushbutton is pressed, the next available tape (MSR) format is displayed. If UNLOAD is pressed in conjunction with FORMAT, the MPU initiates the appropriate test or diagnostic mode.

3.2.3 Hexadecimal Display

The two-digit Hexadecimal Display outputs Fault Symptom Codes (FSC), configuration data when it is being modified or displayed, and the currently selected format.

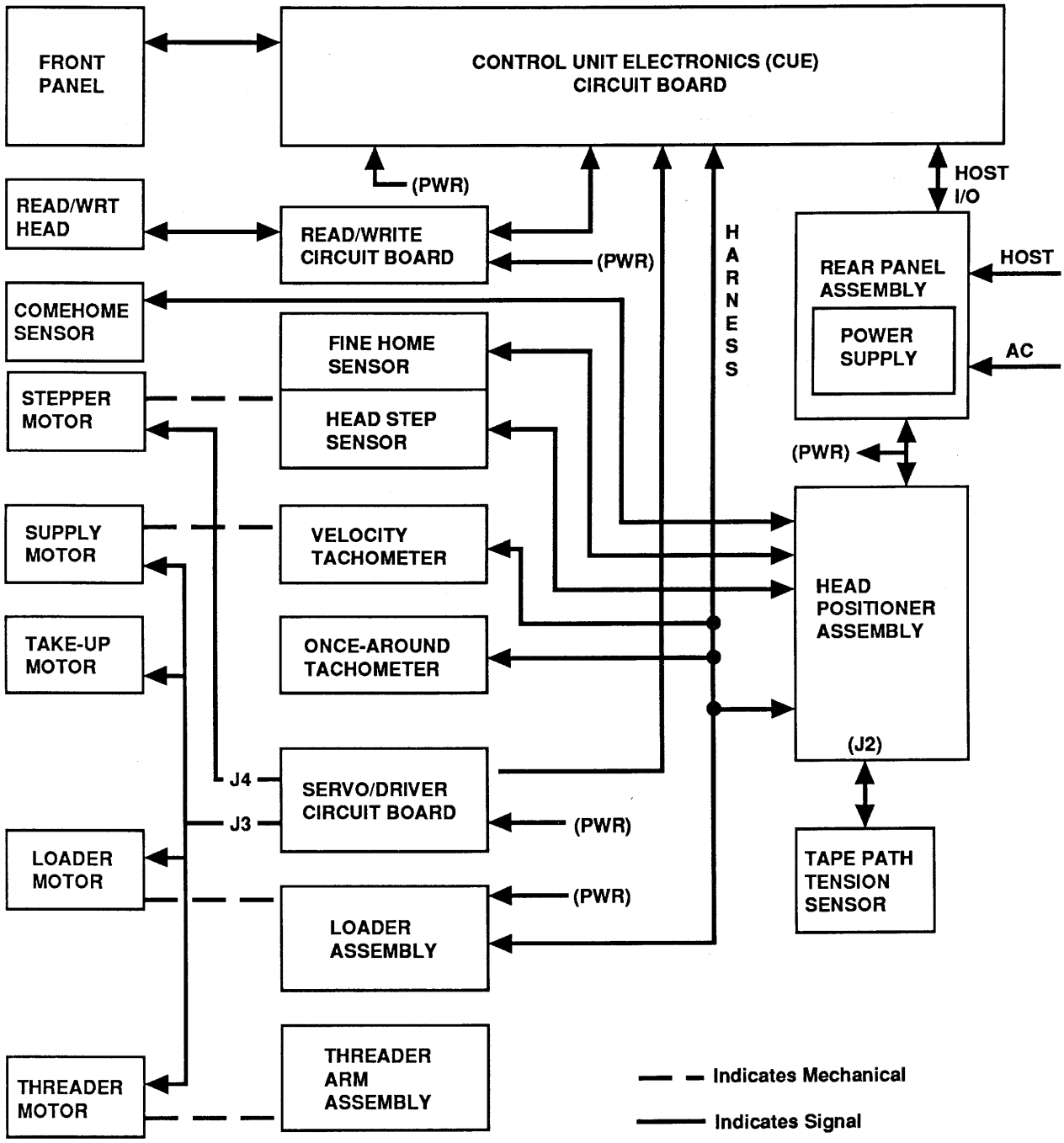


Figure 3-2. 3830 Series Functional Block Diagram

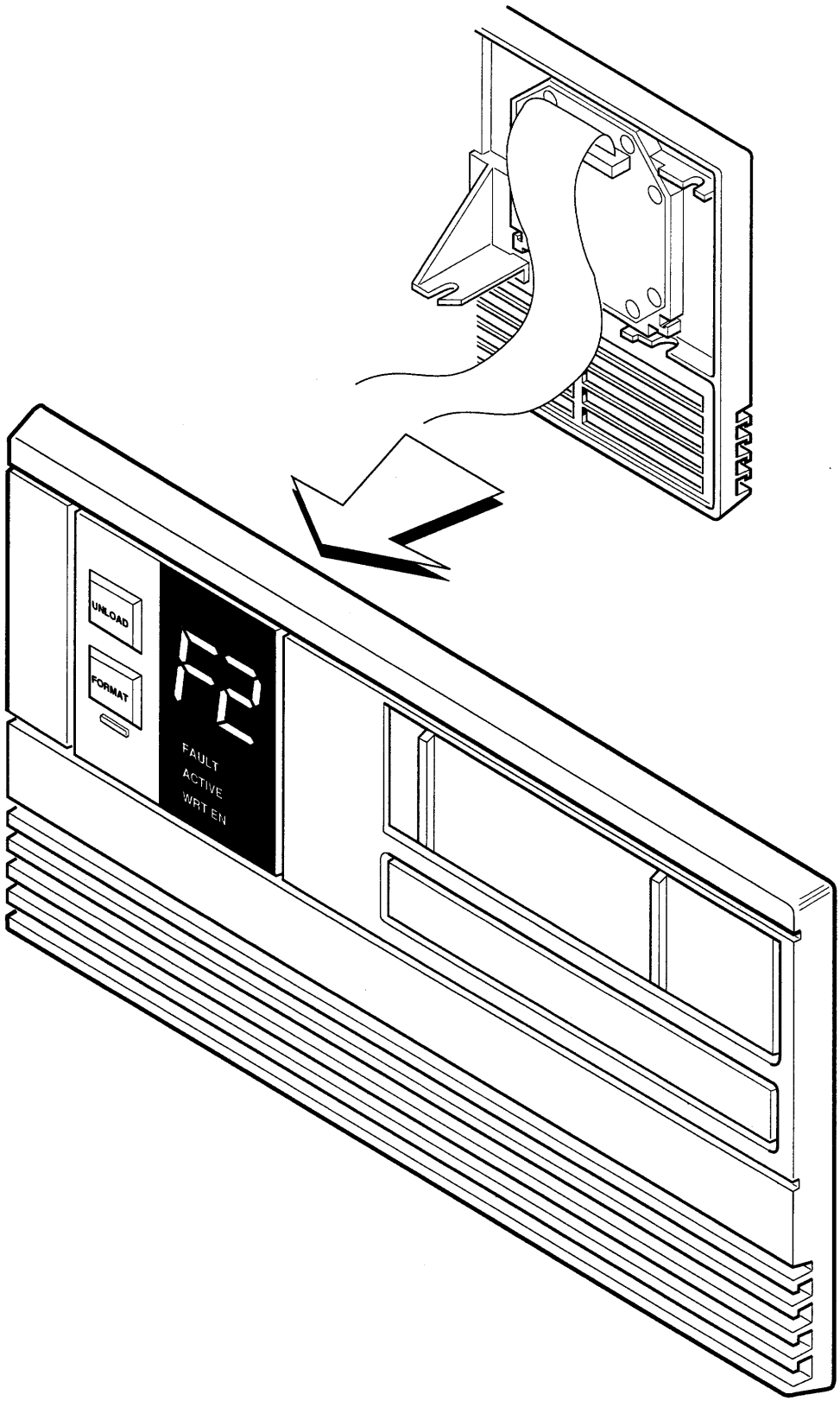


Figure 3-3. Front Panel

3.3 CONTROL UNIT ELECTRONICS

The Control Unit Electronics (CUE) Circuit Board initiates control sequences for all electrical and mechanical parts of the drive (see Figure 3-4).

