

THZ02/THZ27 Magnetic Tape

Owner's Manual

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Overview of THZ02/THZ27 Subsystem

Product Features

- High performance/high capacity
 - 512 kB read/write data cache
 - 1.1 MB/sec raw transfer rate when streaming
 - 800 kB/sec data transfer rate when streaming
 - 5.0 MB/sec data rate on SCSI bus (synchronous mode)
 - 6.0 GB cartridge capacity (42 GB with media loader)
 - Fast reposition time (less than 1.3 seconds)
- Extensive data integrity/recovery features
 - Custom 64-bit CRC on each 2k of data on media
 - Powerful custom Reed Solomon ECC (designed for tape)
 - End-to-end EDC on data (onto media and back), overlapped with parity from the SCSI bus
 - Parity checking on data cache memory
 - Undetected errors < 1 in 10 E+30 bits
 - Unrecovered read errors < 1 in 10 E+17 bits
 - Cache "Water Marking" to minimize drive start-stops, thus increasing drive, head and media life
- Interconnect flexibility
 - Available three types of firmware to be either:
 - * Compliant with SCSI-2 requirements or
 - * Provide 8mm emulation or
 - * Provide attachment to the IBM AS/400.
 - 8-bit wide SCSI data path
 - Both single ended and differential implementations
 - Optional remote panel for SCSI ID selection
- Firmware update capability using flash EEPROM technology:
 - Customer can do the update
 - Allows inexpensive fixing of bugs
 - Allows inexpensive product enhancements

Overview of THZ02/THZ27 Subsystem

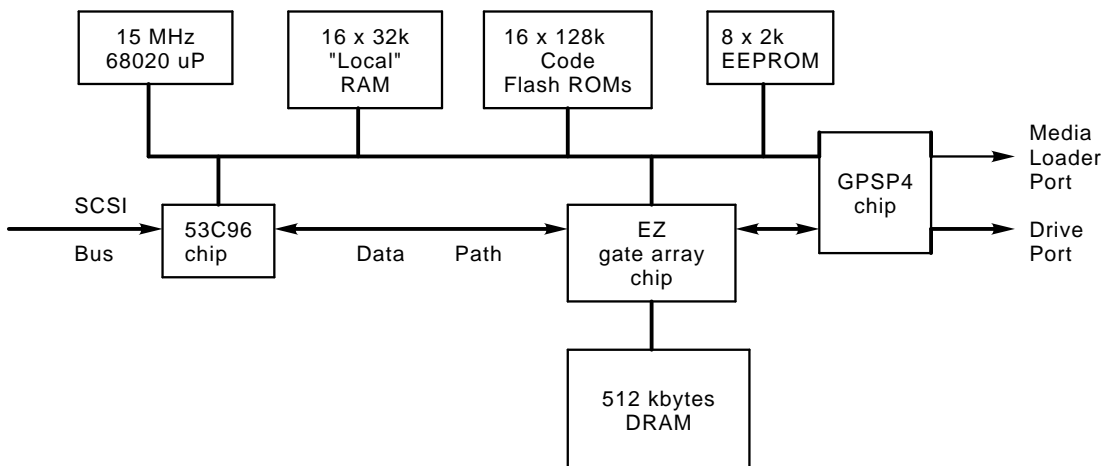
- Extensive embedded diagnostic self-test software
 - Automatic determination of need for head cleaning
 - Extensive built-in diagnostics
 - LEDs for indication of POST failure/success, and command traffic
 - Errors recorded in EEPROM for later analysis at repair sites
- General Details
 - NCR 53C96 SCSI controller chip used for the SCSI interface.
 - Based on a 68020 microprocessor
 - Most subsystem code is written in 'C'
 - 4K blocking factor on tape:
 - * Increases user-data rate to tape
 - * Decreases uP power needed to manage data/command traffic
 - * Record sizes from 1 up to 256k bytes supported

THZ02 Controller Hardware

This section describes the THZ02 controller hardware. The main hardware areas are listed and some of the assumptions in the hardware design discussed and its operation explained.

2.1 Overview

Figure 2–1 THZ02 Controller Block Diagram



The THZ02 controller connects to the SCSI bus via a standard 50 pin SCSI connector. Using synchronous data transfer mode, it can sustain a 5 MB/sec data rate on the SCSI interconnect. Along with an efficient message system, this minimizes the bus bandwidth required for a THZ02 subsystem, allowing more SCSI devices to share the same bus — assuming an efficient host adapter. To support streaming, the host adapter must efficiently process the SCSI protocol, and data transfers must be fast enough to offset SCSI bus overhead and activity on the bus by other devices.

To maintain streaming operation, the controller formats data from the SCSI bus and supplies it to the drive at the rate of about 800 kB/sec of initiator data. For every eight 4k blocks of data from the bus, the controller generates two 4k blocks of Reed Solomon ECC information. Together, this brings the raw data rate at the drive to over 1 MB/second.

To maintain this transfer rate, the controller uses a 68020 microprocessor. To aid the 68020, the NCR 53C96 chip is used for SCSI bus protocol handling. Two gate arrays have been developed to help control the data paths and format the data. Finally, the THZ02 has a sizable data buffer to minimize or eliminate latencies added by drive repositions when the host is not able to maintain the average 800 kB/sec data transfer rate.

THZ02 Controller Hardware

2.1 Overview

The controller consists of the following sections.

- 68020 microprocessor subsystem:
 - 256 kB of firmware flash EEPROM
 - 64 kB SRAM for data structures
 - 2 kB EEPROM for configurable parameters
- SCSI interface:
 - NCR 53C96 SCSI controller chip
 - Synchronous and asynchronous data transfers supported
 - Differential and single-ended SCSI bus options
- Cache and drive interface:
 - SCSI, formatter and ECC (EZ) gate array
 - 512 kB formatter/ECC buffer RAM, with parity
 - GPSP4 gate array:
 - 2 channel drive I/O interface
 - Drive communication port
 - Media loader communication port
 - Remote panel inputs

2.2 Controller Theory of Operation

2.2.1 SCSI Interface and Memory

All SCSI commands and responses are initiated by the 68020 through the NCR 53C96 chip. Messages and commands are copied out and into the 53C96 chip directly. Data transfers are carried out between the 53C96 and the EZ chips directly, under DMA control.

The blocking factor of the device is 4k. This means that internally the data is managed in units of 4k, and does not affect or limit the block size used by initiators. However, data is stored in units of 4k on the media, and blocks that are not an integral multiple of 4k will cause capacity and throughput reductions.

2.2.2 Write Operation

Command Handling

The SCSI protocol controller automatically handles selection, message out, and command transfers. The uP decodes the command, validates it, and if memory is available will begin transferring data without a disconnect. Otherwise, if the command is valid and disconnect privilege is granted, a disconnect message will be sent and the bus released. When memory is available, a reconnection to the initiator (if needed) will be done.

THZ02 Controller Hardware

2.2 Controller Theory of Operation

Data Transfer into EZ RAM

Data will be transferred in units of 4k bytes, except for the remainder bytes of blocks that are not an integral multiple of 4k. Disconnections (if allowed) will be done based on the value of the maximum burst size mode parameter, and the availability of buffer memory. Disconnections will always be on a 4k byte boundary.

As the data is transferred in, the hardware checks the SCSI bus parity (unless parity checking is disabled via the controller or remote panel switch package switch defined for this purpose), and stores the data and parity into DRAM buffer memory. At the same time, the EZ gate array calculates an XOR-rotate type EDC on the data which is also stored in DRAM. This EDC is eventually written onto the media, and verified as part of the read-after-write checking, and again during read operations.

If a bus parity error is detected during Data Out, the THZ02 will immediately stop the transfer, issue a Restore Pointers message, and restart the transfer from the point defined by the last Save Data Pointer message. To allow this, Save Data Pointer messages will be sent to the initiator at strategic points in the transfer (but always on a 4k boundary).

After the data is transferred, if caching is enabled, the Status byte and Command Complete message byte are sent immediately and the bus released. Otherwise, the Save Data Pointer and Disconnect messages are sent and the bus released. When the block is written onto media, a reconnection will be done to report the outcome of the operation.

Formatting, Generation of ECC and Transfer to Tape

Once these 2056 byte buffers are constructed in FECC memory, the control field information can be created and attached to the end of each buffer. The 68020 will format the control field information in local memory and then append it to the 2056 byte data blocks in FECC memory making the physical tape block size equal to 2076. This is done just before the blocks are written to tape since some fields in the control information change very dynamically depending on rewrite retries.

As each of these buffers or blocks are formatted, the 68020 will program the GPSP3 to start requesting the transfer of the blocks to tape via the FECC gate array. As the FECC gate array fetches the data words for the GPSP3, it will also feed them to the Reed Solomon generator which is being done concurrent with the write operation. That reduces the memory bandwidth requirements on the FECC memory.

This process of requesting data, generating ECC and writing data to tape continues for the entire 2076 block length. At the end of the transfer, the GPSP3 will interrupt the 68020 so that it can set up the next set of pointers to start writing the next block and calculate the ECC. After eight 4k tape blocks have been written to tape, the two 4k ECC blocks will be ready to be written.

THZ02 Controller Hardware

2.2 Controller Theory of Operation

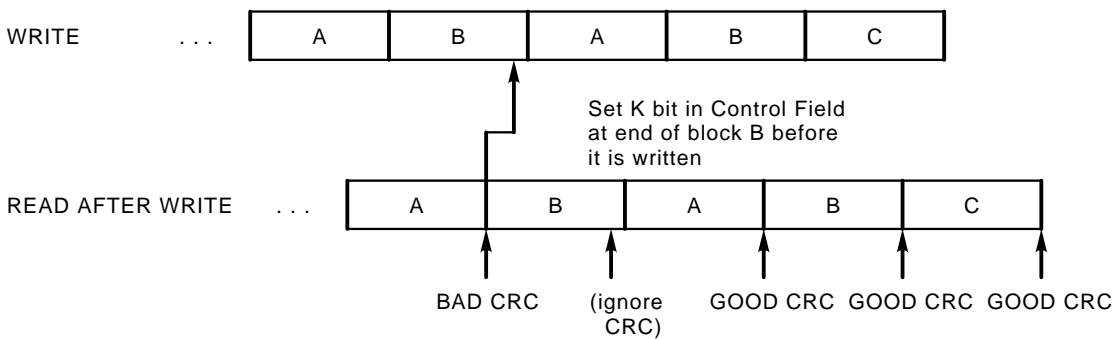
Error Recovery During Writes

At the same time a block is being written to tape the previous block is being read. At the CRC check time, the GPSP3 will interrupt the 68020 so that status can be checked. If a block on either track is bad, it will be rewritten without stopping the tape. Because the drive is a streaming tape drive, rewrites are done in line on the fly. What this means is that if we have written block A and start writing block B, the read after write of A will not be complete until B is already started. If A is determined to be bad by the CRC (or EDC check) results, then 68020 has to modify a bit in the control field of block B (the "K" bit) so the controller knows to ignore it later during a read, and finish writing B. The controller then has to rewrite A and B again until the read after write of A is correct.

This process of rewrites continues for every block written until the read after write of that block is correct. If however the rewrite count defined in controller software is exceeded then, the controller will stop the tape, backup to the beginning of the rewrite sequence, and start all over again. This entire sequence is repeated for up to the "Over-Write" retries value. If still not successful a hard write error will then be reported. Also at the CRC check time the EDC that was generated by the Swift gate array is checked by the GPSP3. The writing and checking of the EDC on tape gives the controller end to end checking on its data path to minimize otherwise undetected errors.

Because the rewrite of blocks affect the Reed Solomon calculation due to the fact that writes are linked directly to the Reed Solomon generator, the software in the controller has to retain multiple copies of the Reed Solomon calculation and only use the copies that were generated by blocks that had good read after write status. The following figure illustrates the rewrite of block A.

Figure 2-2 Rewrites



2.2.3 Read Operation

This is similar to write command handling. After the READ command is validated, buffer memory is checked to see if enough data is there to satisfy the command. If so, no disconnect is performed, the correct data is located and the transfer started. Otherwise a disconnect is executed until the data is located or read off the tape.

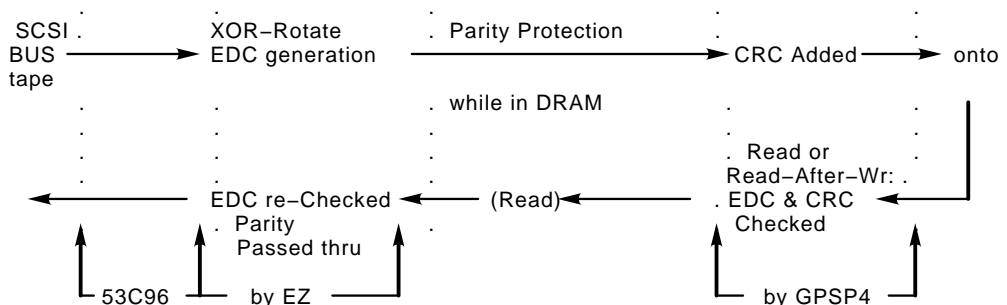
When the transfer is complete, if the requested block size matches the size of the block read off the tape, Status and Command Complete are returned immediately. If there is an error or exception case (for example due to a block size "mismatch"), a disconnect may be performed, with a later reconnection to report the status of the operation.

If the initiator asserts the ATN signal during the Data In, the THZ02 will stop almost immediately, and go to Message Out. If an Initiator Detected Error message is received, a Restore Pointers message will be sent, and the transfer restarted from the point at which a Save Data Pointer message was last sent.

2.2.4 Data Protection and Recovery

The THZ02 has full end-to-end data protection. As shown in the following figure, as the data comes onto the controller (and bus transmission errors checked for), the 53C96 chip checks and passes parity to the EZ chip, which builds a 16 bit XOR-rotate type EDC for each 512 bytes of data as it writes the data into EZ controlled memory. This word of EDC is appended to the data in RAM, and is then considered as part of the data during all subsequent data handling operations. While stored in controller cache memory, the data is also protected with byte parity by the hardware. When the data is DMAed to the drive's write circuitry, a 64 bit CRC is generated on the data and EDC, which is also written onto the media. The read-after-write that occurs immediately after writing checks both the CRC and EDC. This allows detection of data corruptions that might occur on the controller at the time data is written, instead of later, during a critical restore operation.

Figure 2-3 THZ02 Data Path Protection



During a read, the EDC and CRC are again both checked. In addition, block format information is also checked. If any error or inconsistency is detected, the Reed-Solomon correction algorithm is applied using ECC blocks that were generated and stored on the tape during the write process. There are two 4k ECC blocks for every eight 4k data blocks (each 4k is divided into two 2k blocks that go on different channels in parallel) and up to 4 of the 2k data blocks can be recreated which helps give the THZ02 its very low unrecovered error rate.

THZ02 Controller Hardware

2.2 Controller Theory of Operation

If too many 2k blocks are in error, the tape is stopped and reread retries performed and correction done if appropriate. Once the data has been recovered, and is sent over the SCSI bus, the EZ chip again checks the EDC word on each 512 bytes of data. In the unlikely case that the EDC check fails, the controller will abort the data transfer and flag an error to the host.

Retries will be performed in this case using the data in memory and the Restore Pointers mechanism, but the chances of success are small since the error is most likely due to a corrupted buffer. Fortunately the chance of this type of error is extremely low.

This chapter provides information for installing, configuring and operating the THZ02 tape drive.

3.1 Installation

Note

The SCSI (small computer system interface) bus must be terminated at both ends of the bus, and at least one device must supply terminator power.

The THZ02 controller module has sockets for the termination resistor packs. Note that there are two positions labeled on the etch: **NO TERM** and **TERM**.

If the THZ02 is the last device on the bus, and external termination of the cables is not going to be done, you should ensure that the three resistor packs are placed in the **TERM** position. (The **NO TERM** position is a holding place for the resistor packs.)

You can configure the THZ02 to supply **TERM PWR** on the bus by moving the **TERM PWR** jumper on the controller from **NO PWR** to **PWR**.

Be sure the resistors are in the **NO TERM** position if you use external termination.

3.2 Configuration

Select the SCSI ID by using the three rightmost switches on the controller. These switches specify an encoded value from 0 to 7. The left switch disables checking for parity on the SCSI bus by the tape unit, and should be done for systems that do not generate parity.

3.2.1 SCSI ID Switch Settings

Use Figure 3–1 to determine the SCSI ID switch settings. Switch 2 is the most significant bit (MSB) and switch 4 is the least significant bit (LSB): Refer to Figure 3–2 for details of physical switch location on the tabletop box.

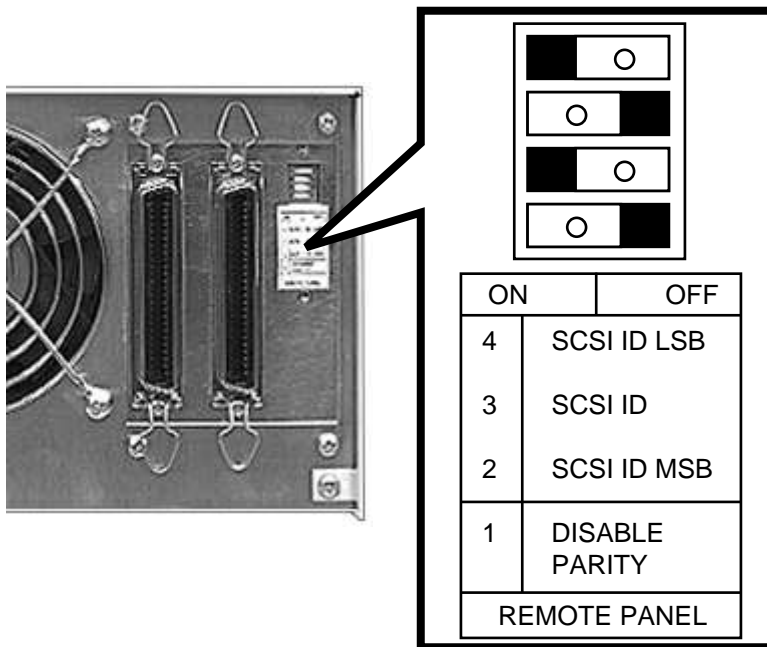
Installation

3.2 Configuration

Figure 3–1 SCSI ID Selection

SCSI ID	Switch 2	Switch 3	Switch 4
0	Off	Off	Off
1	Off	Off	On
2	Off	On	Off
3	Off	On	On
4	On	Off	Off
5	On	Off	On
6	On	On	Off
7	On	On	On

Figure 3–2 Rear Panel Switches



SHR-TZ86-04

Tape Drive Operation

4.1 Power-On Self-Test

The power-on self-test (POST) includes:

- Diagnostic LED test
- 68020 microprocessor register and instruction test
- Local RAM test
- NCR 53C96 chip test
- EZ gate array test
- GPSP4 gate array test
- Cache (EZ) RAM test
- Flash code ROM test
- Timer and other tests

POST completes and the subsystem responds normally to all commands within 5 seconds. However, it may take longer for the media to be made ready. After a bus reset, the tape drive responds within a bus selection timeout period or less.

Tape Drive Operation

4.2 Front Panel Indicators and Controls

4.2 Front Panel Indicators and Controls

The front panel consists of the following indicators and controls:

- Indicators
 - Write Protected
 - Tape in Use
 - Use Cleaning Tape
 - Operate Handle
 - Beeper
- Controls
 - Unload button
 - Cartridge insert/release handle

Table 4–1 Front Panel Indicators

Label	State	Purpose
Write Protected	On	Tape is write protected
	Off	Tape is write enabled
Tape in Use	Blinking	Tape is moving
	On	Tape is loaded and ready for use
Use Cleaning Tape	On	Drive heads need cleaning or the tape is bad
	Off	Cleaning is complete or cleaning is unnecessary
Operate Handle	On	Operate the cartridge insert/release handle
	Off	Do not operate the cartridge insert/release handle
Beeper	On	Sounds when you can operate the cartridge insert/release handle

4.3 Front Panel Lights

4.3.1 OK To Lift Handle Light

When the OK To Lift Handle light is on by itself, it is okay to operate the handle. Do not attempt to open the handle if the OK To Lift Handle light is not on.