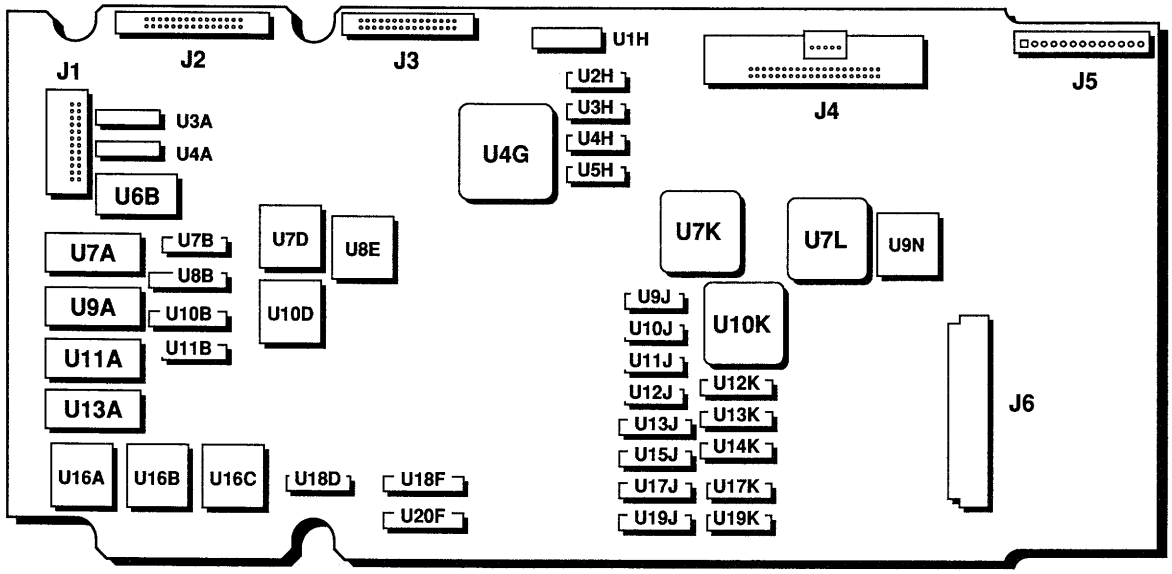


Figure 3-4. Control Unit Electronics Circuit Board

The major components of the CUE Board, which are explained in the following paragraphs, are as follows:

Host Interface
Microprocessor Unit (MPU)
Microcode (EPROM) Memory
Scratch (SRAM) Memory
Power Restore (NVRAM) Memory
Controller Input/Output (CIO)
Direct Memory Access (DMA)
Cache Data Manager (CDM)
Cache Memory
Tachometer (TACH)
High Speed Buffer (HSB)
CUE Interfaces

3.3.1 Host Interface

The Host Interface provides the interfacing protocol, handshaking, and error checking for transfers between the tape drive and the host computer. The detailed functions of the available interfaces are described in separate Product Specifications.

3.3.2 Microprocessor Unit (MPU)

A 16-bit Z8002 MPU executes a firmware program that controls all drive functions. Support hardware for the CPU includes program memory (EPROM), 8K words of Scratch (SRAM) Memory, semipermanent storage (NVRAM), counter/timers, I/O ports, and address decode logic.

3.3.2.1 Firmware (EPROM) Memory

Two EPROMs contain the firmware executed by the MPU. The firmware controls the motor servos, host data flow, read/write data flow, diagnostics, and fault detection functions.

3.3.2.2 Scratch (SRAM) Memory

The MPU uses the SRAM, 8K x 16-bit (plus two parity bits), for stacks, variable storage, and other operations that require temporary storage. Bidirectional driver/receivers generate and check parity during SRAM accesses. Parity errors are latched in a CIO input port for examination by the MPU.

3.3.2.3 Power Restore (NVRAM) Memory

A 128 x 8-bit NVRAM provides the Power Restore Memory. Information stored here includes the position of moving parts when power was removed, Device Reliability Indicator data, and the Fault Symptom Code log.

3.3.2.4 Controller Input/Output

Three CIO devices provide the counters and timers necessary for servo control. The CIOs also provide input and output ports for interfacing the MPU with other drive hardware.

3.3.3 Direct Memory Access

The Direct Memory Access (DMA) is a four-channel (Table 3-2) programmable device. DMA programs are loaded into the DMA Static Memory (DMASRAM) by the MPU and executed by the DMA to perform cache data transfers.

Channel	Program
0	R/W Circuit Board access to Cache Memory
1	CPU access to Cache Memory
2	Host interface access to Cache Memory
3	Cache Memory Refresh

Table 3-2. DMA Channel Assignments

3.3.4 Cache Data Manager and Buffer Controller

The Cache Data Manager (CDM) and Buffer Controller (BC) are two custom LSI devices that control data flow to and from the host interface High Speed Buffer (HSB). Data being moved between the HSB and cache passes through the CDM where CRC is checked and parity is generated (during transfers to the HSB) or parity is checked and CRC generated (transfers from the HSB). The CDM performs request/acknowledge handshakes with the BC, and the BC generates the necessary control signals to write to the HSB. The CDM also performs the high-speed handshaking needed to move data between the cache and R/W Board.

3.3.5 Cache Memory

A 512-kilobyte Cache Memory stands logically between the host and the drive's mechanics. A read or write command from the host results in reading from cache or writing to cache.

Data is transferred between the tape and cache one sector at a time. The sector size depends on the recording format of the drive. The MPU can access the cache to update control information and to read certain control information stored with each sector.

3.3.6 Tachometer

The Tachometer (TACH) chip processes the pulses from the Velocity Tachometer (512 lines per rotation) for the Supply Motor and from the Once-around Tachometer for the Take-up Motor. The TACH stores velocity values and accumulated totals in registers used by the MPU during servo control sequences. All physical positions on tape are calculated using tachometer counts stored in the TACH LSI.

3.3.7 High Speed Buffer

The High Speed Buffer (HSB) acts as a speed matching buffer between the host interface and the cache. During a write sequence data is stored in the HSB at the interface transfer rate and passed through the CDM to cache; the CDM checks and strips parity and appends CRC to data before

sending the data to the cache. For reads, the CDM checks and strips CRC, adds parity, and transfers data to the HSB for transmission to the host.

3.3.8 CUE Interfaces

The CUE Board interfaces with the following circuits, circuit boards, and assemblies:

Host Computer Interface
Front Panel
Head Positioner
Loader
Servo/Driver Circuit Board
Read/Write Circuit Board
Power Supply

3.4 HEAD POSITIONER

The Head Positioner (Figure 3-5) guides the tape across the R/W Head, moves the head to indexed tape track locations with the required zenith and azimuth, and cleans debris from the tape. It also contains the Reference (EEPROM) Memory, which stores the Fine Home Position value, and provides sensor status to the MPU.

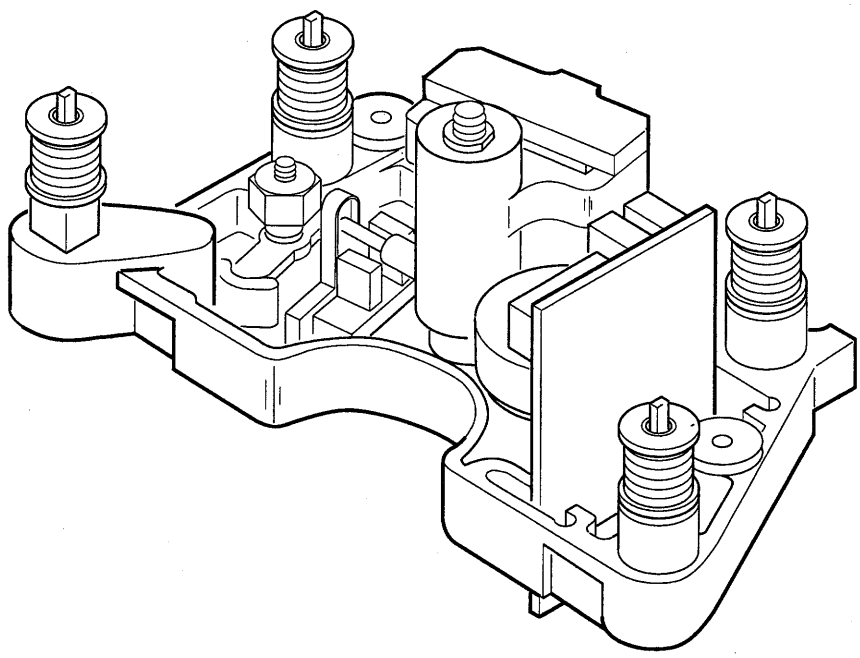


Figure 3-5. Head Positioner

The Base Plate for the Head Positioner is die cast from aluminum and machined precisely for accurate mounting of the self-locating components. The Base Plate is attached with screws to the Deck Plate and electrically connected to the CUE Board.