If the OK To Lift Handle light flashes by itself, this indicates that the cartridge leader may be bad. Raise the handle and extract the cartridge. Carefully open the door of the cartridge, and check to see if the loop on the cartridge leader is visible. If it is not visible or the leader appears to be broken or mispositioned, replace the cartridge.

4.3.2 Tape In Use Light

The Tape In Use light indicates that a tape is in use or the drive is initializing. If the Tape In Use light stays on, then the tape is stopped. If the Tape In Use light is flashing, then the tape is moving or the drive is initializing.

4.3.3 Write Protect Light

4.3.3.1 Write Protect Light On Steady

If the Write Protect light is on steady, it indicates that the tape is write protected (recorded data is protected). If the Write Protect light is on steady, then one or more of the following conditions is true:

- The write protect switch on the cartridge is set.
- The cartridge is software write protected from the host.
- The cartridge has TK50 or TK70 calibration tracks written on it. (TK50 and TK70 cartridges can be read by a THZ02 but not written).

4.3.3.2 Write Protect Light Blinking

If the drive is unloaded, the handle closed, and the Write Protect light is blinking by itself, the drive is in the initial stage of code update mode. See Chapter 7 for a more detailed description of code update mode.

Tape Drive Operation

4.3 Front Panel Lights

4.3.4 Use Cleaning Tape Light

The front panel Use Cleaning Tape light is turned on or off following calibration. The light is turned on for the following reasons:

- For TX85 media, the noise is measured for all four channels while the tape is stopped and while the tape is erasing. The difference between the moving noise and stopped noise is compared to the 2f amplitude. If this ration of noise to signal exceeds a given level for any of the four channels, then the Use Cleaning Tape light is turned on.
- For TX85 media, if the resolution is less than a given minimum for any of the four channels, then the Use Cleaning Tape light is turned on.
- For TX70/50 media, if the VCG for any of the four channels is 0, this means that the calibration procedure was unable to set the gain high enough. This may indicate a dirty head, and the Use Cleaning Tape light is turned on.
- For TX70/50 media, if the 1f amplitude is less than a given minimum, then the Use Cleaning Tape light is turned on.
- For any media, if the calculated tape tension is greater than a given maximum or less than a given minimum, then the Use Cleaning Tape light is turned on.

The Use Cleaning Tape light will also be turned off after a cleaning cartridge has been used. Note that if the cartridge is 'used up', the Use Cleaning Light will not be turned off after the cleaning cartridge has been used.

4.3.5 All Four Lights Flashing

All four lights will flash constantly when the drive is in an error condition. You may try to reinitialize the drive and unload the tape by pressing the unload button. All three lights will briefly turn on and the drive will try to reinitialize.

4.3.6 Tape In Use and Write Protect Lights Flashing

If both the Tape In Use and Write Protect lights are flashing, this indicates that the drive is in code update mode. See Chapter 7 for a more detailed description of code update mode.

4.3.7 Power On Light Sequence

All four front panel lights will turn on sequentially when the drive is powered up (top to bottom). All four lights will remain on for a few seconds while the drive goes through power-on self-test (POST). After POST is complete, the Tape In Use light will flash slowly and the other three lights will turn off while the drive initializes.

After initialization, the drive will be in one of the four states listed below:

- If no cartridge is present, the amber light will turn off, the green light will turn on, the handle will be unlatched, and the drive will beep. It is now okay to raise the handle and insert a cartridge.
- If a cartridge is present and the handle is down, the drive will load the cartridge. When the amber light stops flashing and stays on, then the drive is ready for use.
- If a cartridge is present but the handle is up (not recommended), the amber light will turn off and the green light will turn on. The handle should then be lowered and the cartridge will load.
- If the drive detects an error condition, then all four lights will flash repeatedly. You may try to unload the tape and reinitialize the drive by pressing the unload button. The four lights will stop flashing and the drive will try to reinitialize as just described.

4.3.8 Unload Button

The unload button is used primarily to indicate that the user wants to unload the tape. When the user pushes the unload button, the THZ02 waits until an active write to tape is completed before beginning the unload sequence.

If the drive is in error state (all four front panel lights flashing), pushing the unload button will cause the drive to reset and unload the tape if possible.

4.4 Write Protect Switch on Cartridge

If the user changes the state of the cartridge write protect switch, the drive will turn on the write protect LED immediately. However, if the drive is currently writing to the tape, the write protect will not take effect until the current write is completed.

Tape Drive Operation

4.5 Cleaning Cartridge

4.5 Cleaning Cartridge

4.5.1 Cleaning Algorithm

When the drive detects that a cleaning cartridge has been loaded the drive will initiate the cleaning algorithm. Note that the cleaning algorithm will occur regardless of whether the cleaning light is on.

- Tape motion is started and the head is moved to the bottom stop and then up a given number of steps. Tape motion is stopped.
- Tape motion is started and the head is scanned through an area of tape where previous cleaning (and writing) may have taken place. A/D samples are taken as the head is stepped up. The maximum and minimum A/D samples for each channel are stored. When the head has finished stepping and the tape has moved a certain distance, tape motion is stopped. If the difference between the maximum and minimum signal amplitudes is less than a given threshold, then it is assumed that the tape has not been written on and is fresh. This is because, as described in more detail below, a number of 'tracks' are written on the cleaning tape each time it is used. When it is read, there will be areas of no signal and areas of strong signal.
- If it is determined that the area of tape being scanned has been written, then the above procedure is continued on the next area of tape until an unwritten area is found or until the diameter of the supply cartridge is less than a given diameter indicating that the cartridge is used up.
- Once a clean area of tape has been found, a number of passes are made over the tape while writing a 1f frequency with VCWs set to a nominal value. On each pass the head is moved a number of steps.
- After the last pass, the Use Cleaning Tape light is turned off.
If the drive was unable to find an unwritten area of tape (tape is used up), then the Use Cleaning Tape light will not be turned off.
- After cleaning is complete, the THZ02 will unload the tape.

The **Unload** button rewinds the tape and unloads the tape from the drive back to the cartridge. The tape must be completely rewound and unloaded into the cartridge before you remove the cartridge from the drive.

4.5.2 Cartridge Insert/Release Handle

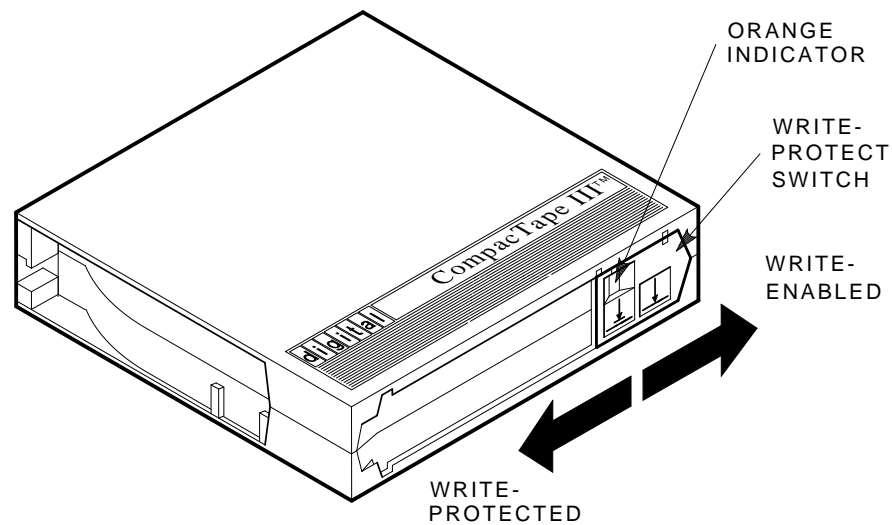
Operate the cartridge insert/release handle only when the **Operate Handle** indicator is **on**, and the momentary beep sounds.

4.5.3 CompacTape III Cartridge

The CompacTape III is a 4-inch, gray plastic, cartridge containing 1100 feet of 1/2 inch magnetic metal particle tape.

The medium is a CompacTape III half-inch cartridge or ANSI-compatible equivalent. It is written and read using the interchange format as proposed in ANSI X3B5/91-227.

Figure 4-1 Tape Cartridge



SHR_X1020C_89

The CompacTape III has a **write-protect switch** to prevent accidental erasure of data. When you slide the switch to the left and the small orange rectangle is visible, data cannot be written to the tape. The arrow (beneath the orange rectangle and over the two lines on the write-protect switch) lets you know that data cannot be written to the tape.

On the right side of the write-protect switch is another symbol: an arrow over one line. This symbol indicates that if you slide the write-protect switch to the right, data can be written to the tape.

Tape Drive Operation

4.5 Cleaning Cartridge

4.5.4 Loading the Tape

Note

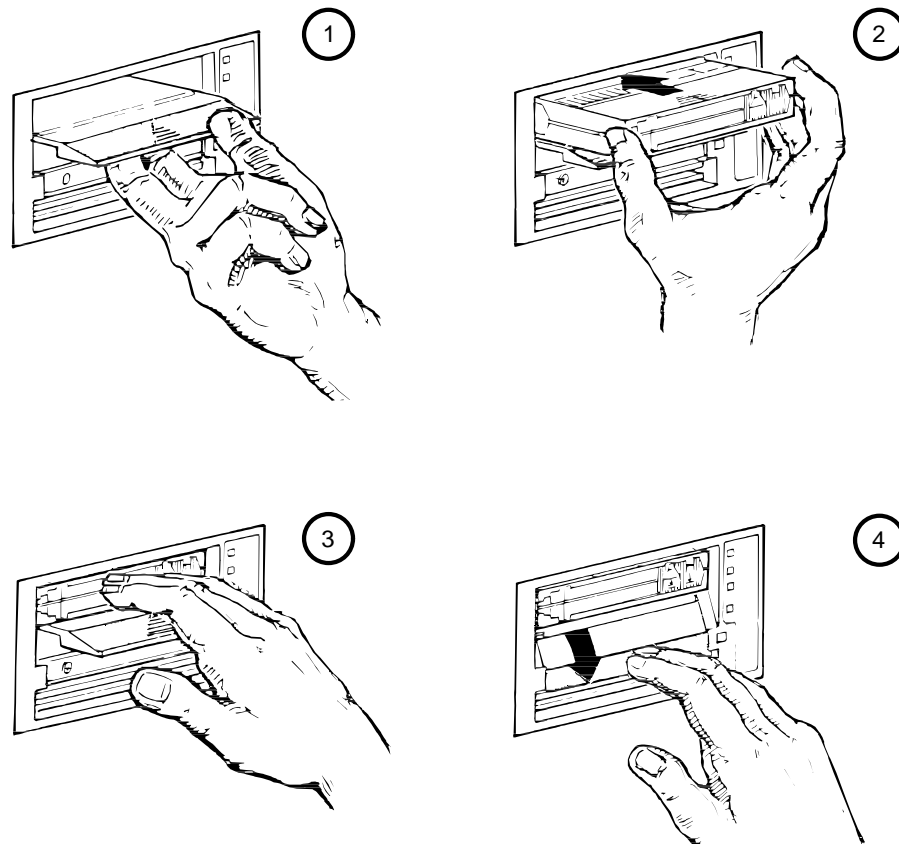
The directions for loading a cartridge into, and unloading a cartridge from the drive, are printed on the front of the drive.

To load a tape, refer to these steps:

1. Pull the cartridge insert/release handle open when the green light is on steadily.
2. Insert the cartridge.
3. Push the cartridge into the drive.
4. Push the handle closed.

The green light turns off and the yellow light blinks to show that the cartridge is loaded. When the tape is at the BOT marker, the yellow indicator turns on steadily. The tape is now ready for use.

Figure 4-2 Loading the Tape



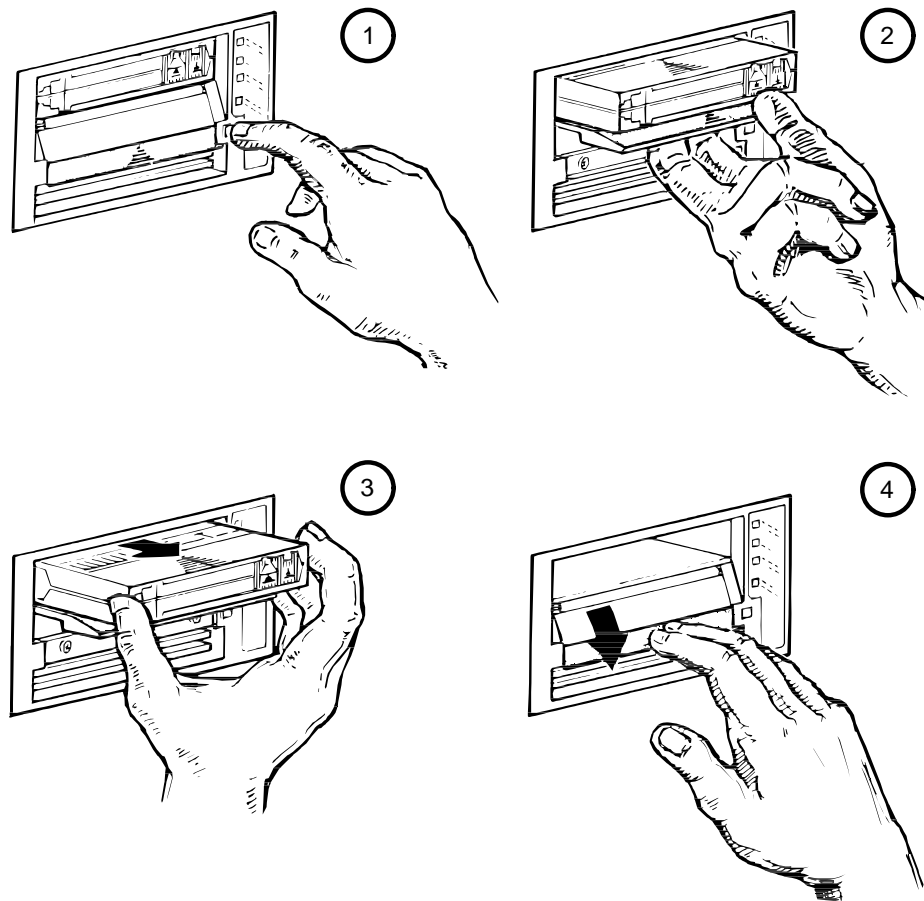
SHR-0256-87
SHR_X1093_89_CPG

4.5.5 Unloading the Tape

To unload a tape, follow these steps:

1. Press the **Unload** button.
2. Pull the cartridge insert/release handle open to eject the cartridge when the green light turns on and the beeper sounds.
3. Remove the cartridge.
4. Push the handle closed.

Figure 4-3 Unloading the Tape



SHR-0257-87
SHR_X1049_89_CPG

Media Loader Operation

This chapter explains THZ27 subsystem operation:

- Power-on process
- Mode Select key modes
- Operator control panel (OCP) indicator functions
- Slot Select, Load/Unload, and Eject button functions
- Magazine cartridge insertion and removal

5.1 Introduction to The Media Loader

The media loader option is a half-rack form factor packaging of the THZ02 and a media loader that services the drive and a 7-cartridge magazine.

The media loader is controlled by the same SCSI target controller board as the tape drive. The loader is presented as an SCSI-2 medium changer device on LUN 1 (the tape drive is always LUN 0) if the controller detects its presence on power up.

The SCSI-2 medium changer commands allow random access to the media stored in the magazine slots. In addition, sequential access of the media is supported automatically in auto-loading mode. Auto-loading is implemented as a side-effect of the SCSI UNLOAD command. If an UNLOAD is specified, and a media loader is present, after winding the tape back into the cartridge and moving it from the drive to the magazine slot it came from, the cartridge in the next slot is moved from the magazine into the drive and made ready. If the next slot is empty, or the cartridge unloaded was for the last slot in the magazine, the drive is left empty.

5.2 Power-On Process

When the THZ27 subsystem powers on, all of the indicators on the operator control panel (OCP) light within 15 seconds. The power-on self-test, or POST, is initializing the subsystem. When POST completes successfully, all OCP indicators, including the Magazine Fault and Loader Fault indicators, turn off — except for Power On.

Note

If the Magazine Fault or Loader Fault indicator remains on, POST has detected an error.

Media Loader Operation

5.2 Power-On Process

The elevator scans the magazine to determine which slots contain cartridges. If the subsystem has a magazine with a cartridge in slot 0, and no cartridge is in the drive, these indicators should be on:

Power On
Eject
Load/Unload
Slot Select
Slot 0

5.3 Mode Select Key

The Mode Select key (Figure 5–1) can lock the loader transfer assembly into the enclosure, as well as lock the receiver closed. It has four modes: OCP Disabled, Automatic, Manual, and Service. The OCP Disabled, Automatic, and Manual modes are for operational use; the Service mode is for head cleaning and servicing procedures.

5.3.1 Operating Modes

The following modes are for operational use:

- **OCP Disabled** — When the magazine is inserted into the receiver and the receiver is closed, the loader transfer assembly scans the magazine. The first cartridge in the magazine automatically loads into the drive. Operations stop if you are copying data to tape and either the storage capacity of the last tape cartridge is exceeded, or no tape cartridge is in the next sequential slot in the magazine.

To lock the THZ27 subsystem into the enclosure and lock the receiver, set the Mode Select key to **OCP Disabled** mode. The OCP pushbuttons are disabled.

- **Automatic** — This mode is the default, or normal, mode of the THZ27 subsystem. It automatically loads and unloads cartridges as necessary during backup procedures. Operations stop if you are copying data to tape and either the storage capacity of the last tape cartridge is exceeded, or no tape cartridge is in the next sequential slot in the magazine.

To lock the THZ27 subsystem into its normal operating position in the enclosure but leave the receiver unlocked, set the Mode Select key to **Automatic** mode. The receiver can be opened; all OCP pushbuttons are enabled.

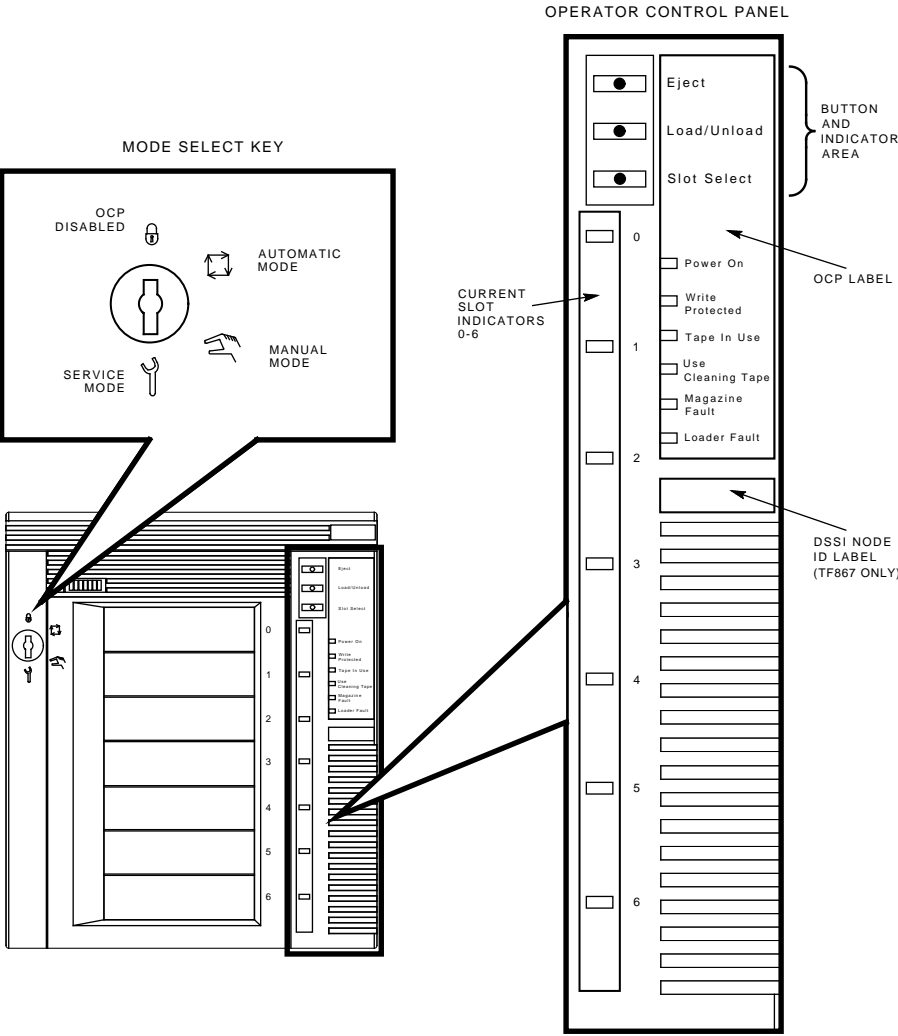
- **Manual** — Automatic loading and unloading of cartridges does not occur in this mode; rather, you must press the Load/Unload button to move each cartridge. This mode is most useful for, but not restricted to, copying specific files to or from tape.