The Head Positioner components are as follows:

Head Positioner Circuit Board
Reference (EEPROM) Memory
Roller Guides
Tape Path Tension Sensor
Read/Write Head Carriage
Coarse Home Sensor
Stepper Motor
Fine Home Sensor
Head Step Sensor
Velocity Tachometer

3.4.1 Head Positioner Circuit Board

The Head Positioner Circuit Board contains the Reference (EEPROM) Memory, provides the power for the head position and tachometer optical sensors, and conditions the Tape Path Tension Sensor's output for use by the MPU. Control and status information is exchanged between the Head Positioner and the CUE Board.

3.4.2 Reference Memory

The Reference (EEPROM) Memory stores information for identifying and positioning the R/W Head, including the type of head (2 or 4 tracks), the serial number, date of manufacture, and the distance from the Fine Home Position to the tape reference track.

3.4.2.1 Reference Track Position

The EEPROM contains a step count for positioning the head to the reference track on the tape. This value is the number of head-motor steps required to move the head from the fine home position to the Reference Track.

3.4.3 Roller Guides

The four roller guides and the "outrigger" bumps on each side of the head are designed to correct and stabilize the tape's travel across the R/W Head.

3.4.4 Tape Path Tension Sensor

The Tape Path Tension Sensor is a variable-resistance strain gauge incorporated in Roller Guide 4. The MPU uses the signal from the sensor to maintain a constant tape tension by controlling the current for the feed reel driver. The feed reel driver may be the Supply Motor or the Take-up Motor, depending on the direction the tape is being moved across the Read/Write Head.

3.4.5 Read/Write Head Carriage

The Read/Write Head Carriage is designed to provide extremely accurate zenith and azimuth head alignment. The carriage has a lead screw shaft that is gear driven by the Stepper Motor. The threaded shaft moves the R/W Head vertically to all track locations. The precision parts move the R/W Head in 0.0005-inch steps and provide track-position accuracy within ± 0.001 inches relative to the center point of Roller Guides 2 and 3.

The R/W Head's wrap angle is maintained during vertical movements by an anti-rotation bracket with a vertical slot that captures a precision dowel pin extending from the side of the R/W Head Carriage.

The positioning of the R/W Head is sensed by the Course Home Sensor, Fine Home Sensor, and the Head Step Sensor. Each sensor consists of an LED providing light to a photodetector in a molded plastic housing. The mechanical breaking of the light beam provides the required signal changes which are used to establish the precise position of the Read/Write Head in relation to the reference edge of the tape.

3.4.5.1 Read/Write Head

The Read/Write Head contains a write gap between two read gaps for each track. There is a blank track between each set of read and write gaps. The R/W Head configuration and positioning allow simultaneous writing or reading of two tracks with the model 3832 and four tracks with the model 3834. The odd tracks are accessed when the tape is traveling between the cartridge (Supply Reel) and the Take-up Reel. The even tracks are accessed when the tape is wound back into the cartridge.

3.4.5.2 Stepper Motor

The unipolar Stepper Motor is driven in incremental steps by dc current supplied to its windings from the Servo/Driver Circuit Board. The bidirectional Stepper Motor's gear drives a threaded shaft that moves the Read/Write Head vertically to all indexed track locations.

3.5 SUPPLY MOTOR

The brushless dc Supply Motor drives the Supply Reel in the cartridge. The basic Supply Motor is exactly the same as the Take-up Motor and works with it to retain the correct tape tension while rotating the Supply Reel in the requested direction. Power for the Supply Motor is controlled by

the Supply Motor Driver on the Servo/Driver Circuit Board. The Supply Motor Assembly includes the Velocity Tachometer.

3.5.1 Velocity Tachometer

The Velocity Tachometer (512 pulses per rotation), mounted on the Supply Motor Assembly, provides pulses to the CUE Board's TACH chip for conversion to the Supply Motor's speed (velocity). The TACH chip also provides a running total of the pulses, which is used by the MPU to determine the current physical position of the tape.

3.6 TAKE-UP MOTOR

The brushless dc Take-up Motor drives the Take-up Reel. The basic Take-up Motor is exactly the same as the Supply Motor and works with it to retain the correct tape tension while rotating the Take-up Reel in the requested direction. Power for the Take-up Motor is controlled by the Take-up Motor Driver on the Servo/Driver Circuit Board. The Take-up Motor Assembly includes the Once-around Tachometer.

3.6.1 Once-around Tachometer

The Once-around Tachometer, mounted on the Take-up Motor Assembly, is used with the Velocity Tachometer to calculate tape-pack radius and tape velocity. The tachometer consists of a photosensor and an opaque disk with a single slot. Its output is sent to the CUE Board.

3.7 SERVO/DRIVER CIRCUIT BOARD

The Servo/Driver Circuit Board (Figure 3-6) contains the drivers that control the motors in the tape drive. The Servo/Driver circuits, which are described in the following paragraphs, are as follows:

Take-up Motor Driver
Supply Motor Driver
Threader Motor Driver
Loader Motor Driver
Stepper Motor Driver

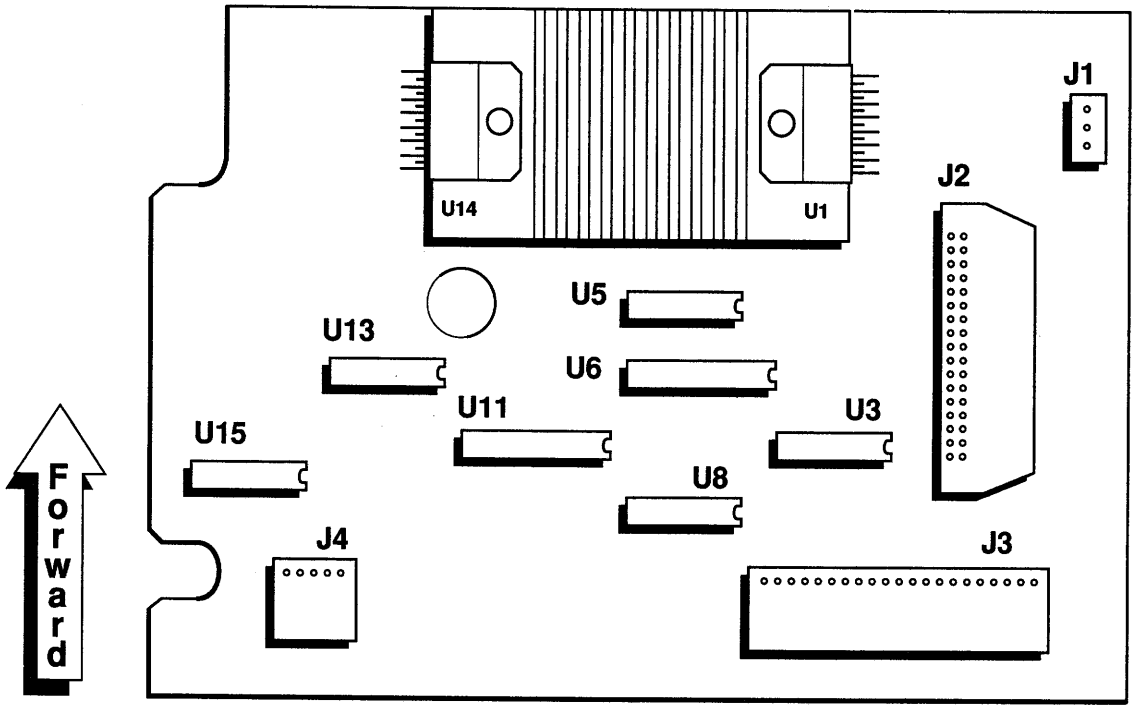


Figure 3-6. Servo/Driver Circuit Board

3.7.1 Take-up and Supply Motor Drivers

The Take-up Motor Driver and the Supply Motor Driver provide the current to power these brushless dc motors. The motors work in conjunction to retain the correct tape tension and speed while rotating in the requested direction. Signals from the CUE Board select the rotational direction of the motors.

The Motor Drivers also brake the motors by shorting the motor windings.

3.7.2 Threader Motor Driver

The Threader Motor Driver provides the current to power the bidirectional Threader Motor. The Threader Motor moves the Threader Arm clockwise to thread the tape and counterclockwise to unthread it. The current applied to the Threader Motor is controlled by the MPU, which applies maximum current to extract and insert the leader block of the cartridge and reduced current during normal threading and unthreading.

3.7.3 Loader Motor Driver

The Loader Motor Driver provides dc current to drive the bidirectional Loader Motor that raises and lowers the cartridge tray. When a cartridge is inserted, the Loader Motor Driver is enabled by the MPU on the CUE Board. The cartridge is moved to the Supply Motor area while being held in alignment by locating pins and the clamping action of the tray.