To lock the THZ27 subsystem into the enclosure, set the Mode Select key to **Manual** mode. The receiver is unlocked and can be opened; all OCP pushbuttons are on.

Note

During Manual mode, the cartridge returns to the magazine, but the current Slot Select indicator does not advance forward to the next available cartridge.

Figure 5-1 THZ27 Operator Control Panel



SHR_X1025E_91

Media Loader Operation

5.3 Mode Select Key

5.3.2 Service Mode

Service mode is for performing head cleaning by manually loading the CleaningTape III and for performing servicing procedures.

To unlock the THZ27 subsystem from its enclosure and remove it from its normal operating position, set the Mode Select key to **Service** mode. The receiver is unlocked and can be opened.

5.4 Operator Control Panel

The THZ27 operator control panel (OCP) has 3 OCP pushbuttons and 16 indicators that are used with the Mode Select key (Table 5–1). See Section 5.3 for information on the Mode Select key and its functions. See Section 5.5 for more details on button and indicator operations.

Table 5–1 THZ27 Operator Control Panel

Button/Indicator	Color	Function
Eject button	–	Opens the receiver, allowing access to the magazine for removal and insertion of cartridges. Also used to unload the tape from the drive to the magazine.
Eject indicator	Green	Indicates a magazine fault, and that you can press the Eject button to unload cartridges from the drive to the magazine and to open the receiver.
Load/Unload button	–	Loads the currently selected cartridge into the tape drive. Unloads the cartridge currently in the tape drive. Resets the subsystem if there is a loader fault.
Load/Unload indicator	Green	Indicates that you can press the Load/Unload button.
Slot Select button	–	Increments the current slot indicator to the next slot.
Slot Select indicator	Green	Indicates that you can press the Slot Select button. Pressing this button moves the current slot indicator to the next slot.
Power On indicator	Green	Indicates the THZ27 magazine tape subsystem is in a known good power state (ac and dc voltages are within tolerance).
Write Protected indicator	Orange	When on, indicates that the cartridge currently in the drive is write-protected by one of these methods: <ul style="list-style-type: none">• Setting the write-protect switch to write-protect• Using software write-protect qualifiers When off, indicates that the current cartridge is write-enabled.

(continued on next page)

Table 5–1 (Cont.) THZ27 Operator Control Panel

Button/Indicator	Color	Function
Tape In Use indicator	Yellow	Indicates tape drive activity as follows: <ul style="list-style-type: none"> • Slow blinking indicates tape is rewinding. • Rapid blinking indicates tape is reading or writing. • When on steadily, indicates that a cartridge is in the drive and the tape is not moving. • When off, indicates that no cartridge is in the drive.
Use Cleaning Tape indicator	Orange	Indicates that the read/write head needs cleaning.
Magazine Fault indicator	Red	Indicates a magazine failure.
Loader Fault indicator	Red	Indicates a loader transfer assembly error or drive error.
Current slot indicators 0–6	Green	Identifies the current slot (see Slot Select button). Each current slot indicator blinks when its corresponding cartridge moves to or from the drive. Also used with the Magazine Fault or Loader Fault indicator to show the type of fault.

5.5 Slot Select, Load/Unload, and Eject Button Functions

The Slot Select, Load/Unload and Eject buttons are OCP pushbuttons. They contain a green indicator, and they are operable only when their corresponding indicators are on.

Note

The Load/Unload button has three functions: *load*, *unload*, and *reset*. If there is a loader fault and the Loader Fault indicator is on, press the Load/Unload button to reset the THZ27 subsystem.

5.5.1 Selecting a Cartridge

Use the **Slot Select** button to select a cartridge; press this button to advance the slot indicator light to the next available slot. After a successful initialization, the THZ27 subsystem automatically selects slot 0 and the Slot Select button becomes active. The Load/Unload and Eject indicators remain on during the slot selection.

Media Loader Operation

5.5 Slot Select, Load/Unload, and Eject Button Functions

5.5.2 Loading the Cartridge

Press the **Load/Unload** button to load the cartridge into the drive. This action causes the Select Slot, Load/Unload, and Eject indicators to turn off, and the elevator to move to the selected slot, indicated by the light. The cartridge is then removed from the magazine and placed in the elevator. The elevator moves to the drive position and inserts the cartridge into the drive. The indicators remain off until the tape has loaded to the beginning of the tape (BOT). After the cartridge is loaded into the drive, the Eject and Load/Unload indicators turn on, and the corresponding buttons are enabled. The Slot Select indicator remains off.

5.5.3 Unloading the Cartridge

Caution

Do not press the Load/Unload button until backup or other tape operations are stopped at the terminal. Doing so can result in operation failure and drive unavailability.

When you press the Load/Unload button, the Select Slot, Load/Unload, and Eject indicators turn off, and the cartridge unloads from the drive into the magazine. However, automatic operation now stops and the Select Slot operation does not increment. The indicators turn on once the cartridge is returned to the magazine.

The Load/Unload indicator must be on before you press the button to load or unload a cartridge. If the Loader Fault indicator is on, showing a malfunction, press the Load/Unload button to reset the subsystem and try to clear the error.

5.5.4 Opening the Receiver

The **Eject** button opens the receiver for insertion or removal of the magazine. It is disabled when the Mode Select key is in the OCP Disabled position. The Eject button can also be used to *unload* a tape from the drive.

Note

When a cartridge is not in the drive, the Slot Select, Load/Unload, and Eject indicators are on before any operation begins. Pressing the Eject button causes all indicators to turn off. The elevator then returns to its home position and the receiver opens.

When a cartridge is in the drive, the Eject and Load/Unload indicators are on before the operation begins. When you press the Eject button, both indicators turn off, and the cartridge unloads from the drive and moves back into the magazine. The receiver then opens to allow access to the magazine.

In both situations, once the receiver is closed again, a magazine scan begins, and the indicators turn back on when the scan is complete.

5.6 Magazine

The front of the magazine has numbers, 0 through 6, that indicate the number of the slot.

Note

Insert and remove all cartridges at the *front* of the magazine.

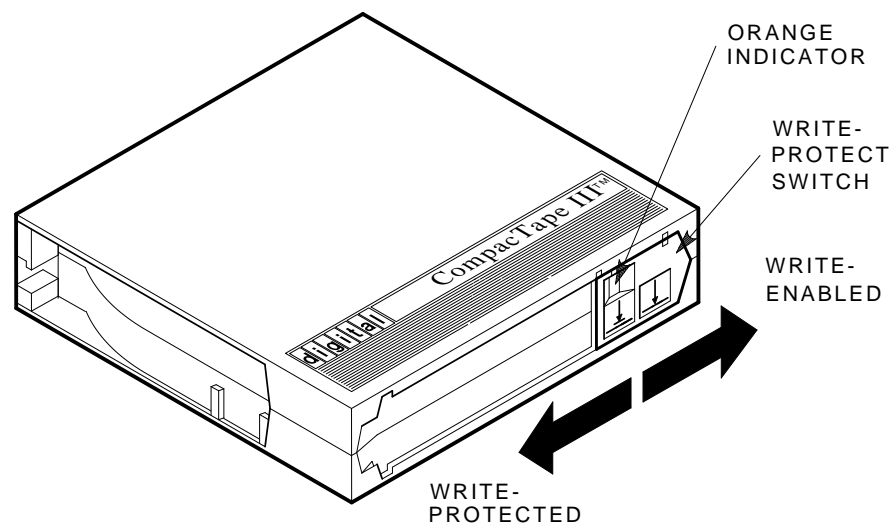
5.6.1 Inserting a Cartridge into the Front of the Magazine

To simplify cartridge insertion, place the magazine on a flat surface with the slots facing you (Figure 5–3). Each slot is numbered — to ensure that you are inserting the cartridge correctly in the front of the magazine. Usually, cartridges are inserted into consecutive slots.

To insert a cartridge into the magazine:

1. Grasp the cartridge with the CompactTape III label facing up and the write-protect switch facing you (Figure 5–2).
2. Set the cartridge's write-protect switch to the desired position. If you want to write on the tape, slide the switch to the right (orange indicator is not visible). If you want to write-protect the tape, slide the switch to the left (orange indicator is visible).
3. Insert the cartridge (Figure 5–3) by pushing it into the slot until you hear a click. A small metal tab holds the cartridge in place.

Figure 5–2 Write-Protect Switch on a Cartridge

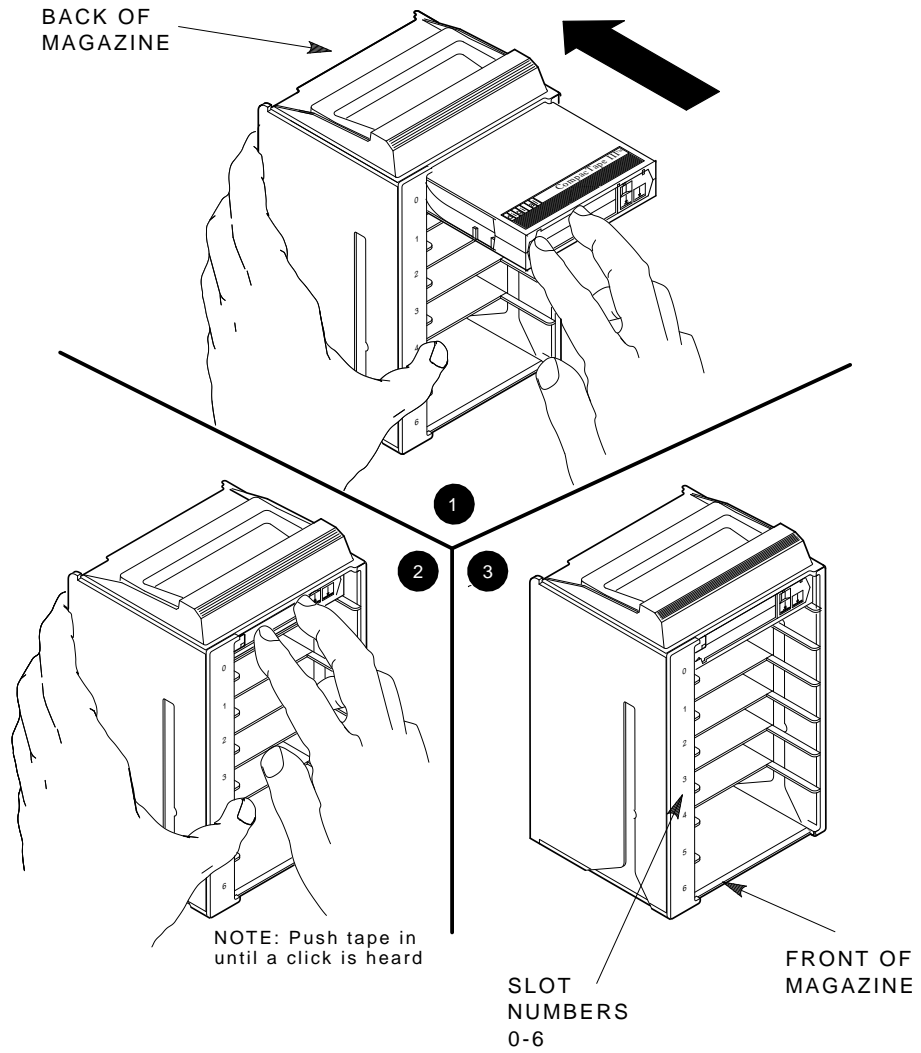


SHR_X1020C_89

Media Loader Operation

5.6 Magazine

Figure 5-3 Inserting a Cartridge into the Magazine



SHR_X1021_89

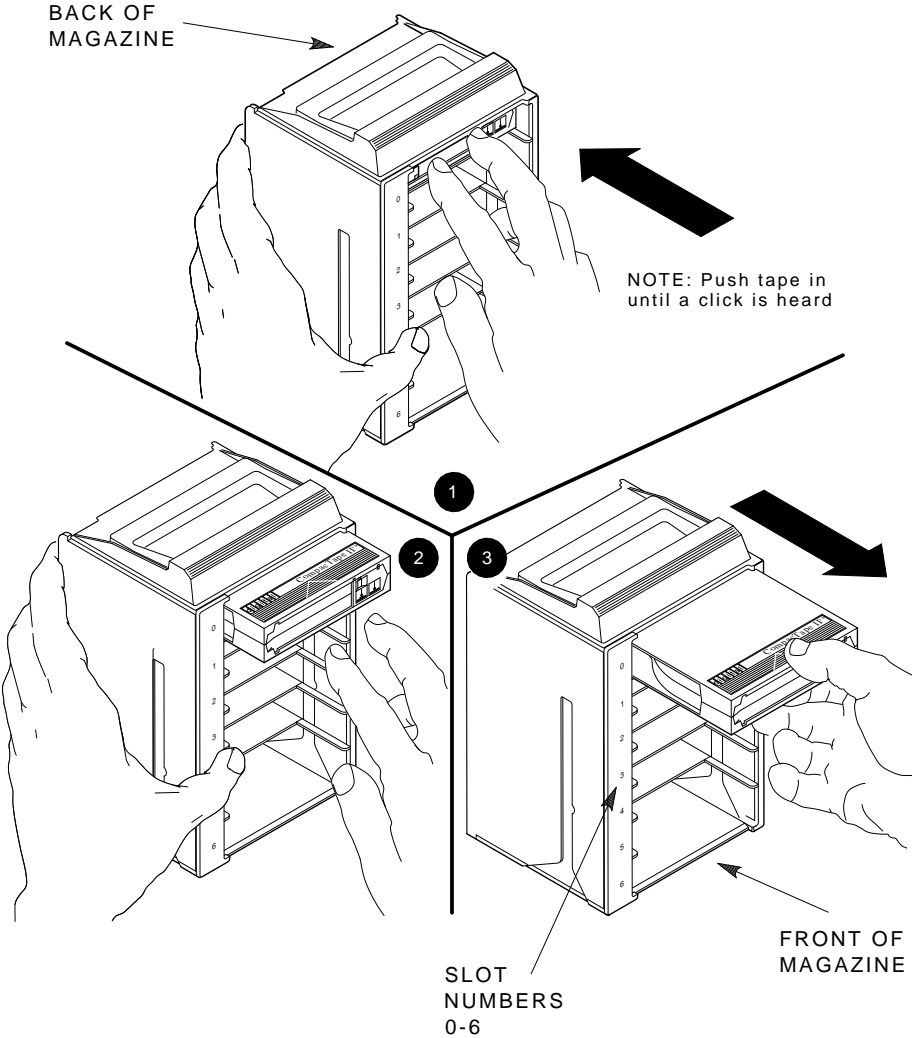
5.6.2 Removing a Cartridge from the Magazine

To remove a cartridge from the magazine, press the cartridge (Figure 5-4) at the front of the magazine until you hear a click; then release. The slot uses a spring-release action. When you press the cartridge in all the way, it pops out.

Note

Never apply labels to the top or bottom of tape cartridges. Doing so can cause cartridge jams in the THZ27 subsystem. Use the space on the front of the cartridge for labels.

Figure 5-4 Removing a Cartridge from the Front of the Magazine



SHR_X1022_89

Media Loader Operation

5.6 Magazine

5.6.3 Removing the Magazine from the Receiver

To remove the magazine from the receiver, first be sure that:

1. The Power On indicator is on (Figure 5–1).
2. The tape drive is unloaded.
3. The Eject indicator is on. (It must be on before you can press the Eject button.)

Then:

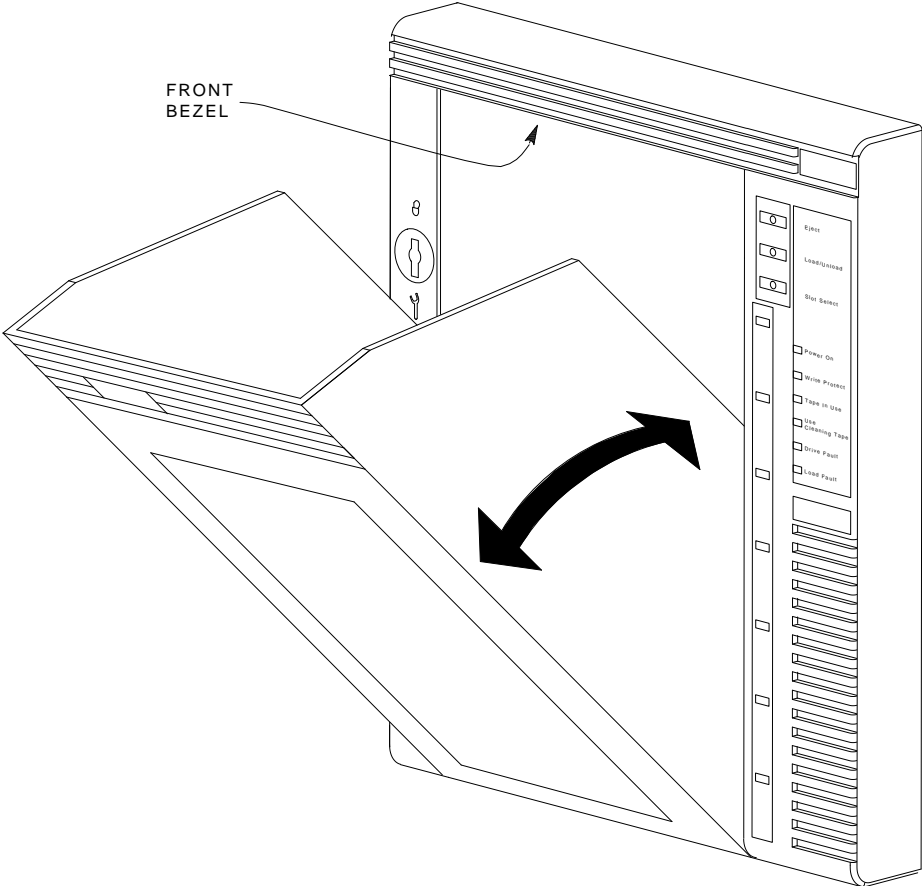
1. Press the Eject button (Figure 5–1) to open the receiver.
2. Grasp the receiver after it opens (Figure 5–5), and gently pull it forward to access the magazine.
3. Grasp the magazine's handle only to lift the magazine out of the receiver.

5.6.4 Installing the Magazine into the Receiver

To install the magazine into the receiver:

1. Slide the magazine down into the receiver (Figure 5–5) while holding the magazine by the handle. Since the magazine is slotted, you can restore it in the correct orientation only.
2. Push the receiver closed.
3. Observe that the receiver is fully closed in the THZ27 subsystem before proceeding.

Figure 5-5 Receiver Opened



SHR-X0046-90

6.1 Overview

This chapter covers the details of the SCSI Protocol features that the product implements.

The following sections do not fully reiterate the ANSI SCSI specification but rather describes which commands, messages, and options are supported, and what the error recovery procedures are.