3.7.4 Stepper Motor Driver

The Stepper Motor Driver provides dc current to power the multi-winding Stepper Motor which positions the Read/Write Head. The Stepper Motor Driver uses a timed 24-volt boost pulse at the beginning of each step winding change.

3.8 LOADER

The Loader (Figure 3-7) moves the cartridge to the Supply Motor. During the process, it automatically loads and aligns the cartridge.

The Loader components, described in the following paragraphs, are as follows:

Base Plate
Sensing Switches
Cartridge Slide Housing
Cartridge Slide Tray
Loader Motor

The Loader's Base Plate, guided by two locating pins, attaches to the Deck Plate. Electrically, it connects to the CUE and Servo/Driver Circuit Boards.

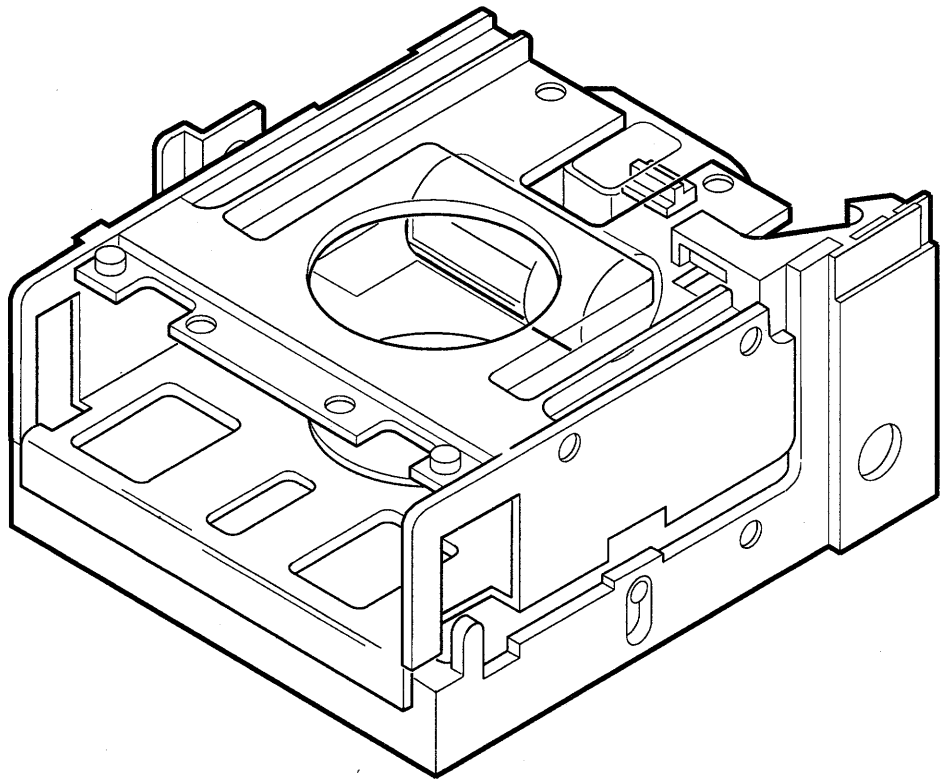


Figure 3-7. Loader

3.8.1 Sensor Switches

The Loader has two sensor switches: Cartridge-Inserted and Write-Enabled. The switches provide the status of the cartridge for the MPU.

3.8.2 Loader Motor

The 24-volt dc gearhead Loader Motor controls the motion of the Cartridge Slide Tray. When a cartridge is fully inserted, the Loader Motor moves the Cartridge Slide Tray down to engage the Threader Arm and Supply Motor. The process is reversed during an unload operation and the Cartridge Slide Tray is moved up into the eject position.

3.8.3 Cartridge Slide Housing

The Cartridge Slide Housing, mounted to the Loader's Base Plate, contains and guides the Cartridge Slide Tray. The housing also provides mounting provisions for the Loader Motor and the components used to transfer motion to the Cartridge Slide Tray.

3.8.4 Cartridge Slide Tray

The Cartridge Slide Tray receives the cartridge when it is inserted through the Front Panel opening. The Cartridge Slide, which is contained and guided by the Cartridge Slide Housing, is moved to the Threader Arm and Supply Motor when the MPU activates the Loader Motor Driver.

The Cartridge Slide Tray includes the Cartridge Control Module, which contains the Cartridge-Inserted, switch and the Write-Enabled switch.

3.9 THREADER

The Threader Arm removes the Leader Block from the cartridge and inserts it into the Take-up Reel hub. During the Threader Arm's travel, it threads or unthreads the tape past the Read/Write Head.

The Threader Arm components are as follows:

Base Plate
Threader Arm
Threader Motor

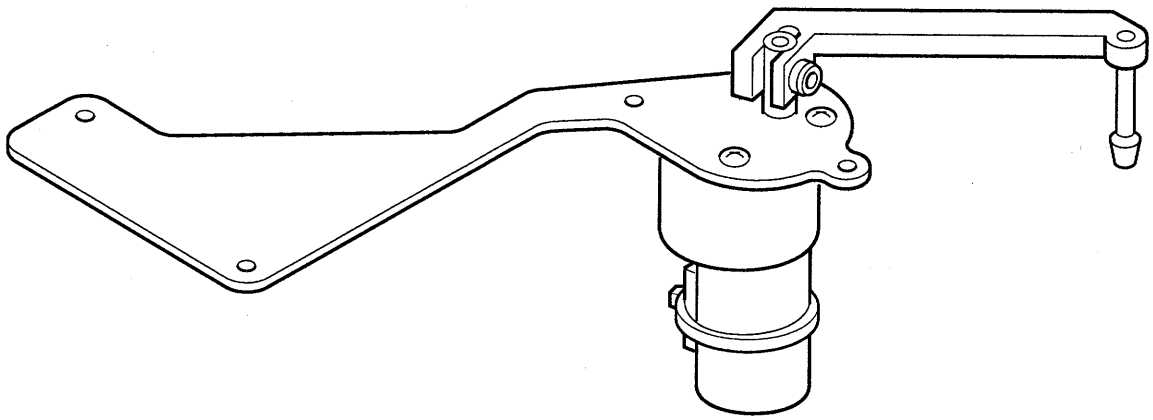


Figure 3-8. Threader Arm

The Threader is secured mechanically with screws to the Deck Plate. It interfaces mechanically with the Loader, Mechanical Stop Plate, and Take-up Motor. The Threader Arm interfaces electrically with the Servo/Driver Circuit Board.

3.9.1 Threader Arm

The Threader Arm engages the tape's Leader Block with a pin. When loading the tape, the Threader Arm detaches the tape's Leader Block from the cartridge, threads it past the Read/Write Head, and inserts it into the Take-up Reel hub. The Threader Arm moves clockwise to thread the tape or counterclockwise to unthread the tape. Figure 3-8 shows the path followed by the Leader Block.

When unloading, the tape is rewound by the Supply Motor. The Supply Motor continues to rewind the tape while the Threader Arm disengages the Leader Block from the Take-up Reel hub and inserts it into the cartridge.

3.9.2 Threader Motor

The Threader Motor drives the Threader Arm between the cartridge and the Take-up Reel hub. Sufficient current is applied to the Threader Motor to ensure there is enough torque to seat or unseat the Leader Block at the cartridge and the Take-up Reel hub. During the Threader Arm's travel between the cartridge and the Take-up Reel hub, the current is reduced to avoid stretching the tape.

3.10 READ/WRITE CIRCUIT BOARD

The Read/Write Circuit Board controls reads and writes. Detailed information is proprietary.

The MPU exchanges signals with the R/W Circuit Board that perform the following functions:

Initialize the R/W Circuit Board.
Select control ports.
Begin a read or write.
Signal a read has reached an Intersector Gap (ISG).
Turn the Write Regulator on or off.
Show that a Read Decoder status or Write Formatter status is available.
Indicate the CUE Board is ready to receive or send another byte.
Send data, and indicate the direction of the transfer.

3.11 POWER SUPPLY

The optional Power Supply automatically adjusts itself for 110 Vac or 220/240 Vac operation at either 50 or 60 Hertz. The ac voltage is rectified, regulated, and filtered to provide +5 Vdc, – 5 Vdc, and +24 Vdc for the circuits and motors inside the drive.

3.12 CARTRIDGE TAPE

The 3830 Series uses the ANSI-defined 3480-type half-inch cartridge tape shown in Figure 3-9.