6.2 General SCSI Bus Operation

6.2.1 Data Transfer

The THZ02 supports asynchronous and synchronous data transfers. There are differential and single ended versions of the product. Odd parity is generated during all information transfer phases where the device writes data to the SCSI bus, and checked during all information transfer phases where data is read from the bus. However, parity will not be checked if the corresponding controller or remote panel switch is set to Disable Parity Checking.

The THZ02 supports a maximum block size of 256K bytes.

Disconnects from the SCSI bus will be done at regular intervals during a data transfer. This is to allow other devices access to the bus. This disconnecting is configurable by use of the disconnect-reconnect mode parameters page.

6.2.2 Initiator/Target Operation

The THZ02 does not act as an initiator on the SCSI bus.

Therefore, the device will not do any of the following:

- Generate unsolicited interrupts to the host.
- Initiate its own SCSI commands.
- Assert bus reset.

SCSI Interface

6.2 General SCSI Bus Operation

6.2.3 SCSI IDs And Logical Unit Numbers

The SCSI ID is a value ranging from 0-7 which determines the address of the device controller on the SCSI bus. The THZ02 has a switch-selectable SCSI ID, so that this value may be changed easily. The default setting will be factory shipped at SCSI address 0. The THZ02 with optional medium changer has two logical units, that will always appear as LUN 0 (the tape drive), and LUN 1 (the medium changer).

Unsupported LUN numbers shall be treated as follows: If the logical unit number (LUN) specified in the IDENTIFY message is invalid, the THZ02 shall accept the command descriptor block (CDB). There are three cases of what happens next:

1. If the command is INQUIRY, the target shall return the inquiry data with the peripheral qualifier set to 011, indicating that the target will never support the LUN in question.
2. If the command is REQUEST SENSE, the target shall return sense data. The sense key shall be ILLEGAL REQUEST, with an additional sense code of INVALID logical unit number.
3. For any other command, the target shall terminate the command with CHECK CONDITION status, and generate the above sense data.

6.2.4 Unit Attention Condition

Queued unit attentions are implemented on this device, and are maintained separately for each valid LUN for each initiator. Unit attentions will be created in the following circumstances:

- Power on
- BUS reset
- Bus device reset message
- When the media may have changed asynchronously
- Another initiator changed the mode parameters
- A firmware (microcode) update has completed

Two queued unit attentions are not unusual. For example, if a unit is powered up and a cartridge is loaded, Power up and not-ready to ready transition unit attentions are created. Due to a limited number of unit attention buffers, if an initiator does not clear unit attentions queued for it, at some point the tape device will stop generating new unit attentions for that I-L combination (but existing ones will be left queued).

A LOAD command will not generate a unit attention for the initiator that issued the command, since the transition to ready is synchronous.

6.2.5 Behavior Around Power-On and SCSI Bus Reset

- All device SCSI lines shall go to high impedance when the THZ02 is powered off.
- The THZ02 will not generate any spurious signals on the SCSI bus at power-on.
- Within 5 seconds of power on, and within 250 milliseconds (typically under 4 ms) after a bus reset, the THZ02 will respond to SCSI bus selections and return appropriate, normal, responses. Tape motion commands will be returned with CHECK CONDITION status, Sense Key Not Ready, until the media has been made ready.
- The hard bus reset option is implemented.
- The media is rewound to BOP.

The THZ02 will be able to recognize multiple bus resets in succession and bus resets of arbitrarily long duration. It will recover within the time limits specified above, following the last bus reset.

6.2.6 Data Cache and Tape Write Interaction

The THZ02 contains a data cache that is used to buffer blocks (records) until they are written. This section defines specific times that blocks shall be written to tape. A mode select parameter is present that allows the data cache to be disabled (unbuffered mode). In this mode, every WRITE command will cause the data to be written to the media before the STATUS byte and the COMMAND COMPLETE message is returned to the host. Unbuffered mode is *not* recommended due to the poor performance that will result.

The write data cache shall be written (flushed) to the media under the following circumstances:

- When two or more WRITE FILEMARKS commands are issued without intervening tape motion commands.
- When a WRITE 0 FILEMARKS command is issued.
- Data which has been in the cache for a period of more than specified by the value of the Mode Parameter "Write Delay Time", shall be automatically written to media.
- When a nonwrite type media access command is received (for example, SPACE, READ, UNLOAD, etc.).

SCSI Interface

6.2 General SCSI Bus Operation

6.2.7 Other SCSI Functionality

1. Linked commands are supported.
2. Untagged queuing is supported.
3. The THZ02 does not use the wide-SCSI data path.

6.2.8 Bus Phases

The THZ02 conforms to the bus state transition table shown in the SCSI-2 standard, "Phase Sequences". In addition, the information in the following sections applies.

6.2.9 ATTENTION Signal Response

The THZ02 will respond to an ATN condition at least at every phase transition, as long as the initiator sets the ATN bit before the target deasserts the REQ for the last byte of the previous phase. Generally ATN will be recognized immediately by the THZ02, and it will change the bus phase to Message Out.

6.2.10 STATUS Phase

The THZ02 will enter the status phase just once per command, unless a retry is requested by the initiator. The only exception is during error cases when the device goes immediately to bus free, as defined in the SCSI-2 standard (Section 6.3 of rev 10c).

The status bytes that the tape drive returns are as follows:

- **GOOD (00):** This status indicates that the drive has successfully completed the command.
- **CHECK CONDITION (02):** A contingent allegiance condition has occurred. The REQUEST SENSE command should be sent following this status to determine the nature of the event.
- **BUSY (08):** The target is busy. This status is returned whenever the device is unable to accept a command from an otherwise acceptable initiator. The initiator should reissue the command at a later time.
- **INTERMEDIATE GOOD (10h):** This status is returned instead of GOOD status for commands issued with the Link bit set. Following the return of this status, the drive will proceed to the command phase for the transfer of the next linked command.
- **RESERVATION CONFLICT (18h):** This status is returned by the drive whenever an SCSI device attempts to access the drive when it has been reserved for another initiator with a RESERVE UNIT command.
- **COMMAND TERMINATED (22h):** This is the status returned for a command that was terminated by a TERMINATE I/O PROCESS message. This status also indicates that a contingent allegiance condition has occurred.

SCSI Interface

6.2 General SCSI Bus Operation

- **QUEUE FULL (28h):** This status is returned when a **QUEUE TAG** type message is received and the command queue is full. The command received is discarded.

Note

In contrast to the **BUSY** status condition, the **DRIVE NOT READY** sense key is returned as part of the Sense data following a **REQUEST SENSE** command and indicates that a media access command has been issued and the media is not ready to be accessed (for example, the media is not installed, the media has been unloaded, the drive is currently initializing the media to prepare it for access, etc.).

In the not ready state, the initiator cannot perform any operation which would cause tape motion (for example, write, read, verify, space, etc.). These commands will return a **CHECK CONDITION** status with a **DRIVE NOT READY** sense key. The initiator may, however, execute commands that don't require access to the media and a **GOOD** status may be returned. These commands are as follows:

- **INQUIRY**
- **LOAD UNLOAD**
- **LOG SENSE/SELECT**
- **MODE SELECT**
- **MODE SENSE**
- **PREVENT/ALLOW MEDIUM REMOVAL**
- **READ BLOCK LIMITS**
- **READ BUFFER**
- **READ ELEMENT STATUS**
- **RECEIVE DIAGNOSTIC RESULTS**
- **REQUEST SENSE**
- **RESERVE/RELEASE UNIT**
- **SEND DIAGNOSTIC** (nonmedia access diagnostics)
- **WRITE BUFFER**

The **TEST UNIT READY** command is used to determine whether the tape drive would accept a media access command without returning **CHECK CONDITION** status.

SCSI Interface

6.3 SCSI Message System

6.3 SCSI Message System

The message system allows communication between an initiator and a target for the purpose of physical path management.

To support certain SCSI-1 initiators, an Identify message is not required by the THZ02. If a message is sent by the initiator after the SELECTION phase, it should be an IDENTIFY, ABORT, or BUS DEVICE RESET message. If the THZ02 receives any other message in this case, it will go directly to BUS FREE phase.

The following messages are supported:

Table 6–1 Supported SCSI Messages

Code	In/Out	Description	Section
06	Out	ABORT	ABORT (06h)
0D	Out	ABORT TAG	ABORT TAG (0Dh)
0C	Out	BUS DEVICE RESET	BUS DEVICE RESET (0Ch)
0E	Out	CLEAR QUEUE	CLEAR QUEUE (0Eh)
00	In	COMMAND COMPLETE	COMMAND COMPLETE (00h)
04	In	DISCONNECT	DISCONNECT (04h)
01	Both	EXTENDED MESSAGE (SDTR only)	EXTENDED MESSAGE (01h)
80->FF	Both	IDENTIFY	IDENTIFY (80h-FFh)
05	Out	INITIATOR DETECTED ERROR	INITIATOR DETECTED ERROR (05h)
0A	In	LINKED COMMAND COMPLETE	LINKED COMMAND COMPLETE (0Ah)
0B	In	LINKED COMMAND COMPLETE w/flag	LINKED COMMAND COMPLETE, with Flag (0Bh)
09	Out	MESSAGE PARITY ERROR	MESSAGE PARITY ERROR (09h)
07	Both	MESSAGE REJECT	MESSAGE REJECT (07h)
08	Out	NO-OP	NO-OP (No Operation) (08h)
03	In	RESTORE POINTERS	RESTORE POINTERS (03h)
02	In	SAVE DATA POINTER	SAVE DATA POINTER (02h)

ABORT (06h)

This message is sent from the initiator to the target to clear, on the selected unit, the current I/O process. Buffered (cached) write operations will be completed if possible. The target goes directly to the BUS FREE phase after successful receipt of this message. Current settings of mode select parameters and reservations are not affected. Commands, data and status for other initiators is not affected.

This message can be sent to a logical unit that is not currently performing an operation for the initiator. If no unit has been selected, the target goes to BUS FREE, and no commands, data or status on the target is affected.

ABORT TAG (0Dh)

This message is sent from the initiator to the target to clear, on the selected unit, the current I/O operation only. The target goes directly to the BUS FREE phase after successful receipt of this message. Current settings of mode select parameters and reservations are not affected.

BUS DEVICE RESET (0Ch)

This message from an initiator clears all commands, data and status in the tape controller. When it recognizes this message, the drive aborts the command currently being executed and proceeds to the BUS FREE state. The drive then executes a hard reset which leaves it as if a bus reset had occurred. All data in the write buffer is lost.

CLEAR QUEUE (0Eh)

This message clears all I/O processes for all initiators. A Unit Attention condition will be generated for all other initiators that had outstanding I/O processes, with Additional Sense Code (ASC) of Command Cleared by Another Initiator. The target goes directly to the BUS FREE phase after successful receipt of this message. Current settings of mode select parameters and reservations are not affected.

COMMAND COMPLETE (00h)

This message is sent from a target to an initiator to indicate that the execution of a command (or a series of linked commands) has completed and valid status has been sent to the initiator. After it has sent the message successfully, the target goes to the BUS FREE phase by releasing BSY. If received by the tape unit, it is handled as an illegal message; the drive returns MESSAGE REJECT and enters the STATUS phase reporting CHECK CONDITION with the sense key set to COMMAND ABORTED.

DISCONNECT (04h)

A target sends DISCONNECT to tell an initiator that the present physical path is going to be broken (the target intends to disconnect by releasing BSY). Later, reselection is required in order to complete the current operation. This message does not cause the initiator to save the Data pointer.

When received from an initiator, the tape drive may respond in one of two ways. First, it may take the message as a request by the initiator to disconnect and comply by entering message in phase and sending the DISCONNECT message back to the initiator (possibly preceded by the SAVE DATA POINTERS message). In this case, it will delay a minimum of 200 μ s before arbitrating for the bus again. Alternately, it may enter the message in phase and return MESSAGE REJECT.

EXTENDED MESSAGE (01h)

This is sent as the first byte of a multiple-byte message (> 2 bytes) by either initiator or target. EXTENDED MESSAGE has the following format:

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6.3 SCSI Message System

Figure 6–1 Extended Message Format

Byte 0	Extended Message Identifier – 01h
Byte 1	Extended Message Length
Byte 2	Extended Message Code
Byte 3	Extended Message additional parameters

The extended message length specifies the length of the extended message plus the number of additional parameter bytes that are to follow. The length does not include bytes 0 and 1. A value of 0 for the extended message length indicates 256 bytes to follow.

Possible extended message codes are as follows:

- 00h — MODIFY DATA POINTER (not supported)
- 01h — SYNCHRONOUS DATA TRANSFER REQUEST
- 02h — Reserved
- 03h — WIDE DATA TRANSFER REQUEST (not supported)
- 04h-7Fh — Reserved
- 80-FFh — Vendor Unique

If the tape drive receives an extended message which it does not support, it switches to message in phase and returns MESSAGE REJECT after all the bytes of the message have been transferred.

IDENTIFY (80h-FFh)

These messages are sent either by the initiator or by the target to establish (or reestablish) the physical connection path between an initiator and target for a particular logical unit. The message byte consists of the following bits:

- Bit 7: Always set to 1.
- Bit 6: Set by initiator if target is allowed to disconnect/reconnect.
- Bit 5: Must be set to 0 ("Target Routines" not supported)
- Bit 4: Reserved. Must be set to 0.
- Bit 3: Reserved. Must be set to 0.
- Bits 2-0: Logical Unit Number (LUN).

When the identify message is sent from a target to an initiator during reconnection, a RESTORE POINTERS message is implied.

INITIATOR DETECTED ERROR (05h)

This message is sent from an initiator to inform a target that an error (for example, a bus parity error) has occurred that does not prevent the target from trying the operation again. When received, the THZ02 attempts to retransfer the last command, data or status bytes by using the RESTORE POINTERS message mechanism.

LINKED COMMAND COMPLETE (0Ah)

This message is sent from a target to an initiator to indicate that the execution of a linked command (with the Flag bit 0) is complete and that status has been sent. The initiator then sets the pointers to the initial state for the next command.

When received as a target, it is handled as an illegal message; the drive enters the MESSAGE IN phase and returns MESSAGE REJECT.

LINKED COMMAND COMPLETE, with Flag (0Bh)

This message is sent from a target to an initiator to indicate that the execution of a linked command (with the Flag bit set to 1) is complete and that status has been sent.

MESSAGE PARITY ERROR (09h)

This message is sent from the initiator to the target to indicate that one or more bytes in the last message it received had a parity error.

To indicate that it intends to send the message, the initiator sets the ATN signal before it releases ACK for the REQ/ACK handshake of the message that has the parity error. This provides an interlock so that the target can determine which message has the parity error. If the target receives this message under any other conditions, it proceeds directly to the BUS FREE state by releasing the BSY signal, signifying a catastrophic error.

The target's response to this message shall be to switch to the MESSAGE IN phase and resend from the beginning all the bytes of the message which generated the original MESSAGE PARITY ERROR message.

MESSAGE REJECT (07h)

This message is sent from the initiator or target to indicate that the last message received was inappropriate or has not been implemented.

In order to indicate its intentions of sending this message, the initiator asserts the ATN signal before it releases ACK for the REQ/ACK handshake of the message that is to be rejected.

MESSAGE REJECT is issued in response to any messages which the drive considers to be illegal or not supported. When sending to the initiator, the tape device will do so before requesting any additional message bytes.

NO-OP (No Operation) (08h)

If a target requests a message, the initiator sends NO-OP if it does not currently have any other valid message to send. The message is accepted when the drive is acting as a target, and may be sent when it is an initiator. If NO-OP is received during a selection, the drive proceeds to the command phase (provided that ATN does not continue to be asserted). The NO-OP message is ignored by the tape drive.

RESTORE POINTERS (03h)

This message is sent from a target to direct the initiator to restore the most recently saved pointers (for the currently attached logical unit). Pointers to the command, data and status locations for the logical unit are restored to the active pointers. command and status pointers are restored to the beginning of the present command and status areas. The data pointer is restored to the value at the beginning of the data area in the absence of a SAVE DATA POINTER message, or to the value at the last SAVE DATA POINTER message occurred for that logical unit.

When the RESTORE POINTERS message is received as a target, the target switches to the message in phase and returns MESSAGE REJECT.

SAVE DATA POINTER (02h)

This message, sent from a target to the initiator, saves a copy of the present active data pointer for the logical unit which is currently attached.

The tape drive accepts this message if in the initiator mode (while performing a COPY command). As a target, the tape drive sends this message before a disconnect during a data transfer. It does not send a SAVE DATA POINTER message if it intends to move directly to STATUS phase. When received as a target, it switches to message in phase and returns MESSAGE REJECT.

SCSI Interface

6.3 SCSI Message System

Synchronous Data Transfer Request (SDTR)

This extended message allows the target and initiator to agree on the values of the parameters relevant to synchronous transfers. THZ02 will *not* initiate the Synchronous Data Transfer Request message, but relies on the Initiator to do so. The SDTR message has the following format:

Figure 6–2 SDTR Extended Message Format

Byte 0	Extended Message Identifier – 01h
Byte 1	Length = 3
Byte 2	Message Code = 1 (SDTR msg)
Byte 3	Transfer Period (min=50. = 32h)
Byte 4	Transfer Req/Ack Offset (max=15)

6.4 Tape Drive SCSI Commands

6.4.1 Control Byte — Flag and Link Bits

The control byte of the command descriptor block contains the Flag and Link bits. Use of these bits is entirely initiator dependent. Setting the Link bit provides an automatic link to the next command, bypassing the usual ARBITRATION, SELECTION, and MESSAGE OUT phases which would normally occur between commands.

All other bits in the control byte are considered to be reserved.

6.4.2 Summary of Supported Sequential-Access Device Commands

The following table shows what SCSI commands are supported by the THZ02 tape drive.

Table 6–2 THZ02 Supported SCSI Commands

Opcode	Command	Section
19	ERASE	Section 6.4.2.1
12	INQUIRY	Section 6.4.2.2
1B	LOAD-UNLOAD	Section 6.4.2.3
2B	LOCATE	Section 6.4.2.4
4C	LOG SELECT	Section 6.4.2.5
4D	LOG SENSE	Section 6.4.2.6
15	MODE SELECT	Section 6.4.2.7
1A	MODE SENSE	Section 6.4.2.8
1E	PREVENT/ALLOW MEDIUM REMOVAL	Section 6.4.2.9
08	READ	Section 6.4.2.10
05	READ BLOCK LIMITS	Section 6.4.2.11
3C	READ BUFFER	Section 6.4.2.12
34	READ POSITION	Section 6.4.2.13
1C	RECEIVE DIAG RESULTS	Section 6.4.2.14
17	RELEASE UNIT	Section 6.4.2.15
03	REQUEST SENSE	Section 6.4.2.16
16	RESERVE UNIT	Section 6.4.2.17
01	REWIND	Section 6.4.2.18
1D	SEND DIAGNOSTIC	Section 6.4.2.19
11	SPACE	Section 6.4.2.20
00	TEST UNIT READY	Section 6.4.2.21
13	VERIFY	Section 6.4.2.22
0A	WRITE	Section 6.4.2.23
3B	WRITE BUFFER	Section 6.4.2.24
10	WRITE FILEMARK	Section 6.4.2.25

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.1 ERASE (19h)

Figure 6–3 ERASE CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (19h)							
	1	Logical Unit Number			Reserved			Immed	Long
	2	Reserved							
	3	Reserved							
	4	Reserved							
	5	Unused			Reserved			Flag	Link

ERASE causes data on the tape to be erased. Any write data that is currently held in buffer memory and has not been written to tape yet, is flushed to tape before the ERASE is executed.

Immed

If the Immediate bit is set to 0, the target will not return status until the selected operation has completed. If the bit is set to 1, status will be returned as soon as the operation has been initiated.

Long

The Long bit controls the distance to be erased. If the bit is set, filler and EOD blocks will be written if needed, and then the entire rest of the tape will be erased.

Note

This command is a NOP on the THZ02 unless the Long bit is set.

6.4.2.2 INQUIRY (12h)

The INQUIRY command implementation is dependent upon the type of firmware that is loaded in the THZ02 controller. Refer to Table 6–3 for the appropriate section for your type of code.

Table 6–3 INQUIRY Command Sections

Code Type	Description	Section
Type 1	SCSI II	Section 6.4.2.2.1
Type 2	8mm emulation	Section 6.4.2.2.2
Type 3	AS400 attachment	Section 6.4.2.2.3

6.4.2.2.1 INQUIRY — SCSI II INQUIRY tells the drive to send information regarding the device's parameters to the initiator.

Figure 6–4 INQUIRY CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (12h)							
	1	Logical Unit Number			Reserved				EVPD
	2	Page Code							
	3	Reserved							
	4	Allocation Length							
	5	Unused		Reserved				Flag	Link

The INQUIRY command executes normally even if the specified LUN is not attached. INQUIRY returns a CHECK CONDITION status only when the target cannot return the requested inquiry data. If INQUIRY is received from an initiator with a pending UNIT ATTENTION condition (before the drive reports CHECK CONDITION status), the target will perform the INQUIRY and will not clear the UNIT ATTENTION condition.

EVPD

The THZ02 implements the Vital Product Data pages option on LUNs 0 and 1.

Page Code

There are three Vital Product Data pages implemented:

- 00h — Supported Vital Product Data pages
- 80h — Unit Serial Number page
- C0h — Code Build Information page

If the page code field contains a different value, the drive generates a CHECK CONDITION with ILLEGAL REQUEST sense key.

Allocation Length

This specifies the maximum number of bytes that the initiator has allocated for returned inquiry data. An allocation length of 0 indicates that no inquiry data is transferred. This condition is not considered an error. The drive will terminate the DATA IN phase when allocation length bytes have been transferred, or when all available inquiry data has been transferred to the initiator, whichever is less.

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.2.1.1 Drive Inquiry Response

The THZ02 passes back the following information in response to an INQUIRY command on the drive LUN:

Figure 6–5 Inquiry Response Data

		Bit							
		7	6	5	4	3	2	1	0
0	Peripheral Qualifier	Peripheral Device Type							
1	RMB	Device Type Modifier							
2	ISO Version	ECMA Version			ANSI–Approved Version				
3	AENC	TrmIOP	Reserved		Response Data Format				
4	Additional Length (33h)								
5	Reserved								
6	Reserved								
7	RelAdr	WBus32	WBus16	Sync	Linked	Rsrved	CmdQue	SftRe	
08–15	Vendor ID = "DEC "								
16–31	Product ID = "THZ02 (C) DEC"								
32–35	Product Revision Level = "hss"								
36–55	Vendor Unique bytes								

Peripheral Qualifier

The tape drive returns one of the following values in this field:

- 000b — The indicated peripheral device type is connected to the logical unit.
- 001b — The indicated peripheral device type is not connected to the logical unit, however, the tape drive is capable of supporting the indicated peripheral device type at the specified logical unit.
- 011b — The target is not capable of supporting a physical device on this logical unit. For this case, the peripheral device type will be set to 1Fh.

Peripheral Device Type

On the tape drive LUN, this field is set to 01h, indicating a sequential access device. On the medium changer LUN, this field is set to 08h. All other LUNs will return 1Fh.

RMB

The Removable Medium bit is 1.

Device-Type Modifier

The device-type modifier is set to 0.

ISO Version

The ISO version is set to 0.

ECMA Version

The ECMA version is set to 0.

ANSI Approved Version

The ANSI approved version is set to 2, indicating compliance with SCSI-2.

AENC

AENC — Set to 0 (asynchronous event notification not supported).

TrmIOP

TrmIOP — Set to 1 (Terminate I/O process message supported).

Response Data Format

Response data format — set to 2 (inquiry data in SCSI-2 format).

Additional Length

Additional length — The tape drive sets this field to indicate the number of additional bytes of inquiry response data available. This value is not adjusted to reflect the actual number of bytes which will be transferred (possibly determined by the allocation length specified by the initiator).

Sync

Sync — Set to 1 (synchronous data transfers supported).

Linked

Linked — Set to 1 (linked commands supported).

Vendor Identification

Vendor identification — see figure.

Product Identification

Product identification — see figure. Note: if a media loader is attached to the tape drive, the Product ID will indicate "THZ27" instead of "THZ02".

Product Revision Level

Product revision level — This field contains four bytes of ASCII data, which define the product's software revision levels. The first two bytes are the read/write board's firmware version number, the second two bytes are the controller's (SCSI target's) firmware version number. When a firmware update is performed on the THZ02, this part of the revision level field will change appropriately.

SCSI Interface

6.4 Tape Drive SCSI Commands

Vendor Specific

Vendor specific — (see below)

Figure 6–6 Inquiry Vendor Unique Bytes Definition

36	Released SCSI (controller) Firmware
37	Firmware Major Version #
38	Firmware Minor Version #
39	EEPROM Format Major Version #
40	EEPROM Format Minor Version #
41	Firmware Personality
42	Firmware Sub-personality
43	Tape Directory Format Version #
44	Controller Hardware Version #
45	Drive EEPROM Version #
46	Drive Hardware Version #
47	Media Loader Firmware Version #
48	Media Loader Hardware Version #
49	Media Loader Mechanical Version #
50	Media Loader Present flag
51 55	VU-reserved

Vendor Specific Inquiry Bytes

To more precisely identify the product and the installed firmware, additional information is available:

- Released flag — differentiates between released and test versions of firmware.
- Various version numbers (see figure) in binary (not ASCII)
- Firmware personality — coded value identifying OEM versions of product
- Sub-personality — further differentiates product versions
- Loader present — nonzero if a media loader is present

6.4.2.2.1.2 Vital Product Data Pages

The following figures show the information in the supported vital product data pages.

Figure 6–7 Supported Vital Product Data Pages page

		Bit							
		7	6	5	4	3	2	1	0
0	Peripheral Qualifier	Peripheral Device Type							
1	Page Code (00h)								
2	reserved								
3	Page Length (3 more bytes)								
4	00h – (this page)								
5	80h – Unit Serial Number page								
6	C0h – Firmware Build Info page (VU)								

Figure 6–8 Unit Serial Number Page

		Bit							
		7	6	5	4	3	2	1	0
0	Peripheral Qualifier	Peripheral Device Type							
1	Page Code (80h)								
2	reserved								
3	Page Length (14h)								
4–13	Controller Serial Number								
14–23	Drive Serial Number								

Controller Serial Number

The controller serial number is the serial number of the controller card mounted on the top of the THZ02. It can be found on the bar code label. The controller serial number is returned in ASCII.

Drive Serial Number

The drive serial number is the serial number of the electronics module mounted on the bottom of the THZ02. It can be found on the bar code label. The controller serial number is returned in ASCII.

SCSI Interface

6.4 Tape Drive SCSI Commands

Figure 6–9 Firmware Build Information Page — VU

		Bit							
		7	6	5	4	3	2	1	0
0	Peripheral Qualifier	Peripheral Device Type							
1	Page Code (C0h)								
2	reserved								
3	Page Length (20h)								
4–5	Drive Firmware Checksum								
6–7	Drive EEPROM Checksum								
8–11	Controller Firmware Checksum								
12–35	Controller Firmware Build Date								

The checksums are binary, and are for positive firmware and EEPROM identification.

Firmware build date is an ASCII string in the DD-Mmm-YYYY HH:MM::SS format.

6.4.2.2.1.3 Media Loader Inquiry Response

The THZ02 controller generates inquiry data on the medium changer LUN that is very similar to that for the tape drive LUN. The key differences are:

- Peripheral device type is set to "8" for SCSI-2 medium changer.
- Product ID bytes are set to "TZ media changer".

6.4.2.2.2 INQUIRY — 8mm Emulation INQUIRY tells the drive to send information regarding the device's parameters to the initiator.

Figure 6–10 INQUIRY CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (12h)							
	1	Logical Unit Number			Reserved				
	2	Reserved							
	3	Reserved							
	4	Allocation Length							
	5	Unused		Reserved				Flag	Link

The INQUIRY command executes normally even if the specified LUN is not attached. INQUIRY returns a CHECK CONDITION status only when the target cannot return the requested inquiry data. If INQUIRY is received from an initiator with a pending UNIT ATTENTION condition (before the drive reports CHECK CONDITION status), the target will perform the INQUIRY and will not clear the UNIT ATTENTION condition.

Allocation Length

This specifies the maximum number of bytes that the initiator has allocated for returned inquiry data. An allocation length of 0 indicates that no inquiry data is transferred. This condition is not considered an error. The drive will terminate the DATA IN phase when allocation length bytes have been transferred, or when all available inquiry data has been transferred to the initiator, whichever is less.

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.2.2.1 Drive Inquiry Response

The THZ02 passes back the following information in response to an INQUIRY command on the drive LUN:

Figure 6–11 Inquiry Response Data

		Bit							
		7	6	5	4	3	2	1	0
0	Peripheral Qualifier	Peripheral Device Type							
1	RMB	Device Type Modifier							
2	ISO Version	ECMA Version			ANSI–Approved Version				
3	Reserved								
4	Additional Length – 2Fh								

Peripheral Qualifier

The tape drive returns one of the following values in this field:

- 000b — The indicated peripheral device type is connected to the logical unit.
- 001b — The indicated peripheral device type is not connected to the logical unit, however, the tape drive is capable of supporting the indicated peripheral device type at the specified logical unit.
- 011b — The target is not capable of supporting a physical device on this logical unit. For this case, the peripheral device type will be set to 1Fh.

Peripheral Device Type

On the tape drive LUN, this field is set to 01h, indicating a sequential access device. On the medium changer LUN, this field is set to 08h. All other LUNs will return 1Fh.

RMB

The Removable Medium bit is 1.

Device-Type Modifier

The device-type modifier is set to 0.

ISO Version

The ISO version is set to 0.

ECMA Version

The ECMA version is set to 0.

ANSI Approved Version

The ANSI approved version is set to 1, indicating compliance with SCSI-1.

Additional Length

Additional length — The tape drive sets this field to 2Fh, indicating the number of additional bytes of inquiry response data available.

Vendor Specific

Vendor specific — (see below)

Figure 6–12 Inquiry Vendor Unique Bytes Definition

		Bit							
		7	6	5	4	3	2	1	0
05		Reserved							
06		Reserved							
07		Reserved							
08	(MSB)	Vendor Identification							
15	(LSB)								
16	(MSB)	Product Identification							
31	(LSB)								
32	(MSB)	Firmware Revision Level							
35	(LSB)								
36	(MSB)	Vendor Unique							
55	(LSB)								

Vendor Specific Inquiry Bytes

Vendor Identification

Vendor identification — see figure.

Product Identification

Product identification — see figure. Note: if a media loader is attached to the tape drive, the product ID will indicate "THZ27" instead of "THZ02".

Product Revision Level

Product revision level — This field contains four bytes of ASCII data, which define the product's software revision levels. The first two bytes are the read/write board's firmware version number, the second two bytes are the controller's (SCSI target's) firmware version number. When a firmware update is performed on the THZ02, this part of the revision level field will change appropriately.

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.2.3 INQUIRY — AS400 Attachment INQUIRY tells the drive to send information regarding the device's parameters to the initiator.

Figure 6–13 INQUIRY CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (12h)							
	1	Logical Unit Number			Reserved				
	2	Reserved							
	3	Reserved							
	4	Allocation Length							
	5	Unused		Reserved				Flag	Link

The INQUIRY command executes normally even if the specified LUN is not attached. INQUIRY returns a CHECK CONDITION status only when the target cannot return the requested inquiry data. If INQUIRY is received from an initiator with a pending UNIT ATTENTION condition (before the drive reports CHECK CONDITION status), the target will perform the INQUIRY and will not clear the UNIT ATTENTION condition.

Allocation Length

This specifies the maximum number of bytes that the initiator has allocated for returned inquiry data. An allocation length of 0 indicates that no inquiry data is transferred. This condition is not considered an error. The drive will terminate the DATA IN phase when allocation length bytes have been transferred, or when all available inquiry data has been transferred to the initiator, whichever is less.

6.4.2.2.3.1 Drive Inquiry Response

The THZ02 passes back the following information in response to an INQUIRY command on the drive LUN:

Figure 6–14 Inquiry Response Data

		Bit							
		7	6	5	4	3	2	1	0
0	Peripheral Qualifier	Peripheral Device Type							
1	RMB	Device Type Modifier							
2	ISO Version	ECMA Version			ANSI–Approved Version				
3	Reserved					Response Data Format			
4	Additional Length – 33h								

Peripheral Qualifier

The tape drive returns one of the following values in this field:

- 000b — The indicated peripheral device type is connected to the logical unit.
- 001b — The indicated peripheral device type is not connected to the logical unit, however, the tape drive is capable of supporting the indicated peripheral device type at the specified logical unit.
- 011b — The target is not capable of supporting a physical device on this logical unit. For this case, the peripheral device type will be set to 1Fh.

Peripheral Device Type

On the tape drive LUN, this field is set to 01h, indicating a sequential access device. On the medium changer LUN, this field is set to 08h. All other LUNs will return 1Fh.

RMB

The Removable Medium bit is 1.

Device-Type Modifier

The device-type modifier is set to 0.

ISO Version

The ISO version is set to 0.

ECMA Version

The ECMA version is set to 0.

ANSI Approved Version

The ANSI approved version is set to 1, indicating compliance with SCSI-1.

Response Data Format

The response data format is set to a 1 to indicate vendor unique response data is being returned.

Additional Length

Additional length — The tape drive sets this field to 33h, indicating the number of additional bytes of inquiry response data available.

SCSI Interface

6.4 Tape Drive SCSI Commands

Vendor Specific

Vendor specific — (see below).

Figure 6–15 Inquiry Vendor Unique Bytes Definition

		Bit							
		7	6	5	4	3	2	1	0
05		Reserved							
06		Reserved							
07		Reserved							
08	(MSB)	Vendor Identification							
15	(LSB)								
16	(MSB)	Product Identification							
31	(LSB)								
32	(MSB)	Firmware Revision Level							
35	(LSB)								
36	(MSB)	Vendor Unique							
55	(LSB)								

Vendor Specific Inquiry Bytes

Vendor Identification

Vendor identification — see figure.

Product Identification

Product identification — see figure. Note: if a media loader is attached to the tape drive, the product ID will indicate "THZ27" instead of "THZ02".

Product Revision Level

Product revision level — This field contains four bytes of ASCII data, which define the product's software revision levels. The first two bytes are the read/write board's firmware version number, the second two bytes are the controller's (SCSI target's) firmware version number. When a firmware update is performed on the THZ02, this part of the revision level field will change appropriately.

6.4.2.3 LOAD-UNLOAD (1Bh)

Figure 6–16 LOAD-UNLOAD CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code(1Bh)							
	1	Logical Unit Number			Reserved				Immed
	2	Reserved							
	3	Reserved							
	4	Reserved				EOT	Re-Ten	Load	
	5	Unused		Reserved				Flag	Link

LOAD-UNLOAD tells the target to load or unload the media in the tape cartridge. If no cartridge is in the drive, both LOAD and UNLOAD will return a CHECK CONDITION status with a NOT READY sense key set. If the drive has received an UNLOAD command with the Immed bit set and then receives another command which would involve tape motion or TEST UNIT READY, the drive will return a CHECK CONDITION status with a NOT READY sense key set.

Operation of the UNLOAD version of this command will be different if a media loader is present. See the chapter on Media Loader Operation. If a loader is present, and an UNLOAD command is received by the subsystem, the current cartridge will be unloaded and automatically moved to the magazine slot it originated from. Then the cartridge from the next slot in the magazine, if not empty, is automatically moved from the magazine into the drive, loaded, and made ready. If the next magazine slot is empty, no CHECK CONDITION status is created.

If the cartridge is unloaded into magazine slot 6 (the last one), the subsystem does not cycle back to slot 0. This is to prevent accidental overwriting of data when using the subsystem in sequential auto-loading mode. The next cartridge must be selected and loaded manually, or with an SCSI MOVE MEDIUM command.

A media loader does not affect the device’s processing of the LOAD flavor of the LOAD-UNLOAD command.

The command specific bits are used as follows:

- **Immed** — If this bit is set, status is returned as soon as the operation is started. Otherwise, the status is returned after the operation has completed.
- **Re-Ten** — Retension operations are not needed on the THZ02, so this bit is ignored.
- **Load** — When a cartridge is inserted, the media is automatically loaded and positioned by the drive at BOM. Logically, the drive will be positioned at the beginning of partition 0.

If the Load bit is set, and the media is already loaded, no action is taken. If the media was unloaded but the cartridge was not removed, a LOAD will cause it to be loaded to BOP again and made ready.

SCSI Interface

6.4 Tape Drive SCSI Commands

If the Load bit is 0 and media is loaded, the drive writes any buffered data and filemarks to the tape and rewinds the tape to BOM and unloads the media into the THZ02 cartridge. The "Operate Handle" green LED is luminated and the cartridge can be removed from the drive. If the media is already unloaded, no action is taken.

- EOT — This bit is ignored by the THZ02, unless both the EOT and Load bits are both set, then the drive returns CHECK CONDITION, ILLEGAL REQUEST.

6.4.2.4 LOCATE (2Bh)

Figure 6–17 LOCATE CDB

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	Operation Code (2Bh)								
	1	Logical Unit Number			Reserved		BT	CP	Imm	
	2	Reserved								
	3	(MSB)								
	4	Block Address								
	5									
	6									(LSB)
	7	Reserved								
	8	Partition								
	9	Unused	Reserved				Flag	Link		

The LOCATE command is used to do high speed positioning to the specified block address. Average positioning time is about 90 seconds, maximum time is under 3 minutes.

The READ POSITION command can be used to obtain the block address, when writing, where particular blocks of data (for example, a data file) are about to be written. Then the LOCATE command can be used to position back to the same logical position for high performance restore operations of particular blocks of data.

- BT — The Block Type bit indicates how the block address field is interpreted. For the THZ02 products, SCSI logical block addresses are always returned, for example, the setting of the BT bit does not affect the values returned. The first recorded object (block or filemark) is at address 0, and block addresses count both data blocks and filemarks.
- CP — Since multiple partitions are not supported this bit must be 0.
- Imm — If set, STATUS is returned when the command has been started.

Block Address

The SCSI logical block address to which the media will be positioned. These addresses start at 0, and include data blocks and filemarks, so they could also be considered an object address.

6.4.2.5 LOG SELECT (4Ch)

Figure 6–18 LOG SELECT CDB

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	Operation Code (4Ch)								
	1	Logical Unit Number (0)			Reserved			PCR	SP	
	2	PC		Reserved						
	3	Reserved								
	4	Reserved								
	5	Reserved								
	6	Reserved								
	7	(MSB)	Parameter List Length							
	8									(LSB)
	9	Unused	Reserved				Flag	Link		

LOG SELECT allows the host to manage statistical information maintained by the device about its own hardware or the installed media. The description should be read in conjunction with the description of the LOG SENSE command which follows it, to provide the reader with information about log page format, parameters and supported pages. The command specific bits are used as follows:

- PCR — If Parameter Code Reset bit is set to 1 and parameter list length is 0, all accumulated values of page code 2 and 3 are set to 0 and all threshold values are set to default. If PCR is set 1 and the parameter list length field is not 0, the command will be terminated with a CHECK CONDITION status, with sense key of ILLEGAL REQUEST, and ASC of INVALID FIELD IN CDB.
- SP — The Save Page bit is not supported and must be set to 0. If the SP bit is set, the command will be terminated with CHECK CONDITION status, with sense key of ILLEGAL REQUEST, and ASC of INVALID FIELD IN CDB.

SCSI Interface

6.4 Tape Drive SCSI Commands

- PC — The page control field defines the type of parameter values to be selected:

Figure 6–19 LOG Page Control Definitions

PC	Type of Parameter Values
00b	Threshold Values
01b	Cumulative Values
10b	Default Threshold Values
11b	Default Cumulative Values

All types of parameter values all changeable through LOG SELECT.