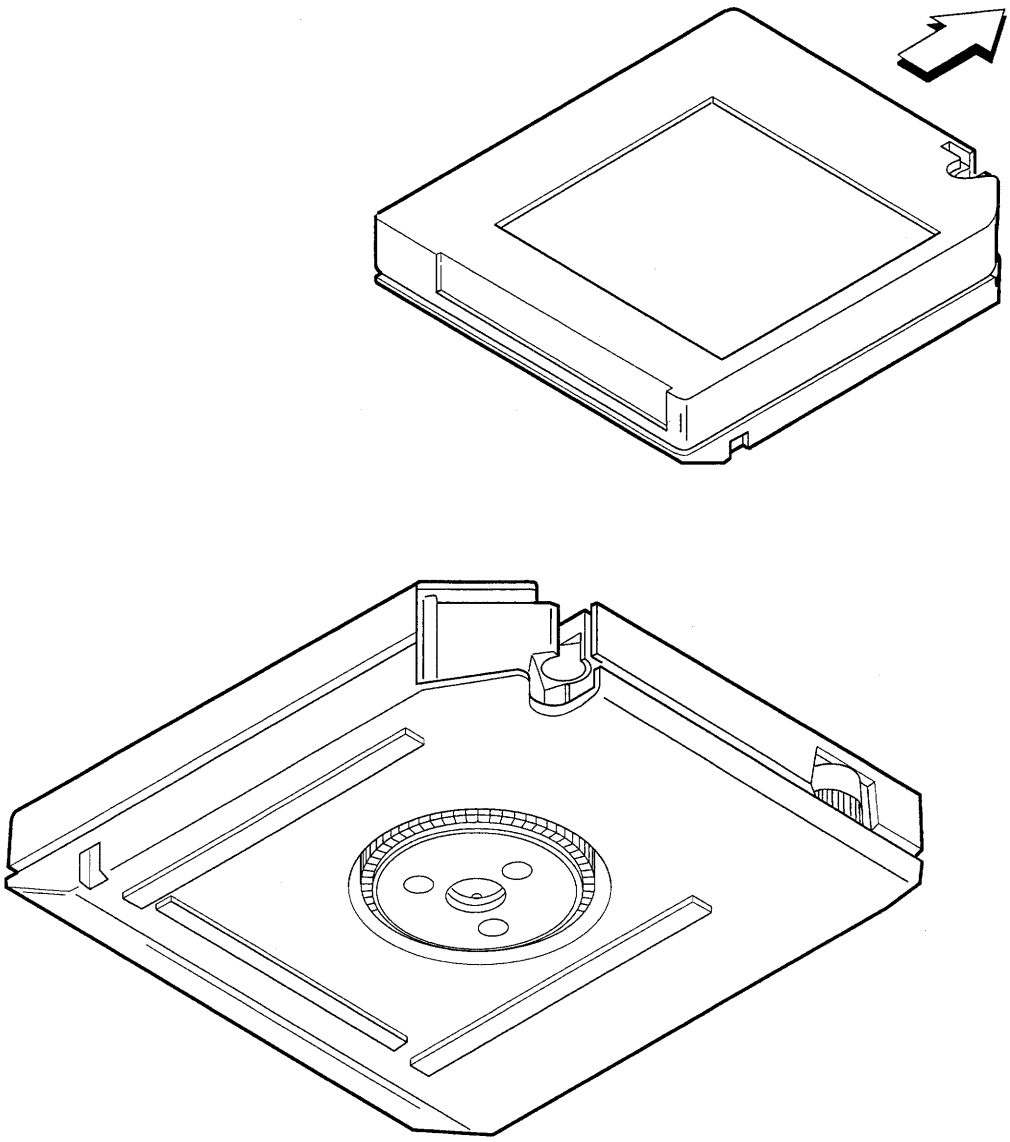


Figure 3-9. Half-Inch Cartridge Tape

3.12.1 Cartridge Tape Description

The compact cartridge design, 4 inches x 5 inches x 1 inch, houses the tape in a single reel. The tape is a chromium dioxide medium capable of recording approximately 30,000 flux transitions per inch.

The cartridge is a durable plastic container designed to protect the tape from physical damage and contamination. The Leader Block snaps into the cartridge to prevent the tape from being unwound manually and to position the Leader Block correctly for automatic wind and rewind. Tape file protection is provided with an integrated Write-Protect Thumb Wheel at the rear of the cartridge.

Data is recorded on the tape in a Multi-track Serpentine Recording (MSR) format, one track group at a time. The model 3832 writes and reads two tracks; the 3834 can write and read four or two tracks.

3.12.2 Tape Interlayer Slippage

Interlayer slippage is rare, but can occur when the tape is wound loosely on the Supply Reel hub. It can also occur when stored cartridges are subjected to radical changes in temperature or humidity, which can cause uneven expansion of the medium. To avoid interlayer slippage, the 3830 Series drives test each cartridge during the load operation. If slippage is detected, the drive winds the entire tape forward onto the Take-up Reel. Then, it rewinds the tape back onto the Supply Reel. This operation ensures correct tension.

3.12.3 Cleaning Cartridge

A Cleaning Cartridge is used to clean the Read/Write Head. The drive senses the cleaning cartridge and automatically activates the cleaning routine. When the cleaning routine is finished, the drive ejects the cartridge.

Chapter 4 Specifications

4.0 INTRODUCTION

This chapter provides specifications of the 3830 Series Cartridge Tape Drives.

4.1 PHYSICAL DIMENSIONS

The 3830 Series drives width and height are standard eight-inch form factor measurements, and both dimensions hold tolerances of ± 0.020 inches. The depth dimensions have tolerances of +00, – 0.040 inches.

DC Unit Basic Size	4.62" High x 8.55" Wide x 15.75" Deep
AC Unit Basic Size	4.62" High x 8.55" Wide x 21.25" Deep
Bezel Depth	0.38"
Mounting Holes	Standard SA850 for 8" disk drives
Unpacked Weight	AC 28 lbs, DC 20 lbs

4.2 TAPE CARTRIDGE

The medium is a 3480-type half-inch cartridge or ANSI-compatible equivalent.

4.3 PERFORMANCE SPECIFICATIONS

4.3.1 Host Block Size

The host may designate data block sizes of 1 byte through 64 kilobytes.

4.3.2 Drive Sector Size

3832 = 4096 Bytes of data, plus control characters

3834 = 8192 Bytes of data, plus control characters

4.3.3 Nominal Tape Tension

The Supply and Take-up Motor torque is controlled to maintain the tape tension at a nominal eight ounces.

4.3.4 Timing Characteristics

The reposition times listed below are measured from one write to the next write.

Recording/Rewind Speed	111 inches/second
Maximum Load Time	22 seconds
Maximum Unload Time	15 seconds
Maximum Rewind Time	70 seconds
Maximum Start/Stop Time	150 milliseconds
Maximum Start/Stop Distance	8.33 inches
Maximum Reposition Time-Write	
MSR-2	615 milliseconds
MSR-4	605 milliseconds
Maximum Reposition Time-Read	
MSR-2	505 milliseconds
MSR-4	505 milliseconds

4.3.5 Formatted Data Capacity

The actual data storage capacity of the cartridge tape listed in Table 4-1 is a function of the application block size, format, and usable length of the tape. The capacity amounts represent megabytes of formatted user data, excluding BOT, EOT, EOD, format ID, and cartridge-statistics sectors. The block sizes represent multiples of 1,024 bytes (1K).

Format	Block Size						
	1K	2K	4K	8K	16K	24K	32K
MSR-2	80M	160M	320M	320M	320M	320M	320M
MSR-4	40M	80M	160M	320M	320M	320M	320M

Table 4-1. Formatted Data Capacity

4.4 POWER REQUIREMENTS

The 3830 Series requires single-phase ac or dc power.

4.4.1 AC Power

In the ac mode the drive automatically selects the correct voltage range and frequency to match the connected source.

Nominal Range	Operating Range
100-120V, 50/60 Hz	88-140V, 47.5-63.0 Hz
200-240V, 50/60 Hz	176-259V, 47.5-63.0 Hz

Table 4-2. AC Power Ranges

4.4.2 DC Power

Source Ratings	+5 Vdc	-5 Vdc	+24 Vdc
Nominal	±5%	±5%	±10%
Nominal Standby	9A (min 2A)	2.5A (min 0.75A)	0.5A
Nominal Operating	9A (min 2A)	2.5A (min 0.75A)	2A

Table 4-3. DC Power Requirements

4.4.3 Steady State Power Consumption

Nominal 150 watts per hour
Maximum 180 watts per hour

4.5 ENVIRONMENTAL SPECIFICATIONS

4.5.1 Environmental Tolerance

The 3830 Series conforms to a modified Subclass C environment, which is based on non-air conditioned buildings with normal winter heating and normal ventilation. However, the following operating limits can be restricted by the cartridge's required environment.