Parameter List Length

This field specifies the length in bytes of the LOG SELECT parameter list to be transferred from the initiator to the target during the DATA OUT phase. A parameter list length of 0 indicates that no data is to be transferred. This condition is not considered as an error (see also the description of parameter code reset and page control fields above).

Error Detection Summary in LOG SELECT CDB

Following conditions constitute errors that will be detected by the drive in relation to the CDB. The request sense data is set to ILLEGAL REQUEST, INVALID FIELD IN CDB.

- If PCR bit is set to 1 and parameter list length is not 0.
- If SP bit is set 1.
- A parameter list length that would cause a parameter within a valid page to be truncated or otherwise incompletely initialized.

6.4.2.5.1 Operation of LOG SELECT The purpose of the LOG SELECT command is to allow the initiator to modify and initialize parameters within the logs supported by the device.

To achieve this, during the DATA OUT phase the initiator must send the log page header of the page to be cleared, with the page length field set to 0. The following pages can be cleared in this manner:

Page Code	Page Description
02h	Write Error Counter Page
03h	Read Error Counter Page

If multiple pages are sent during this DATA OUT phase, they must be sent in ascending order according to page code. Otherwise the command will terminate with a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and an additional sense code of INVALID FIELD IN PARAMETER LIST. The same status will be returned if an unsupported page code appears in any header, or if the specified page cannot be cleared.

LOG SELECT Page Format

Each Log page will begin with 4 byte header followed by n number of log parameter blocks (one block for each parameter code). Each block, except for parameter code 05h, will be of size 8 bytes. The parameter block for code 05h will be of size 12 bytes.

Figure 6–20 Read/Write Error Log Select Page Format

	7	6	5	4	3	2	1	0
0	Reserved		Page Code					
1	Reserved							
2	(MSB)	Page Length						
3								(LSB)

Log Parameter(s)

	7	6	5	4	3	2	1	0
0	(MSB) Parameter Code							
1								(LSB)
2	DU	DS	TSD	ETC	TMC	Rsvd	LP	
3	Parameter Length							
4	(MSB) Parameter Value							
11								(LSB)

Note

Parameter value for code 05h will be of 8 bytes, hence the parameter length shall be set to 8.

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6.4 Tape Drive SCSI Commands

Byte 2 of log parameter block in Figure 6–20 is referred to as parameter control byte.

- **DU** — Disable update: DU bit is not defined for LOG SELECT and target shall ignore any value.
- **DS and TSD** — Saving parameters is not supported hence they both should be set to 1. If the DS and/or TSD are set to 0, the command is terminated with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST with the additional sense code set to INVALID FIELD IN PARAMETER LIST.
- **ETC** — Enable threshold comparison: When set 1, drive shall perform a comparison with threshold values once the cumulative value is updated. Comparison criteria is defined in TMC. If the comparison is met and RLEC bit of MODE SELECT/SENSE control page is set 1 then a UNIT ATTENTION is generated for all initiators. The additional sense code set to LOG EXCEPTION and the additional sense code qualifier set to THRESHOLD CONDITION MET. If RLEC bit is 0 and comparison is met then UNIT ATTENTION is not generated.
- **TMC** — Threshold met criteria: See Figure 6–27 for the list of criteria. Once the specified criteria in this field met and ETC bit is 1 and RLEC bit in MODE SENSE/SELECT control page is set 1 then UNIT ATTENTION is generated for all initiators.
- **LP** — List parameter: This bit should always be set to 0 to indicate that parameter codes are treated as data counters.

Error Detection Summary in Log Select Pages

The host should issue a LOG SENSE command to initialize host software which allows:

- Correct determination of the pages the drive uses.
- Determination of the parameter codes and length of each parameter.

The following conditions constitute errors in the parameter block that will cause drive to return CHECK CONDITION with the sense data set to ILLEGAL REQUEST and additional sense code INVALID FIELD IN PARAMETER LIST:

- If a page header is received with unsupported page codes.
- Incorrect log page length is specified in the page header.
- An illegal parameter code within a valid page code.
- Parameter codes for a supported page are not sent in ascending order.
- LP bit is set to 1 in the parameter control byte.
- DS bit is set 0 in the parameter control byte.
- TSD bit is set 0 in the parameter control byte.

6.4.2.6 LOG SENSE (4Dh)

Figure 6–21 LOG SENSE CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (4Dh)							
	1	Logical Unit Number (0)			Reserved			PPC	SP(0)
	2	PC		Page Code					
	3	Reserved							
	4	Reserved							
	5	(MSB)	Parameter Pointer						(LSB)
	6								
	7	(MSB)	Allocation Length						(LSB)
	8								
	9	Unused	Reserved				Flag	Link	

LOG SENSE allows the host to retrieve statistical information maintained by the device about its own hardware or the installed media. It is a complementary command to LOG SELECT.

PPC

A Parameter Pointer Control bit of 0 indicates that the parameter data requested from the device will start with the parameter code specified in the parameter pointer field and return the number of bytes specified in the allocation length field in ascending order of parameter codes from the specified log page. A PPC bit of 0 and a parameter point field of 0 causes all available parameter data for that page code to be returned to the initiator.

If PPC bit is set, then target shall return with parameter code values which have changed since last LOG SENSE or LOG SELECT command. Target shall return the parameter codes following the parameter pointer field. If parameter pointer field is 0 then target shall return all the parameter code values which have changed since last LOG SENSE or LOG SELECT.

If the target does not support a parameter code within this page then it will not return any data associated with this parameter.

SP

Saving log parameters is not supported and shall be always 0.

If the SP bit is set, the command is terminated with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST, and an additional sense code of INVALID FIELD IN CDB.

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6.4 Tape Drive SCSI Commands

PC

The page control field defines the type of parameter values to be returned:

Figure 6–22 LOG Page Control Definitions

PC	Type of Parameter Values
00b	Threshold Values
01b	Cumulative Values
10b	Default Threshold Values
11b	Default Cumulative Values

The default threshold values are the maximum values that each parameter can attain.

The current cumulative values are the values computed since the last reset of the device (either by power-cycling, BUS DEVICE RESET or SCSI RESET).

The default cumulative values are the values to which each parameter gets initialized on a reset condition as described above. Default values are 0.

By default current threshold values = default threshold values.

Note

All types of parameter values are changeable through LOG SELECT.

Page Code

The page code field identifies which log page is being requested by the initiator. If the page is not supported then the command terminates with a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and an additional sense code of INVALID FIELD IN CDB. Supported pages are as follows:

Figure 6–23 LOG SENSE Pages Supported

Page Code	Page Description
00h	List of Supported Pages Page
02h	Write Error Counter Page
03h	Read Error Counter Page
07h	History Page
32h	Compression ratio page

Parameter Pointer

The parameter pointer field allows the host to specify at which parameter within a log page the requested data should begin. For example if a page supports parameters 0 through 5, and the parameter pointer field contains 3, then only parameters 3, 4 and 5 are returned to the initiator. Similarly, if a page supports parameters 1, 3 and 6, and the parameter pointer field contains 2, then only parameters 3 and 6 are returned to the initiator.

If parameter pointer is larger than the highest numbered parameter on the page, then the target will terminate the command with CHECK CONDITION status. The sense key is set to ILLEGAL REQUEST and the additional sense code is set to INVALID FIELD IN CDB.

Note

Parameters within a page are always returned in ascending order according to parameter code.

The following parameter codes are supported for the error counter pages.

Figure 6–24 Parameter Codes Supported

Parameter Code	Description
00h	Errors corrected with substantial delays
01h	Errors corrected with possible delays
02h	Total rewrites or rereads
03h	Total errors corrected
04h	Total times correction algorithm processed
05h	Total bytes processed
06h	Total uncorrected errors
8000h	Vendor Unique

Parameter codes 00h, 01h, and 04h will always return value of 0.

Allocation Length

The allocation length field is used to inform the target how much space the initiator has allocated for data. There must be sufficient space allocated for all the requested data, otherwise the command will terminate with a CHECK CONDITION status with sense key of ILLEGAL REQUEST, and ASC of INVALID FIELD IN CDB.

Error Detection Summary in LOG SENSE CDB

Following conditions constitute errors that will be detected by the drive in relation to the CDB. The request sense data is set to ILLEGAL REQUEST, INVALID FIELD IN CDB.

- If a page is not supported.
- If parameter pointer is larger than highest numbered parameter on the page.
- If SP bit is set 1.
- If the allocation length is smaller than the data being returned by target.

Supported Pages Page Format (Page 0)

When page 0 is requested, the 4 byte page header is returned followed by the pages supported in ascending order, one byte for each.

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6.4 Tape Drive SCSI Commands

Figure 6–25 Supported Pages Page Format

	7	6	5	4	3	2	1	0
0	Reserved		Page Code (00h)					
1	Reserved							
2	(MSB)	Page Length (05h)						
3								(LSB)
4	00h							
5	02h							
6	03h							
7	07h							
8	32h							

Read/Write Error Log SENSE Page Format (Page 2 and 3)

Each log page will begin with 4 byte header followed by n number of log parameter blocks, each block of 8 bytes except for parameter code 5h.

The log parameter block for the parameter total bytes processed (5h) will be of size 12 bytes since the parameter value is 8 bytes long.

Figure 6–26 Read/Write Error Log SENSE Page Format

	7	6	5	4	3	2	1	0
0	Reserved		Page Code					
1	Reserved							
2	(MSB)	Page Length						
3								(LSB)

Log Parameter(s)

	7	6	5	4	3	2	1	0	
0	(MSB)		Parameter Code						
1								(LSB)	
2	DU	DS	TSD	ETC	TMC	Rsvd	LP		
3	Parameter Length								
4	(MSB)		Parameter Value						
5									
6									
7									
8									
9									
10									
11								(LSB)	

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6.4 Tape Drive SCSI Commands

For example, if PPC bit is 0 and parameter pointer is 0 then target will return 4 bytes of page header with page length of 44h followed by 8 bytes of parameter value data for each parameter code except for parameter code 5h. For 5h it will return 12 bytes.

So for parameter code 0h, 1h, 2h, 3h, 4h, 6h, 8000h each page will be of 8 bytes. For parameter code 5h page will be of 12 bytes.

DU, DS, TSD, ETC, TMC and LP are collectively referred to as parameter control byte.

- **DU** — Disable update: A 0 value indicates that target shall update all log parameter values. A value of 1 indicates that target will not update the log parameter values except in response to LOG SELECT. This bit is set by the drive when accumulated values reaches its maximum. This is also returned set if the host set the bit in last LOG SELECT command. The default is 0.

Note

For parameter types other than threshold and cumulative values, this bit is always 0.

- **DS** — Disable save: Saving parameters is not supported, therefore this bit will always be set to 1.
- **TSD** — Target save disable: Saving parameter is not supported, therefore this bit will always be set to 1.
- **ETC** — Enable threshold comparison: ETC of 1 indicates that comparison to threshold is performed. ETC of 0 indicates that this comparison is not performed. This bit is set 1 by MODE SELECT. Default is 0.
- **TMC** — Threshold met criteria: This field is valid only if host sets ETC to 1. It determines the basis for comparison and is specified by host by LOG SELECT. If the result of comparison is true (cumulative = threshold) and MODE SELECT/SENSE control mode page RLEC bit is set 1, then a unit attention is generated for all initiators. The sense key will be set to UNIT ATTENTION, ASC will be set to LOG EXCEPTION and ASCQ will be set to THRESHOLD CONDITION MET. If the RLEC bit in control mode page is 0 then, UNIT ATTENTION will not be generated.

Note

It must be noted that this comparison is performed in real time. Therefore user doesn't need to issue a LOG SENSE command to get the CHECK CONDITION. Once ETC is selected, RLEC bit in control mode page, the CHECK CONDITION will be issued based upon the criteria defined in the TMC bits if the criteria is met in real time.

CHECK CONDITION will not identify for which parameter code the criteria is met. User will need to issue LOG SENSE to read the counters to see for which parameter code criteria is met.

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Figure 6–27 Threshold Met Criteria

Code	Basis of Comparison
00b	Every update of the cumulative value
01b	Cumulative value equal to threshold value
10b	Cumulative value not equal to threshold value
11b	Cumulative value greater than threshold value

- **LP** — List parameter: This bit will always be set to 0 as we treat the parameter codes as data counter. When data counter reaches its defined maximum value then it shall not increment and DU bit shall be set to 1. If the data counter is at or reaches its maximum value during the execution of a command, the drive will complete the command. If the RLEC bit of CONTROL MODE PAGE is 1, drive then will issue status of CHECK CONDITION and set the sense key to RECOVERED ERROR with additional sense code set to LOG COUNTER AT MAXIMUM.

6.4.2.7 MODE SELECT (15h)

The MODE SELECT command implementation is dependent upon the type of firmware that is loaded in the THZ02 controller. Refer to Table 6–4 for the appropriate section for your type of code.

Table 6–4 MODE SELECT Command Sections

Code Type	Description	Section
Type 1	SCSI II	Section 6.4.2.7.1
Type 2	8mm emulation	Section 6.4.2.7.2
Type 3	AS400 attachment	Section 6.4.2.7.3

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6.4.2.7.1 MODE SELECT — SCSI II MODE SELECT enables the host to configure the device. Implementing MODE SELECT and MODE SENSE requires a certain amount of handshaking between the host and the drive. Before configuring the drive, the host should issue a MODE SENSE to get the current configuration and determine what parameters are configurable. The host interprets this information and may then issue MODE SELECT to set the drive to the host's preferred configuration.

The drive always powers-up with its default configurations set. This is also true if the drive receives a BUS DEVICE RESET message or a hard reset through the RST line on the SCSI bus.

Figure 6–28 MODE SELECT CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (15h)							
	1	Logical Unit Number			PF	Reserved			SP(0)
	2	Reserved							
	3	Reserved							
	4	Parameter List Length							
	5	Unused (00)			Reserved			Flag	Link

PF

The Page Format bit indicates that the data sent by the host after the MODE SELECT header and block descriptors complies with the definition of pages in the SCSI-2 specification. The SCSI-1 format will not be implemented, so this bit is required to be set.

SP

The Save Parameters bit instructs the drive to save all saveable pages. This is not supported.

PARAMETER LIST LENGTH

This specifies the length in bytes of the mode select parameter list that is transferred during the DATA OUT phase. A zero parameter list length indicates that no data is transferred.

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6.4 Tape Drive SCSI Commands

6.4.2.7.1.1 Mode Select Parameter List

The mode select parameter list shown below, contains a 4-byte header, followed by one 8-byte block descriptor.

Figure 6–29 Mode Select Parameter List

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Reserved							
	1	Reserved							
	2	ignored	Buffered Mode				Speed		
	3	Block Descriptor Length (08h)							

Block Descriptor:

0	Density Code						
1	(MSB)						
2	Number of Blocks (000000h)						
3							(LSB)
4	Reserved						
5	(MSB)						
6	Block Length						
7							(LSB)

Page Descriptors

0	PS	0	Page Code
1	Additional Page Length		
2	Page Defined or Vendor–Unique Parameter Bytes		

Buffered Mode

The drive will implement immediate reporting on WRITE commands through buffered mode.

If the field is 0, then the drive does not report a GOOD status on WRITE commands until the data blocks are actually written to tape. If the buffered mode field is 1, then the drive reports GOOD status on WRITE commands as soon as the data block has been transferred to the buffer. This is the default configuration for the drive. If buffered mode is not used, the tape drive will suffer a significant degradation in performance, but not capacity.

If this field is greater than 1, the command will be rejected with a CHECK CONDITION, with a sense key of ILLEGAL REQUEST.

Speed

The tape drive supports only one speed, the default speed.

Block Descriptor Length

This specifies the length in bytes of all the block descriptors. Since the drive only allows one block descriptor, this value must be 8 or 0. Any other value causes a CHECK CONDITION status with an ILLEGAL REQUEST sense key to be returned.

Density Code

This field should match the current density of the media, or will be set to 0 if the density is unknown.

- 00h — use default density
- 0Ah — 6667 bpi MFm serial cartridge tape X3B5/86-199 (read only)
- 16h — 10000 bpi MFm serial cartridge tape X3.193-1990 (read only)
- 17h — 42500 bpi MFm serial cartridge tape X3B5/91-174
- 18h — 42500 bpi MFm serial cartridge tape

Number of Blocks

This MODE SENSE field will be sent as 0, indicating that all of the remaining logical blocks on the tape will have the medium characteristics specified by the block descriptor.

Block Length

This specifies the length in bytes of each logical block transferred over the SCSI bus. A block length of 0 indicates that the length is variable (for example, is specified in the I/O command). Any other value indicates the number of bytes per block to use for read, write and verify type commands that specify a "Fixed" bit of 1 (for example, fixed block mode) which also causes the transfer length in the CDB to be defined as a block count.

6.4.2.7.1.2 Mode Select Pages

Following the block descriptor are the mode select pages, which set the device parameters. Each page has a 2-byte header which identifies the page code and indicates the number of bytes in that page.

The page codes that are supported as follows:

Figure 6–30 MODE SENSE/SELECT Pages Supported

Page Code	Description	Sense/Select
00h	No requested page	Sense
10h	Device Configuration	both
02h	Disconnect/Reconnect	both
01h	Error Recovery Page	both
11h	Medium partition Parameters	both
3Eh	EEPROM Parameter Select	Select
3Fh	All pages	Sense

PS Bit

For the MODE SELECT command this bit is reserved. For the MODE SENSE command, a Parameters Saveable (PS) bit of 1 indicates that the page can be saved in nonvolatile memory by the drive. If the PS bit is 0, the supported parameters cannot be saved. (Saveable pages are not supported.)

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6.4 Tape Drive SCSI Commands

Additional Page Length

This indicates the number of bytes in that page. However, the value does not include bytes 0 and 1. The length is returned on MODE SENSE and must subsequently be set to the same value when performing mode select. If the page length does not match that expected by the drive a CHECK CONDITION status is returned with the sense key set to ILLEGAL REQUEST. The drive also returns a CHECK CONDITION status with an ILLEGAL REQUEST sense key if the host sends an unsupported page code, or a page field with values that are not supported or are not changeable. In this case, no parameters will be changed by the command.

6.4.2.7.1.3 Device Configuration Page (10h)

The drive supports the device configuration page which has the following format:

Figure 6–31 Device Configuration Page Format

		Bit														
		7	6	5	4	3	2	1	0							
Byte	0	PS	0	Page Code(10h)												
	1	Additional Page Length (0Eh)														
	2	Res	CAP	CAF	Active Format											
	3	Active Partition														
	4	Write Buffer Full Ratio														
	5	Read Buffer Empty Ratio														
	6	Write Delay Time														
	7									(MSB)						
	8	DBR	BIS	RSmk	AVC	SOCF		RBO	REW							
	9	Gap Size														
	10	EOD Defined			EEG	SEW	Reserv ed									
	11	Buffer Size at Early Warning (optional)														
	12															(MSB)
	13															(LSB)
	14	Select Data Compression Algorithm														
15	Reserved															

In this page, only the write delay parameter is changeable.

PS

Set if the parameters are saveable.

CAP, CAF, Active Format

These fields are not supported and must be 0 on MODE SELECT.

Active Partition

Only partition 0 is supported. Setting this field to any other value will be rejected by the drive with a CHECK CONDITION status and the ILLEGAL REQUEST sense key set.

Write Buffer Full Ratio and Read Buffer Empty Ratio

These indicate how full/empty the buffer memory should be before restarting the writing/reading of the media. THZ02 will set these fields to 0 (unused) because it uses an automatic, adaptive mechanism to dynamically adjust its full/empty ratios according to the average data rates over the SCSI bus.

Write Delay Time

This indicates the maximum time that the drive will wait with a partially full buffer before forcing the data to tape (100 ms increments). Note that the buffer full/empty ratio, which is dynamic, can cause data to be written sooner than the write delay time would indicate. The write delay time defaults to 50 (32h). This causes the buffer to be flushed in 5 seconds. Maximum value is 6500 (1964h) and the minimum is 10 (0Ah). This represents delays from almost 11 minutes down to 1 second.

Byte 8:

- DBR — set to 0 (data buffer recovery not supported)
- BIS — set to 1 (block identifiers supported in media format)
- RSmk — set to 0 (setmarks not supported)
- AVC — set to 0
- SOCF — set to 0
- RBO — set to 0
- REW — set to 0 (don't report early warning EOM on reads)

Gap Size

This field is not used and is set to 0.

EOD Defined

This field is set to 00h; any other value will be rejected by the drive.

EEG

The Enable EOD Generation bit is set to indicate that the drive will generate an EOD. The drive generates an EOD mark before any change of direction following a write-type operation. This bit is ignored on MODE SELECT.

SEW and Buffer Size At Early Warning

The Synchronize at Early Warning bit and buffer size at EW fields are not supported and must be 0.

Select Data Compression Algorithm

This field is not used and must be 0.

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6.4 Tape Drive SCSI Commands

6.4.2.7.1.4 Disconnect/Reconnect Page (02h)

The drive shall support the disconnect/reconnect page which has the following format:

Figure 6–32 Disconnect/Reconnect Page Format

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	PS	0	Page Code(02h)						
	1	Additional Page Length (0Eh)								
	2	Buffer Full Ratio								
	3	Buffer empty Ratio								
	4	(MSB)	Bus Inactivity Limit						—	
	5							(LSB)		
	6	(MSB)	Disconnect time Limit						—	
	7							(LSB)		
	8	(MSB)	Connect Time Limit						—	
	9							(LSB)		
	10	(MSB)	Maximum Burst Size						—	
	11							(LSB)		
	12	Reserved						DTDC		
	13	Reserved								
	14	Reserved								
	15	Reserved								

In this page, only the maximum burst size parameter is changeable.

The following parameters in this page are supported:

Maximum Burst Size

This value specifies the maximum amount of data that will be transferred without disconnecting. A value of 0 sets no limit. This value is in units of 512 bytes. For example, a value of 8 means 4k bytes. Values that are not multiples of 8 are rounded up to the closest multiple of 8.

Data Transfer Disconnect Control (DTDC)

This option is not supported, so this field should be 0.

6.4.2.7.1.5 Medium Partition Page (11h)

The drive supports the medium partitions parameter page, which has the following format:

Figure 6–33 Medium Partition Page Format

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	PS	0	PageCode(11h)					
	1	Additional Page Length (06)							
	2	Maximum Additional Partitions							
	3	Additional Partitions Defined							
	4	FDP	SDP	IDP	PSUM		Reserved		
	5	Medium Format Recognition (01)							
	6	Reserved							
	7	Reserved							

In this page, no parameters are changeable.

Maximum Additional Partitions

No additional partitions are supported, this field must be 0.

Additional Partitions Defined

The field specifies the number of additional partitions to be defined for the tape based on the settings of the SDP and IDP bits. The maximum allowed is the value returned in the maximum additional partitions field. Since only one partition is supported, this field must be 0.

Option Flags

- FDP — The Fixed Data Partitions bit must be 0.
- SDP — The Select Data Partitions bit must be 0.
- IDP — The Initiator Defined Partitions bit must be 0.
- PSUM — The Partition Size Unit of Measure field must be 0.

Medium Format Recognition

This field is only valid on a MODE SENSE and is set to 01h indicating that automatic format recognition is supported.

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6.4 Tape Drive SCSI Commands

6.4.2.7.1.6 Read/Write Error Recovery Page (01h)

The drive shall support the error recovery page which has the following format:

Figure 6–34 Error Recovery Page Format

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	PS	0	Page Code(01h)					
	1	Additional Page Length (0Ah)							
	2	rsvd	rsvd	TB	rsvd	EER	PER	DTE	DCR
	3	Read Retry Count							
	4	Reserved							
	5	Reserved							
	6	Reserved							
	7	Reserved							
	8	Write Retry Count							
	9	Reserved							
	10	Reserved							
	11	Reserved							

In this page, only the post error (PER) flag parameter is changeable. If PER is set, CHECK CONDITIONs will be created, with sense key of RECOVERED ERROR, and VU sense data detailing the cause. Normally, these events should be rare, and only occur if the recovered write or read retry rates reach excessive levels.

Option Flags

- TB — The Transfer Block (when not fully recovered) function is not supported.
- EER — The Enable Early Recovery function is always enabled.
- PER — The Post Error bit turns on reporting of CHECK CONDITION to report recovered read/write errors. The default setting of this bit depends on the personality of the firmware installed.
- DTE — The Disable Transfer on Error feature is not supported so this bit must be 0.
- DCR — The Disable ECC Correction bit feature is not supported so this bit must be 0.

Read Retry Count

This field reports the maximum number of rereads that are done before declaring an unrecoverable error.

Write Retry Count

This field reports the maximum number of overwrite retries that will be performed before declaring an unrecoverable error.

6.4.2.7.1.7 EEROM Vendor Unique Page (3Eh)

The drive shall support a vendor unique page in which one may use to modify saveable parameters. This page is only supported with the MODE SELECT command. Only one saveable parameter may be changed per MODE SELECT command. It has the following format:

Figure 6–35 EEROM Vendor Unique Page Format

0	PS	0	Page Code
1	Additional Page Length		
2	ASCII String of parameter name and value		

The ASCII string has a parameter name, followed by one or more space characters, a parameter value and an ASCII line feed or null character. When the string is parsed, the parameter value will be interpreted as indicated in the following table. The parameter name may be in upper or lower case.

Table 6–5 EEROM Vendor Unique Page Parameters

Name	Value Representation	Usage
VENDORID	ASCII	Vendor identification field in inquiry data
PRODUCTID	ASCII	Product identification field in inquiry data
PRODUCTPID	ASCII	Product identification field in inquiry data of THZ02 drive
FORCEDENSITY	ASCII decimal	0=automatic, 1=THZ01, 2=THZ02
DEFFIXEDBLKLEN	ASCII decimal	Default fixed block size
ENBINQMEDCHGR	ASCII decimal	0=Disable Media Changer bit, 1=enable

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6.4 Tape Drive SCSI Commands

Here is an example of an EEROM vendor unique page which will modify the VENDORID parameter to "XXYY".

Figure 6–36 EEROM Vendor Unique Page Example 1

0	0	0	Page Code (3EH)
1	Page Length (0FH)		
2	"v" (76H)		
3	"e" (65H)		
4	"n" (6EH)		
5	"d" (64H)		
6	"o" (6FH)		
7	"r" (72H)		
8	"i" (69H)		
9	"d" (64H)		
10	" " (20H)		
11	"X" (58H)		
12	"X" (58H)		
13	"X" (58H)		
14	"Y" (59H)		
15	"Y" (59H)		
16	<LF> (0AH) or (00H)		

SCSI Interface 6.4 Tape Drive SCSI Commands

Here is an example of an EEROM vendor unique page which will modify the FORCEDENSITY parameter to 1.

Figure 6–37 EEROM Vendor Unique Page Example 2

0	0	0	Page Code (3EH)
1	Page Length (0FH)		
2	"F" (46H)		
3	"O" (4FH)		
4	"R" (52H)		
5	"C" (43H)		
6	"E" (45H)		
7	"D" (44H)		
8	"E" (45H)		
9	"N" (4EH)		
10	"S" (53H)		
11	"I" (49H)		
12	"T" (54H)		
13	"Y" (59H)		
14	" " (20H)		
15	"1" (31H)		
16	<LF> (0AH) or (00H)		

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6.4 Tape Drive SCSI Commands

6.4.2.7.1.8 Mode Select Changeable Parameters

The following table lists the changeable mode parameters and their minimum and maximum values allowed. See the previous definitions for the units that are used. Parameter rounding is supported for all parameters except the block descriptor length.

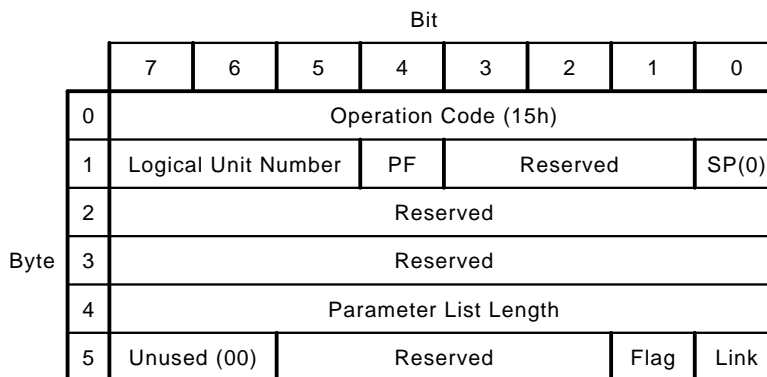
Table 6–6 Changeable Mode Parameters

Page: Parameter	Default	Minimum	Maximum
Header: buffered mode, device specific byte	1	0	1
Block descriptor length	08h	00h	08h
Block descriptor: block length	00000h	00000h	40000h
Read-write error recovery: PER bit	1	0	1
Disconnect-reconnect: maximum burst size	0080h	0000h	FFFFh
Device configuration: write delay time	0032h	0000h	0064h

6.4.2.7.2 MODE SELECT — 8mm Emulation MODE SELECT enables the host to configure the device. Implementing MODE SELECT and MODE SENSE requires a certain amount of handshaking between the host and the drive. Before configuring the drive, the host should issue a MODE SENSE to get the current configuration and determine what parameters are configurable. The host interprets this information and may then issue MODE SELECT to set the drive to the host's preferred configuration.

The drive always powers-up with its default configurations set. This is also true if the drive receives a BUS DEVICE RESET message or a hard reset through the RST line on the SCSI bus.

Figure 6–38 MODE SELECT CDB



Parameter List Length

This specifies the length in bytes of the mode select parameter list that is transferred during the DATA OUT phase. A 0 parameter list length indicates that no data is transferred.

6.4.2.7.2.1 Mode Select Parameter List

The mode select parameter list shown below, contains a 4-byte header, followed by one 8-byte block descriptor.

Figure 6–39 MODE SELECT Data Header

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Reserved							
	1	Reserved							
	2	RSVD	Buffered Mode				Speed		
	3	Block Descriptor Length (08h)							

Figure 6–40 MODE SELECT Block Descriptor

		Bit							
		7	6	5	4	3	2	1	0
0	Density Code								
1	(MSB)	Number of Blocks (000000h)							
2									
3	(LSB)								
4									
4	Reserved								
5	(MSB)	Block Length							
6									
7	(LSB)								

Figure 6–41 MODE SELECT Page Descriptor

		Bit							
		7	6	5	4	3	2	1	0
0	CT	RSVD	ND	RSVD	NBE C	EBD	PE	NAL	
1	Reserved								
2	Motion Threshold								
3	Reconnect Threshold								
4	Gap Threshold								

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6.4 Tape Drive SCSI Commands

Buffered Mode

The drive implements immediate reporting on WRITE commands through buffered mode.

If the field is 0, then the drive does not report a GOOD status on WRITE commands until the data blocks are actually written to tape. If the buffered mode field is 1, then the drive reports GOOD status on WRITE commands as soon as the data block has been transferred to the buffer. This is the default configuration for the drive. If buffered mode is not used, the tape drive will suffer a significant degradation in performance, but not capacity.

Speed

The tape drive supports only one speed, the default speed. This field must be 0.

Block Descriptor Length

This specifies the length in bytes of all the block descriptors. Since the drive only allows one block descriptor, this value must be 0 or 8.

Density Code

This field is returned as 0.

Number of Blocks

This field must be sent as 0, indicating that all of the remaining logical blocks on the tape will have the medium characteristics specified by the block descriptor.

Block Length

This specifies the length in bytes of each logical block transferred over the SCSI bus. A block length of 0 indicates that the length is variable (for example, is specified in the I/O command). Any other value indicates the number of bytes per block that will be used for read, write and verify type commands that specify a "Fixed" bit of 1 (for example, fixed block mode).

6.4.2.7.2.2 EEROM Vendor Unique Page (3Eh)

The drive shall support a vendor unique page in which one may use to modify saveable parameters. This page is only supported with the MODE SELECT command. Only one saveable parameter may be changed per MODE SELECT command. It has the following format:

Figure 6–42 EEROM Vendor Unique Page Format

0	PS	0	Page Code
1	Additional Page Length		
2	ASCII String of parameter name and value		

The ASCII string has a parameter name, followed by one or more space characters, a parameter value and an ASCII line feed or null character. When the string is parsed the parameter value will be interpreted as indicated in the following table. The parameter name may be in upper or lower case.

Table 6–7 EEROM Vendor Unique Page Parameters

Name	Value Representation	Usage
VENDORID	ASCII	Vendor identification field in inquiry data
PRODUCTID	ASCII	Product identification field in inquiry data
PRODUCTPID	ASCII	Product identification field in inquiry data of THZ02 drive
FORCEDENSITY	ASCII decimal	0=automatic, 1=THZ01, 2=THZ02
DEFFIXEDBLKLEN	ASCII decimal	Default fixed block size
ENBINQMEDCHGR	ASCII decimal	0=Disable Media Changer bit, 1=enable

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6.4 Tape Drive SCSI Commands

Here is an example of an EEROM vendor unique page which will modify the VENDORID parameter to "XXXXYY".

Figure 6–43 EEROM Vendor Unique Page Example 1

0	0	0	Page Code (3EH)
1	Page Length (0FH)		
2	"v" (76H)		
3	"e" (65H)		
4	"n" (6EH)		
5	"d" (64H)		
6	"o" (6FH)		
7	"r" (72H)		
8	"i" (69H)		
9	"d" (64H)		
10	" " (20H)		
11	"X" (58H)		
12	"X" (58H)		
13	"X" (58H)		
14	"Y" (59H)		
15	"Y" (59H)		
16	<LF> (0AH) or (00H)		

SCSI Interface 6.4 Tape Drive SCSI Commands

Here is an example of an EEROM vendor unique page which will modify the FORCEDENSITY parameter to 1.

Figure 6–44 EEROM Vendor Unique Page Example 2

0	0	0	Page Code (3EH)
1	Page Length (0FH)		
2	"F" (46H)		
3	"O" (4FH)		
4	"R" (52H)		
5	"C" (43H)		
6	"E" (45H)		
7	"D" (44H)		
8	"E" (45H)		
9	"N" (4EH)		
10	"S" (53H)		
11	"I" (49H)		
12	"T" (54H)		
13	"Y" (59H)		
14	" " (20H)		
15	"1" (31H)		
16	<LF> (0AH) or (00H)		

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6.4 Tape Drive SCSI Commands

6.4.2.7.2.3 Mode Select Changeable Parameters

The following table lists the changeable mode parameters and their minimum and maximum values allowed. See the previous definitions for the units that are used. Parameter rounding is supported for all parameters except the block descriptor length.

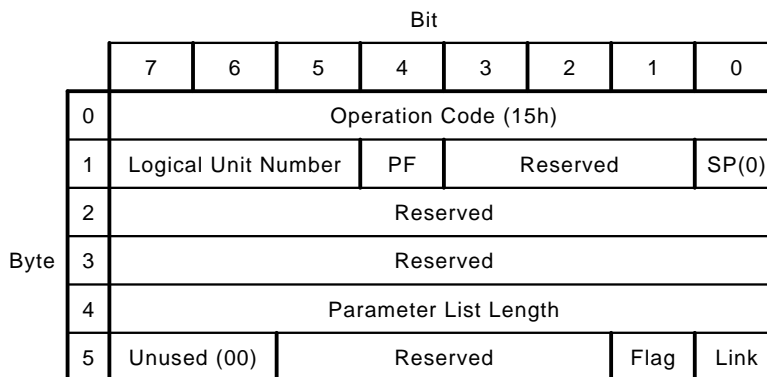
Table 6–8 Changeable Mode Parameters

Page: Parameter	Default	Minimum	Maximum
Header: buffered mode, device specific byte	1	0	1
Block descriptor length	08h	00h	08h
Block descriptor: block length	00000h	00000h	40000h
Read-write error recovery: PER bit	1	0	1
Disconnect-reconnect: maximum burst size	0080h	0000h	FFFFh
Device configuration: write delay time	0032h	0000h	0064h

6.4.2.7.3 MODE SELECT — AS400 Attachment MODE SELECT enables the host to configure the device. Implementing MODE SELECT and MODE SENSE requires a certain amount of handshaking between the host and the drive. Before configuring the drive, the host should issue a MODE SENSE to get the current configuration and determine what parameters are configurable. The host interprets this information and may then issue MODE SELECT to set the drive to the host's preferred configuration.

The drive always powers-up with its default configurations set. This is also true if the drive receives a BUS DEVICE RESET message or a hard reset through the RST line on the SCSI bus.

Figure 6–45 MODE SELECT CDB



PF

The Page Format bit indicates that the data sent by the host after the MODE SELECT header and block descriptors complies with the definition of pages in the SCSI-2 specification. The SCSI-1 format will not be implemented, so this bit is required to be set.

SP

The Save Parameters bit instructs the drive to save all saveable pages. This is not supported.

PARAMETER LIST LENGTH

This specifies the length in bytes of the mode select parameter list that is transferred during the DATA OUT phase. A 0 parameter list length indicates that no data is transferred.

6.4.2.7.3.1 Mode Select Parameter List

The mode select parameter list shown below, contains a 4-byte header, followed by one 8-byte block descriptor.

Figure 6–46 Mode Select Parameter List

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Reserved							
	1	Reserved							
	2	ignored	Buffered Mode				Speed		
	3	Block Descriptor Length (08h)							

Block Descriptor:

0	Density Code							
1	(MSB)							
2	Number of Blocks (000000h)							
3	(LSB)							
4	Reserved							
5	(MSB)							
6	Block Length							
7	(LSB)							

Page Descriptors

0	PS	0	Page Code					
1	Additional Page Length							
2	Page Defined or Vendor–Unique Parameter Bytes							

SCSI Interface

6.4 Tape Drive SCSI Commands

Buffered Mode

The drive will implement immediate reporting on WRITE commands through buffered mode.

If the field is 0, then the drive does not report a GOOD status on WRITE commands until the data blocks are actually written to tape. If the buffered mode field is 1, then the drive reports GOOD status on WRITE commands as soon as the data block has been transferred to the buffer. This is the default configuration for the drive. If buffered mode is not used, the tape drive will suffer a significant degradation in performance, but not capacity.

If this field is greater than 1, the command will be rejected with a CHECK CONDITION, with a sense key of ILLEGAL REQUEST.

Speed

The tape drive supports only one speed, the default speed.

Block Descriptor Length

This specifies the length in bytes of all the block descriptors. Since the drive only allows one block descriptor, this value must be 8 or 0. Any other value causes a CHECK CONDITION status with an ILLEGAL REQUEST sense key to be returned.

Density Code

This field should match the current density of the media, or will be set to 0 if the density is unknown.

- 00h — use default density
- 0Ah — 6667 bpi MFM serial cartridge tape X3B5/86-199 (read only)
- 16h — 10000 bpi MFM serial cartridge tape X3.193-1990 (read only)
- 17h — 42500 bpi MFM serial cartridge tape X3B5/91-174
- 18h — 42500 bpi MFM serial cartridge tape

Number of Blocks

This MODE SENSE field will be sent as 0, indicating that all of the remaining logical blocks on the tape will have the medium characteristics specified by the block descriptor.

Block Length

This specifies the length in bytes of each logical block transferred over the SCSI bus. A block length of 0 indicates that the length is variable (for example, is specified in the I/O command). Any other value indicates the number of bytes per block to use for read, write and verify type commands that specify a "Fixed" bit of 1 (for example, fixed block mode) which also causes the transfer length in the CDB to be defined as a block count.

6.4.2.7.3.2 MODE SELECT Pages

Following the block descriptor are the MODE SELECT pages, which set the device parameters. Each page has a 2-byte header which identifies the page code and indicates the number of bytes in that page.