4.5.2 Temperature & Humidity

4.5.2.1 Operating Ranges

Dry bulb temperature	10 to 40 degrees C
Wet bulb temperature	26 degrees C (maximum)
Temperature gradient	1 degree C per hour
Temperature shock	15 degrees C (over two minutes)
Relative humidity	15 to 85% non-condensing
Humidity gradient	10% per hour

4.5.2.2 Power-on Ranges (No Tape Loaded)

Dry bulb temperature	0 to 40 degrees C
Wet bulb temperature	30 degrees C (maximum)
Temperature gradient	15 degrees C per hour
Temperature shock	15 degrees C (over two minutes)
Relative humidity	10 to 95% non-condensing
Humidity gradient	10% per hour

4.5.2.4 Storage Ranges

Dry bulb temperature	– 40 to 60 degrees C
Wet bulb temperature	30 degrees C
Temperature gradient	20 degrees C per hour
Temperature shock	15 degree C (over two minutes)
Relative humidity	5 to 95% non-condensing
Humidity gradient	10% per hour

4.5.2.5 Shipment Ranges

Dry bulb temperature	– 40 to 60 degrees C
Wet bulb temperature	30 degrees C
Temperature gradient	25 degrees C per hour
Temperature shock	15 degrees C (over two minutes)
Relative humidity	5 to 95% non-condensing
Humidity gradient	10% per hour

4.5.3 Altitude

The 3830 Series is designed to operate in normal pressures from –1,000 to 10,000 feet.

4.5.4 Corrosion & Contamination

The 3830 Series operates properly in a Subclass G1 operating environment.

4.5.5 Vibration & Shock Requirements

The 3830 Series conforms to Vibration Class V4 and Shock Class S2. The V4 Class consists of V2 vibration levels from 5 to 20 hertz and V3 levels from 20 to 500 hertz. For frequencies below 17 hertz the environment is specified by a constant double amplitude displacement; the transient vibrations being 0.008 inches DA and the continuous vibrations being 0.005 inches DA.

4.5.6 EMI Susceptibility

The electromagnetic interference (EMI) susceptibility is controlled by Cipher Standard 961092-001, Paragraph 6. The Radiated Electric Fields for ac-powered drives are in accordance with Cipher QA Standard PE-054. In the Radiated Magnetic Field, the drive must meet all error rate requirements while in any orientation to the poles of an alternating magnetic field of varying field strengths. Note that 160dBpT equals 1 Gauss.

Frequency	Field Strength
45 - 600 Hz	160 dB/picotesla decreasing by 12 dBpT per octave to 120.

4.5.7 Acoustic Noise Emissions

The level for the maximum allowed noise is determined from the energy average of four measurement positions located 3.28 feet from each side of the drive and 4.92 feet above the floor. The measurements are taken in a hemianechoic chamber with the drive placed on a standard acoustic-test table.

Maximum level on loudest side	51 dBA
Maximum operating 4-side average	48 dBA, referenced to 20 microPa

4.5.8 Magnetic Emissions

The 3830 Series was tested at a distance of 2.1 meters.

4.5.8.1 Maximum Magnetic Limit

0.2 microtesla (0.002 Gauss)

4.5.9 Grounding

Frame and signal grounds are capacitively connected, but may be separated.

4.6 REGULATORY REQUIREMENTS

4.6.1 Safety

UL 478

CSA C22.2 #154

IEC 435 and 380

4.6.2 Electromagnetic Emissions

FCC, Part 15 Subpart J, Class A

VDE 0871 and 875, Class B

4.7 PACKAGING STANDARDS

External	NSTA standard
Internal	Cipher Standard 499500-662

4.7.1 Shipping Requirements

4.7.1.1 Shock

Peak acceleration	30g
Duration	30 milliseconds
Waveshape	1/2 Sine pulse
Application	X, Y, Z axes, three times

4.7.1.2 Vibration

Frequency range	5 to 500 Hertz
Peak acceleration	2g
Waveshape	Sinusoidal, 15 minute sweep, 5 to 500 Hertz
Application	X, Y, Z axes, two sweeps per axis

Chapter 5 Reliability Factors

5.0 INTRODUCTION

This chapter provides information on the reliability and service life of the 3830 Series drives. The applicable criteria used in this chapter have been weighted, based on component failure rates, to arrive at the given values.

5.1 DATA RELIABILITY

The normal permanent Read/Write error rates are listed in Table 5-1. The rate is based on using tapes that have a minimum quality level of 2 gigabits between medium-based errors.

Model	Permanent Errors	
	Read	Write
3832	1 in 10^{12}	1 in 10^{12}
3834	1 in 10^{12}	1 in 10^{12}

Table 5-1. Read/Write Error Rates

5.2 DRIVE RELIABILITY

5.2.1 Design Life

The design life statistics, listed below and in the following paragraphs, provide the point at which the statistical failure rate begins to rise.

Design Life	90% of shipped drives have a 5-year life span, based on 3,300 power-on hours per year

5.2.2 Load Mechanism

The load mechanism life may be less than listed if alternate sources for tape cartridges are used.

Load Mechanism	100 loads/day, not to exceed an average 3,000 loads/year, or 15,000 loads over life of drive

5.2.3 Mean Time Between Failures

The Mean Time Between Failures (MTBF) is based on the tape being in motion 20% of the power-on time.

MTBF	15,000 operating hours

5.2.4 Mean Time To Repair

The Mean Time To Repair (MTTR) is based on repairs being made by properly trained and equipped technicians.

MTTR	15 minutes to FRU level

Chapter 6 Installation and Configuration

6.0 INTRODUCTION

This chapter provides information for installing and configuring the 3830 Series Cartridge Tape Drive for operation in the host system.

6.1 INSTALLATION

Three mounting alternatives are available: 8-inch form factor, rack mounting, and table-top. Figure 6-1 provides the physical dimensions and mounting dimensions of the drive. Much of the installation procedure depends on the selected host computer interface. Information on cabling, connnectors, pin connections, etc. is provided in the Technical Manual.

Forced air cooling keeps all components of the drive below their maximum allowable temperatures when the drive is operated within the specifications defined under "Temperature and Humidity" and subjected to an outlet head air pressure of up to 0.02 inches of water.

6.2 CONFIGURATION

The drive has default configuration parameters set at the factory. The parameters are stored in the Non-Volatile (NVRAM) Memory where they are retained even when the power is removed. The default parameters are listed in Table 6-1.

Parameter	Default Setting
Local Format Select	Enabled
Format Display	Enabled
Logical Address	Zero
Interface Parity	No Parity (Cipher Interface)
Interface Transfer Rate	150 KB/s (Cipher Interface)
Interface Ramp Delay	850 microseconds (Cipher Interface)

Table 6-1. Default Configuration Parameters

From the Front Panel, configuration parameters can be reviewed with the User Diagnostics or changed with Customer Engineer (CE) Diagnostics.

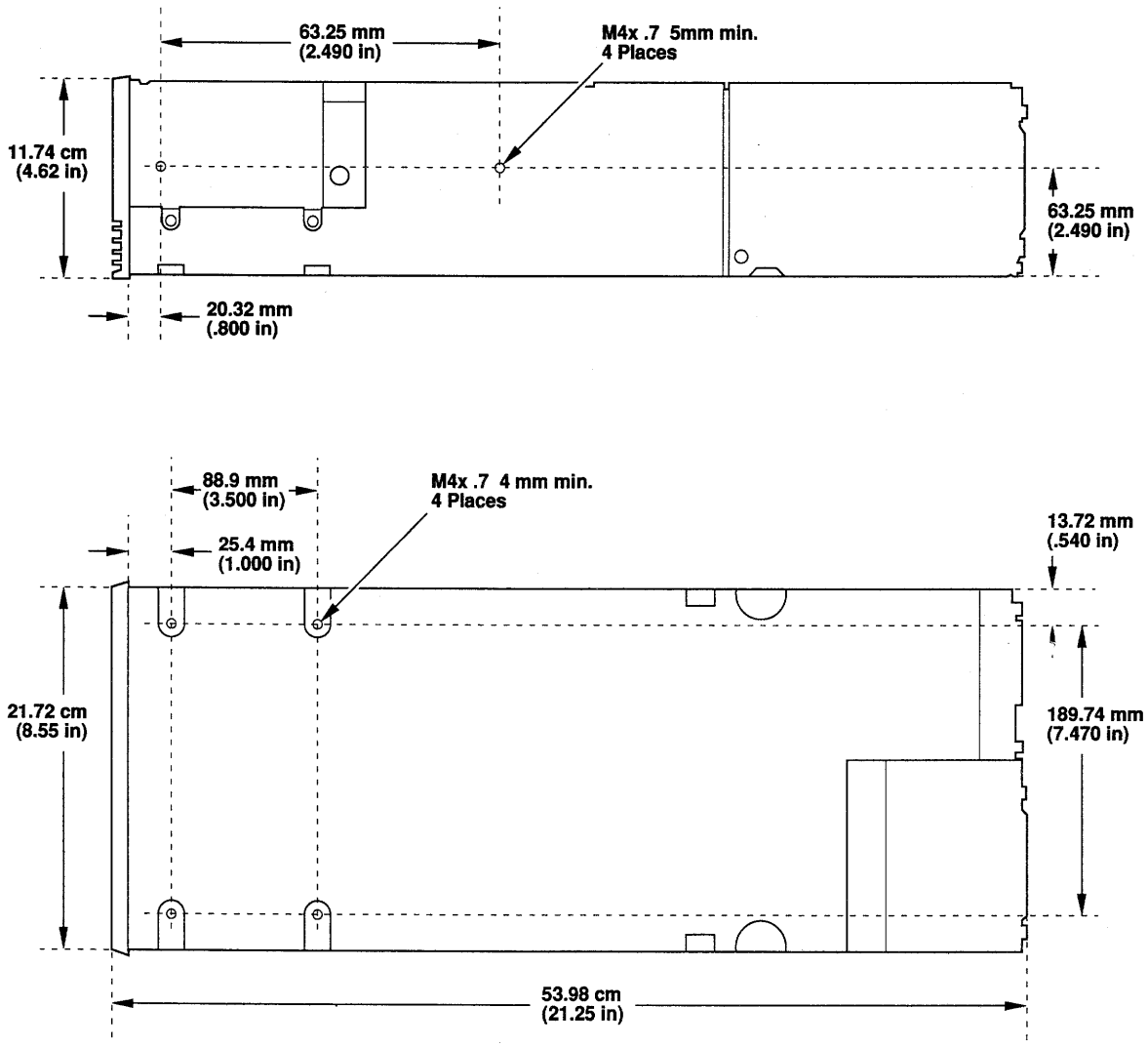


Figure 6-1. Physical Dimensions

Chapter 7 Operating Procedures

7.0 INTRODUCTION

This chapter provides the standard Front Panel operation procedures for the 3830 Series. The drive has been engineered to minimize the interaction between the operator and the drive.

7.1 POWER-UP

After switching on power, all Front Panel lights switch on for two seconds, and then, except for the POWER indicator, switch off. The drive then executes a sequence of diagnostic checks. Successful completion of the checks is indicated when the drive displays the default MSR format or blanks the display, depending on whether the Format Display option is enabled.

7.2 FRONT PANEL CONTROLS

The Front Panel provides the operator with indicator lights, a two-digit hexadecimal display, and two pushbuttons, as shown in Figure 7-1.

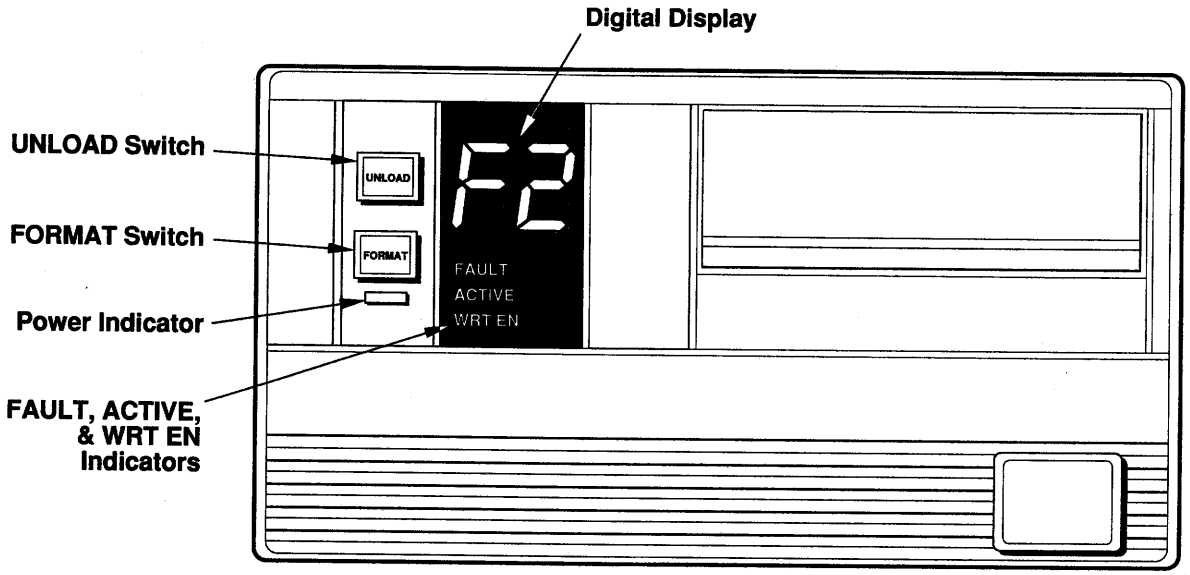


Figure 7-1 3834 Front Panel

7.2.1 Front Panel Indicators

The Front Panel indicator lights are explained in Table 7-1.

Label	Intensity	Explanation
POWER	Steady	Lights when +5V is sent to dc models or when power switch is turned on for ac models.
ACTIVE	Steady	Lights during execution of power-on diagnostics. Lights while performing tests. Lights when drive is executing a tape motion command. Stays on until all tape motion and in-process steps have been completed.
	Flashing	Flashes while cartridge is being loaded and unloaded.
WRT EN	Steady	Lights for two seconds at power on. Switches off if drive passes power-on tests. Lights during cartridge loading if cartridge is write enabled.
FAULT	Steady	Lights for two seconds at power-on. Goes off if drive passes power-on tests. Lights when error or fault detected in drive.
	Flashing	Flashes to signal "ignore request" if drive is busy when Front Panel request is entered.

Table 7-1. Front Panel Indicators

7.2.2 Hexadecimal Display

The uses of the two-digit hexadecimal display are explained in Table 7-2.

Situation	Explanation
Power-on Fault Indicator Test	Displays "88."
Power-On Diagnostic	Displays "00."
Power-On Diagnostic successful	Displays default format number, if Format Display Option is enabled; otherwise blank.
Drive Fault	Displays Fault Symptom Code (FSC) number.
FORMAT pushbutton pressed	Displays the next available format number.
Diagnostic Testing	Displays test numbers and responses.
Test completion	Displays "00" to show drive is ready for next test or to return to normal operations.

Table 7-2. Front Panel Fault Indicator Display

7.2.3 Pushbuttons

The uses of the two pushbuttons, FORMAT and UNLOAD, are listed in Tables 7-3 and 7-4.

Pushbutton	Function	Action
FORMAT	Local format selection is enabled.	Displays next available format: F2 for 3832; F2 or F4 for 3834.
	Write not at BOT	Drive does not act.
UNLOAD	Normal Unload	Completes commands in cache; flashes ACTIVE; causes drive not-ready status; rewinds, unthreads, and ejects tape; extinguishes ACTIVE.
	Cartridge loading	Drive completes load, then unloads cartridge.
	Cartridge loaded and locked by host.	Drive does not act. Flashes FAULT to signal "ignore request." To override lock, press UNLOAD for five seconds.

Table 7-3. Front-panel Pushbutton Functions, Operating Mode

Pushbutton	Function	Action
UNLOAD & FORMAT	Diagnostic mode entry	Press and hold UNLOAD; then press and release FORMAT; release UNLOAD.Display reads "00."
FORMAT	Diagnostic test selection	Press and release FORMAT to increment test number. Hold FORMAT down for continuous change. If unavailable test number is requested, FAULT flashes "ignore request" and drive is returned to Operating Mode.
UNLOAD	Run selected test	Press UNLOAD and release within two seconds. Displayed test executes when button is released.
	Abort test	Press and hold UNLOAD for two seconds, then release it.

Table 7-4. Front-panel Pushbutton Functions, Diagnostic Mode

7.3 LOADING TAPE

Use the following steps to load a cartridge.

1. Ensure the Leader Block is correctly positioned and snapped into the cartridge.

2. Place the Write-Protect Thumb Wheel on the rear of the cartridge in the desired.

3. Place the cartridge in the drive's slot with the Leader Block to the right and the engaging hub teeth down. The drive cannot accept the cartridge in any other position.

4. Insert the cartridge toward the rear of the slot until it is stopped. The ACTIVE indicator lights and the drive automatically loads and threads the tape.

5. Ensure the desired recording format is selected if the tape is new. The drive selects the correct format if the tape already contains data.

7.4 UNLOADING TAPE

Use the following steps to remove a Tape Cartridge from the drive.

1. Press UNLOAD to take the drive offline and start the unloading sequence. The ACTIVE indicator flashes.

2. The drive rewinds the tape into the cartridge, locks the Leader Block into the cartridge, and ejects the cartridge past the slot's lip.

Chapter 8 Error Correction and Fault Isolation

8.0 INTRODUCTION

This chapter describes the error correction and fault isolation capabilities of the 3830 Series tape drive.

Error correction refers to the drive's capability to determine that tape processing errors have occurred and to take measures to correct those errors. Fault isolation is the capability of diagnosing faulty hardware or firmware to the FRU level within the drive itself.

All interface configurations support host participation in the diagnostics, error correction, and hardware fault detection and isolation. However, the variety, implementation, range, and depth of the support varies. This chapter should be read first to gain a general understanding of the drive's error-handling capabilities. Then, the product specification for the selected interface should be read to understand the error handling features implemented for that interface.

8.1 ERROR CORRECTION

The drive performs Error Recovery Procedures (ERP) to correct tape processing errors that occur during normal operation. Drive ERPs are accomplished independently of the host.

All errors that occur in the drive are handled first by the drive's ERPs, which include data integrity measures such as a Cyclic Redundancy Check, Error Correction Code, read-after-write checking, and parity. All read and write errors, whether recoverable or unrecoverable, are recorded in the Buffered Error Log. After all drive ERPs are completed, the host is informed of any unrecoverable errors.

The drive recommends Error Recovery Procedure Actions (ERPAs) to the host for unrecoverable errors. The host is thus relieved of the task of analyzing Machine Exception Data (MED) to determine the appropriate error recovery actions to be taken.

8.1.1 Buffered Error Log

The Buffered Error Log (BEL) contains 32 bytes of status of historical counts useful in statistical analysis of errors: running totals of errors, retries, reads, writes, write skips, etc. An overflow of one of the counters generates an exception flag for the host to allow it to deal with the log either on an exception basis or when the cartridge is unloaded.

When the host requests status from the drive, either the MED or the BEL is transferred, depending on the conditions that preceded the status request. Requests for the error log always return the BEL.

8.1.2 Error Recovery Procedure Action (ERPA)

Error Recovery Procedure Actions (ERPA) are codes that identify host error recovery procedures. These are recommended by the drive to the host after the drive has detected an error and has attempted all its own error recovery procedures without success. ERPAs are logged in Machine Exception Data and transferred to the host with the MED.

8.2 FAULT ISOLATION

When a failure occurs, the hardware and firmware attempt to detect the failure, capture all pertinent data, analyze the data, and generate a Fault Symptom Code. The FSC points to a FRU or FRU group as the source of the failure. The cartridge tape, although not a FRU, may be implicated as the cause of failure.

The 3830 Series drive is designed to detect faults with a 98% confidence level. The FSC points to the correct group of three FRUs with a 95% confidence level and to the most probable FRU (based on MTBF weighted averages) with a 70% confidence level.

8.2.1 Fault Symptom Code (FSC)

The Fault Symptom Code (FSC) is a unique two-byte (16-bit) code word generated when an error or other abnormal condition is detected in a FRU, assembly, or area of firmware.

The FSC is stored in the Power Restore (NVRAM) Memory's FSC Log, which wraps around when full. The NVRAM pointer shows the next available area in the Log. Table 8-2 lists the stored two-byte FSC format.

Byte	Bit(s)	Description
00	7	Severe fault
	6	Turns on FAULT indicator
	5-4	Time of fault: 00 = during installation tests 01 = during Power-On Diagnostic 10 = during normal operation 11 = during Idle Time Test
	3-0	ERPA translation code
01	7-0	Fault Code

Table 8-2. FSC Log Format

8.2.2 Diagnostics

The diagnostic tests are grouped into four operating modes: power-on, idle, background, and selectable. All the modes, except the selectable diagnostics, test and verify the equipment operation without the operator being aware of them, unless an error or fault is discovered.

Five levels of diagnostics are available within the four operating modes:

1. The Power-On Diagnostics verify the circuitry and firmware are performing correctly.

2. The Idle Time Test is a self-initiated diagnostic that protects the user's data by periodic testing when the drive is not processing a host command.

3. The Watchdog Timer, although it is a hardware device, operates in the background to ensure the firmware is executing correctly.

4. The User Diagnostics may be selected to perform read/write tests and review the settings of the configuration parameters.

5. The Customer Engineer (CE) Diagnostics may be used to correct the settings of configuration parameters, as well as identify servicing requirements.

8.2.2.1 Power-On Diagnostics

The Power-On Diagnostics are initiated when the drive is turned on, when it recovers from a system power failure, and when it receives certain commands, including a hard RESET, from the host.

The Power-On Diagnostics test the following firmware, circuits, and hardware:

MPU	CDM	HSB Parity & Data
SRAM	CIO	DAC
NVRAM	Interface	Data Path
DMASRAM	Cache Memory	Watchdog Timer
EPROM Checksum	DMA	R/W Circuitry
EEPROM Checksum	ADC	Registers
+5V	-5V	+24V

If the Power-On Diagnostics are completed successfully, the ACTIVE indicator switches off, the Hexadecimal Display is blanked or displays the default format number, and only POWER remains on.
If any of the diagnostic tests fail or discover a fault, all processing is stopped and the Fault Symptom Code (FSC) is logged in NVRAM and displayed on the Hexadecimal Display. In addition, a cartridge in the drive is unloaded.

8.2.2.2 Idle Time Test

The Idle Time Test is activated automatically when the drive is idle. The drive is considered idle when no read or write activity has occurred for 500 milliseconds and there are no pending commands. The test checks the Direct Memory Access (DMA) and the ROM checksum. During each test the command register is polled at least every 100 milliseconds to determines whether a host command has been received. If a command is received, testing is terminated.

8.2.2.3 Watchdog Timer

The Watchdog Timer is a retriggerable timer circuit that must be retriggered by the MPU periodically. If it does not, the watchdog activates circuits that put the drive in a "safe" condition: the motors are braked and the MPU is disabled to prevent possible damage to the tape.

8.2.2.4 User Diagnostics

The User Diagnostics perform read/write verification tests on the drive and allow the user to review the configuration parameters. The User Diagnostics are activated and controlled using the same procedures as the CE Diagnostics.

8.2.2.5 Customer Engineer (CE) Diagnostics

The Customer Engineer (CE) Diagnostics are used to set the configuration parameters and to execute tests that aid in servicing the drive.

Chapter 9 Preventive Maintenance and Repair

9.0 INTRODUCTION

This chapter provides information for maintaining and repairing the 3830 Series drive. Preventive maintenance, except as noted in the following paragraphs, is performed by the drive's self-initiated diagnostics. Mechanical alignment, motion, and circuit reliability are all monitored and a Fault Symptom Code (FSC) issued if any portion of the drive becomes marginal or faulty.

9.1 PREVENTIVE MAINTENANCE

Preventive maintenance is limited to cleaning the Read/Write Heads. General cleaning is optional.

9.1.1 General Cleaning

A soft brush or vacuum may be used to remove any accumulated dust. If additional cleaning is required, a slightly damp cloth should be used. Avoid using solvents or cleansers which may damage the finish.

9.1.2 Tape Path Cleaning

The Read/Write Heads should be cleaned every eight hours.

A Cleaning Cartridge is available that is designed to clean the Read/Write Head and the tape path. When inserted, the drive senses the Cleaning Cartridge and automatically activates the cleaning routine. When the routine has been completed, the drive ejects the cartridge.

9.2 REPAIR SERVICES

Based on available personnel, tools, and parts at each location, there are three overlapping levels of maintenance: Field Repair Sites, OEM Repair Sites, and Cipher's Repair Depots.

9.2.1 Field Repair Sites

Qualified technicians can use the Front Panel switches and hexadecimal display to isolate problems. In many cases, the technician can troubleshoot the faulty drive, with the user's assistance, over the telephone. If the problem cannot be corrected at the user's location, the drive is returned to an OEM Repair Site for FRU exchanges, or to be forwarded to Cipher.

9.2.2 OEM Repair Sites

The OEM Repair Sites maintain spare FRUs and can perform fault isolation and repair at the FRU level. Drives returned to the OEM Repair Site have the fault isolation data (FSCs) established by the drive's diagnostics stored in the Non-Volatile (NVRAM) Memory.

The technicians at the OEM Repair Site can complete the problem identification and replace the faulty assemblies with pre-adjusted or pre-aligned FRUs. They can also decide whether to return a drive to a Cipher Repair Depot for more complex repairs or for possible replacement.

9.2.3 Cipher Repair Depots

The Cipher Repair Depots can handle all fault isolation, alignment, and repairs. If appropriate, they can also make warranty decisions and replace any drive requiring extensive repairs.