The page codes that are supported as follows:

Figure 6–47 MODE SENSE/SELECT Pages Supported

Page Code	Description	Sense/ Select
00h	No requested page	Sense
10h	Device Configuration	both
02h	Disconnect/Reconnect	both
01h	Error Recovery Page	both
11h	Medium partition Parameters	both
3Eh	EEPROM Parameter Select	Select
3Fh	All pages	Sense

PS Bit

For the MODE SELECT command this bit is reserved. For the MODE SENSE command, a Parameters Saveable (PS) bit of 1 indicates that the page can be saved in nonvolatile memory by the drive. If the PS bit is 0, the supported parameters cannot be saved. (Saveable pages are not supported.)

Additional Page Length

This indicates the number of bytes in that page. However, the value does not include bytes 0 and 1. The length is returned on MODE SENSE and must subsequently be set to the same value when performing MODE SELECT. If the page length does not match that expected by the drive a CHECK CONDITION status is returned with the sense key set to ILLEGAL REQUEST. The drive also returns a CHECK CONDITION status with a ILLEGAL REQUEST sense key if the host sends an unsupported page code, or a page field with values that are not supported or are not changeable. In this case, no parameters will be changed by the command.

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.7.3.3 Device Configuration Page (10h)

The drive shall support the device configuration page which has the following format:

Figure 6–48 Device Configuration Page Format

		Bit														
		7	6	5	4	3	2	1	0							
Byte	0	PS	0	Page Code(10h)												
	1	Additional Page Length (0Eh)														
	2	Res	CAP	CAF	Active Format											
	3	Active Partition														
	4	Write Buffer Full Ratio														
	5	Read Buffer Empty Ratio														
	6	Write Delay Time														
	7									(MSB)						
	8	DBR	BIS	RSmk	AVC	SOCF		RBO	REW							
	9	Gap Size														
	10	EOD Defined			EEG	SEW	Reserv ed									
	11	Buffer Size at Early Warning (optional)														
	12															(MSB)
	13															(LSB)
	14	Select Data Compression Algorithm														
	15	Reserved														

PS

In this page, only the write delay parameter is changeable.

Set if the parameters are saveable.

CAP, CAF, Active Format

These fields are not supported and must be 0 on MODE SELECT.

Active Partition

Only partition 0 is supported. Setting this field to any other value will be rejected by the drive with a CHECK CONDITION status and the ILLEGAL REQUEST sense key set.

Write Buffer Full Ratio and Read Buffer Empty Ratio

These indicate how full/empty the buffer memory should be before restarting the writing/reading of the media. THZ02 will set these fields to 0 (unused) because it uses an automatic, adaptive mechanism to dynamically adjust its full/empty ratios according to the average data rates over the SCSI bus.

Write Delay Time

This indicates the maximum time that the drive will wait with a partially full buffer before forcing the data to tape (100 ms increments). Note that the buffer full/empty ratio, which is dynamic, can cause data to be written sooner than the write delay time would indicate. The write delay time defaults to 50 (32h). This causes the buffer to be flushed in 5 seconds. Maximum value is 6500 (1964h) and the minimum is 10 (0Ah). This represents delays from almost 11 minutes down to 1 second.

Byte 8:

- DBR — set to 0 (data buffer recovery not supported)
- BIS — set to 1 (block identifiers supported in media format)
- RSmk — set to 0 (setmarks not supported)
- AVC — set to 0
- SOCF — set to 0
- RBO — set to 0
- REW — set to 0 (don't report early warning EOM on reads)

Gap Size

This field is not used and is set to 0.

EOD Defined

This field is set to 00h; any other value will be rejected by the drive.

EEG

The Enable EOD Generation bit is set to indicate that the drive will generate an EOD. The drive generates an EOD mark before any change of direction following a write-type operation. This bit is ignored on MODE SELECT.

SEW and Buffer Size At Early Warning

The Synchronize at Early Warning bit and buffer size at EW fields are not supported and must be 0.

Select Data Compression Algorithm

This field is not used and must be 0.

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.7.3.4 Disconnect/Reconnect Page (02h)

The drive shall support the disconnect/reconnect page which has the following format:

Figure 6–49 Disconnect/Reconnect Page Format

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	PS	0	Page Code(02h)						
	1	Additional Page Length (0Eh)								
	2	Buffer Full Ratio								
	3	Buffer empty Ratio								
	4	(MSB)	Bus Inactivity Limit						_____	
	5							(LSB)		
	6	(MSB)	Disconnect time Limit						_____	
	7							(LSB)		
	8	(MSB)	Connect Time Limit						_____	
	9							(LSB)		
	10	(MSB)	Maximum Burst Size						_____	
	11							(LSB)		
	12	Reserved						DTDC		
	13	Reserved								
	14	Reserved								
	15	Reserved								

In this page, only the maximum burst size parameter is changeable.

The following parameters in this page are supported:

Maximum Burst Size

This value specifies the maximum amount a data that will be transferred without disconnecting. A value of 0 sets no limit. This value is in units of 512 bytes. For example, a value of 8 means 4k bytes. Values that are not multiples of 8 are rounded up to the closest multiple of 8.

Data Transfer Disconnect Control (DTDC)

This option is not supported, so this field should be 0.

6.4.2.7.3.5 Medium Partition Page (11h)

The drive supports the medium partitions parameter page, which has the following format:

Figure 6–50 Medium Partition Page Format

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	PS	0	PageCode(11h)					
	1	Additional Page Length (06)							
	2	Maximum Additional Partitions							
	3	Additional Partitions Defined							
	4	FDP	SDP	IDP	PSUM		Reserved		
	5	Medium Format Recognition (01)							
	6	Reserved							
	7	Reserved							

In this page, no parameters are changeable.

Maximum Additional Partitions

No additional partitions are supported, this field must be 0.

Additional Partitions Defined

The field specifies the number of additional partitions to be defined for the tape based on the settings of the SDP and IDP bits. The maximum allowed is the value returned in the maximum additional partitions field. Since only one partition is supported, this field must be 0.

Option Flags

- FDP — The Fixed Data Partitions bit must be 0.
- SDP — The Select Data Partitions bit must be 0.
- IDP — The Initiator Defined Partitions bit must be 0.
- PSUM — The Partition Size Unit of Measure field must be 0.

Medium Format Recognition

This field is only valid on a MODE SENSE and is set to 01h indicating that automatic format recognition is supported.

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6.4 Tape Drive SCSI Commands

6.4.2.7.3.6 Read/Write Error Recovery Page (01h)

The drive shall support the error recovery page which has the following format:

Figure 6–51 Error Recovery Page Format

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	PS	0	Page Code(01h)					
	1	Additional Page Length (0Ah)							
	2	rsvd	rsvd	TB	rsvd	EER	PER	DTE	DCR
	3	Read Retry Count							
	4	Reserved							
	5	Reserved							
	6	Reserved							
	7	Reserved							
	8	Write Retry Count							
	9	Reserved							
	10	Reserved							
	11	Reserved							

In this page, only the post error (PER) flag parameter is changeable. If PER is set, CHECK CONDITIONs will be created, with sense key of RECOVERED ERROR, and VU sense data detailing the cause. Normally, these events should be rare, and only occur if the recovered write or read retry rates reach excessive levels.

Option Flags

- TB — The transfer block (when not fully recovered) function is not supported.
- EER — The enable early recovery function is always enabled.
- PER — The post error bit turns on reporting of CHECK CONDITION to report recovered read/write errors. The default setting of this bit is depends on the personality of the firmware installed.
- DTE — The disable transfer on error feature is not supported so this bit must be 0.
- DCR — The disable ECC correction bit feature is not supported so this bit must be 0.

Read Retry Count

This field reports the maximum number of rereads that are done before declaring an unrecoverable error.

Write Retry Count

This field reports the maximum number of overwrite retries that will be performed before declaring an unrecoverable error.

6.4.2.7.3.7 EEROM Vendor Unique Page (3Eh)

The drive shall support a vendor unique page in which one may use to modify saveable parameters. This page is only supported with the MODE SELECT command. Only one saveable parameter may be changed per MODE SELECT command. It has the following format:

Figure 6–52 EEROM Vendor Unique Page Format

0	PS	0	Page Code
1	Additional Page Length		
2	ASCII String of parameter name and value		

The ASCII string has a parameter name, followed by one or more space characters, a parameter value and an ASCII line feed or null character. When the string is parsed the parameter value will be interpreted as indicated in the following table. The parameter name may be in upper or lower case.

Table 6–9 EEROM Vendor Unique Page Parameters

Name	Value Representation	Usage
VENDORID	ASCII	Vendor identification field in inquiry data
PRODUCTID	ASCII	Product identification field in inquiry data
PRODUCTPID	ASCII	Product identification field in inquiry data of THZ02 drive
FORCEDENSITY	ASCII decimal	0=automatic, 1=THZ01, 2=THZ02
DEFFIXEDBLKLEN	ASCII decimal	Default fixed block size
ENBINQMEDCHGR	ASCII decimal	0=Disable Media Changer bit, 1=enable

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6.4 Tape Drive SCSI Commands

Here is an example of an EEROM vendor unique page which will modify the VENDORID parameter to "XXXXYY".

Figure 6–53 EEROM Vendor Unique Page Example 1

0	0	0	Page Code (3EH)
1	Page Length (0FH)		
2	"v" (76H)		
3	"e" (65H)		
4	"n" (6EH)		
5	"d" (64H)		
6	"o" (6FH)		
7	"r" (72H)		
8	"i" (69H)		
9	"d" (64H)		
10	" " (20H)		
11	"X" (58H)		
12	"X" (58H)		
13	"X" (58H)		
14	"Y" (59H)		
15	"Y" (59H)		
16	<LF> (0AH) or (00H)		

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Here is an example of an EEROM vendor unique page which will modify the FORCEDENSITY parameter to 1.

Figure 6–54 EEROM Vendor Unique Page Example 2

0	0	0	Page Code (3EH)
1	Page Length (0FH)		
2	"F" (46H)		
3	"O" (4FH)		
4	"R" (52H)		
5	"C" (43H)		
6	"E" (45H)		
7	"D" (44H)		
8	"E" (45H)		
9	"N" (4EH)		
10	"S" (53H)		
11	"I" (49H)		
12	"T" (54H)		
13	"Y" (59H)		
14	" " (20H)		
15	"1" (31H)		
16	<LF> (0AH) or (00H)		

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6.4 Tape Drive SCSI Commands

6.4.2.7.3.8 Mode Select Changeable Parameters

The following table lists the changeable mode parameters and their minimum and maximum values allowed. See the previous definitions for the units that are used. Parameter rounding is supported for all parameters except the block descriptor length.

Table 6–10 Changeable Mode Parameters

Page: Parameter	Default	Minimum	Maximum
Header: buffered mode, device specific byte	1	0	1
Block descriptor length	08h	00h	08h
Block descriptor: block length	00000h	00000h	40000h
Read-write error recovery: PER bit	1	0	1
Disconnect-reconnect: maximum burst size	0080h	0000h	FFFFh
Device configuration: write delay time	0032h	0000h	0064h

6.4.2.8 MODE SENSE (1Ah)

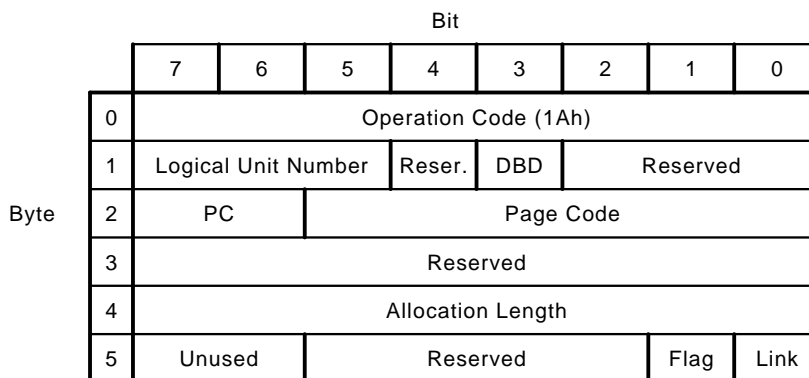
The MODE SENSE command implementation is dependent upon the type of firmware that is loaded in the THZ02 controller. Refer to Table 6–11 for the appropriate section for your type of code.

Table 6–11 Mode Sense Command Sections

Code Type	Description	Section
Type 1	SCSI II	Section 6.4.2.8.1
Type 2	8mm emulation	Section 6.4.2.8.2
Type 3	AS400 attachment	Section 6.4.2.8.3

6.4.2.8.1 MODE SENSE — SCSI II MODE SENSE allows the drive to report its media, current or changeable configuration parameters to the host. It is a complementary command to MODE SELECT.

Figure 6–55 MODE SENSE CDB



DBD

If the Disable Block Descriptors bit is 0, the device returns the block descriptor data. If set, then the block descriptor information is not returned.

PC

The page control field indicates the type of page parameter values to be returned to the host as shown in the following table:

Figure 6–56 MODE SENSE Page Control Definition

PC	Description
0 0	Report Current Values
0 1	Report Changeable Values
1 0	Report Default Values
1 1	Report Saved Values

The additional page length field of each page returned by the drive indicates the number of bytes supported for that page.

Page Code

This allows the host to select any specific page, or all the pages supported by the drive.

Allocation Length

The allocation length field specifies the number of bytes that the host has allocated for returned MODE SENSE data. An allocation length of 0 means that the drive will return no MODE SENSE data. This is not considered an error and GOOD status is returned.

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6.4 Tape Drive SCSI Commands

6.4.2.8.1.1 MODE SENSE Parameter List

The MODE SENSE data contains a 4-byte header followed by one 8-byte block descriptor, followed by zero or more variable length pages, depending on the page code and the allocation length:

Figure 6–57 MODE SENSE Data Header

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Sense Data Length							
	1	Reserved							
	2	WP	Buffered Mode				Speed (0h)		
	3	Block Descriptor Length (08h)							

Figure 6–58 MODE SENSE Block Descriptor

		Bit							
		7	6	5	4	3	2	1	0
0	Density Code								
1	(MSB)	_____							
2	Number of Blocks (000000h)								
3	(LSB)								
4	Reserved								
5	(MSB)	_____							
6	Block Length								
7	(LSB)								

Figure 6–59 MODE SENSE Page Descriptor

		Bit								
		7	6	5	4	3	2	1	0	
0	PS	0	Page Code							
1	Additional Page Length									
2	Page Defined or Vendor–Unique Parameter Bytes									

Data Length

The sense data length specifies the length in bytes of the following MODE SENSE data that is available to be transferred during DATA IN phase. The sense data length does not include itself.

WP

A Write-Protected bit of 0 indicates that the tape is write-enabled. A Write-Protected bit of 1 indicates that the tape is write-protected.

Buffered Mode

The drive implements immediate reporting on WRITE commands through buffered mode.

If the field is 0, then the drive does not report a GOOD status on WRITE commands until the data blocks are actually written to tape. If the buffered mode field is 1, then the drive reports GOOD status on WRITE commands as soon as the data block has been transferred to the buffer. This is the default configuration for the drive. If buffered mode is not used, the tape drive will suffer a significant degradation in performance, but not capacity.

Speed

The tape drive supports only one speed, the default speed.

Block Descriptor Length

This specifies the length in bytes of all the block descriptors. Since the drive only allows one block descriptor, this value will be 8.

Density Code

This field matches the current density of the media, or 0 if the density is unknown.

- 00h — use default density
- 0Ah — 6667 bpi MF M serial cartridge tape X3B5/86-199 (read only)
- 16h — 10000 bpi MF M serial cartridge tape X3.193-1990 (read only)
- 17h — 42500 bpi MF M serial cartridge tape X3B5/91-174
- 18h — 42500 bpi MF M serial cartridge tape

Number of Blocks

This field will be sent as 0, indicating that all of the remaining logical blocks on the tape will have the medium characteristics specified by the block descriptor.

Block Length

This specifies the length in bytes of each logical block transferred over the SCSI bus. A block length of zero indicates that the length is variable (for example, is specified in the I/O command). Any other value indicates the number of bytes per block that will be used for read, write and verify type commands that specify a "Fixed" bit of 1 (for example, fixed block mode).

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6.4 Tape Drive SCSI Commands

6.4.2.8.1.2 MODE SENSE Pages

Following the block descriptor are the MODE SELECT pages, which set the device parameters. Each page has a 2-byte header which identifies the page code and indicates the number of bytes in that page.

The page codes that are supported as follows:

Figure 6–60 MODE SENSE Pages Supported

Page Code	Description	Sense/Select
00h	No requested page	Sense
10h	Device Configuration	both
02h	Disconnect/Reconnect	both
01h	Error Recovery Page	both
11h	Medium partition Parameters	both
3Eh	EEPROM Parameter Select	Select
3Fh	All pages	Sense

PS Bit

A Parameters Saveable (PS) bit of 1 indicates that the page can be saved in nonvolatile memory by the drive. If the PS bit is 0, the supported parameters cannot be saved. (Saveable pages are not supported.)

Additional Page Length

This indicates the number of bytes in that page. However, the value does not include bytes 0 and 1. The length is returned on MODE SENSE and must subsequently be set to the same value when performing MODE SELECT.

6.4.2.8.1.3 Device Configuration Page (10h)

The drive shall support the device configuration page which has the following format:

Figure 6–61 Device Configuration Page Format

		Bit														
		7	6	5	4	3	2	1	0							
Byte	0	PS	0	Page Code(10h)												
	1	Additional Page Length (0Eh)														
	2	Res	CAP	CAF	Active Format											
	3	Active Partition														
	4	Write Buffer Full Ratio														
	5	Read Buffer Empty Ratio														
	6	Write Delay Time														
	7									(MSB)						
	8	DBR	BIS	RSmk	AVC	SOCF		RBO	REW							
	9	Gap Size														
	10	EOD Defined			EEG	SEW	Reserv ed									
	11	Buffer Size at Early Warning (optional)														
	12															(MSB)
	13															(LSB)
	14	Select Data Compression Algorithm														
	15	Reserved														

PS

In this page, only the write delay parameter is changeable.

Set if the parameters are saveable.

CAP, CAF, Active Format

These fields are not supported and will be 0.

SCSI Interface

6.4 Tape Drive SCSI Commands

Active Partition

Only partition 0 is supported.

Write Buffer Full Ratio and Read Buffer Empty Ratio

These indicate how full/empty the buffer memory should be before restarting the writing/reading of the media. THZ02 will set these fields to 0 (unused) because it uses an automatic, adaptive mechanism to dynamically adjust its full/empty ratios according to the average data rates over the SCSI bus.

Write Delay Time

This indicates the maximum time that the drive will wait with a partially full buffer before forcing the data to tape (100 ms increments). Note that the buffer full/empty ratio, which is dynamic, can cause data to be written sooner than the write delay time would indicate. The write delay time defaults to 50 (32h). This causes the buffer to be flushed in 5 seconds. Maximum value is 6500 (1964h) and the minimum is 10 (0Ah). This represents delays from almost 11 minutes down to 1 second.

Byte 8:

DBR — set to 0 (data buffer recovery not supported)
BIS — set to 1 (block identifiers supported in media format)
RSmk — set to 0 (setmarks not supported)
AVC — set to 0
SOCF — set to 0
RBO — set to 0
REW — set to 0 (don't report early warning EOM on reads)

Gap Size

This field is not used and is set to 0.

EOD Defined

This field is set to 00h.

EEG

The Enable EOD Generation bit is set to indicate that the drive will generate an EOD. The drive generates an EOD mark before any change of direction following a write-type operation.

SEW and Buffer Size At Early Warning

The Synchronize at Early Warning bit and buffer size at EW fields are not supported and will be 0.

Select Data Compression Algorithm

This field is not used and will be 0.

6.4.2.8.1.4 Disconnect/Reconnect Page (02h)

The drive shall support the disconnect/reconnect page which has the following format:

Figure 6–62 Disconnect/Reconnect Page Format

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	PS	0	Page Code(02h)						
	1	Additional Page Length (0Eh)								
	2	Buffer Full Ratio								
	3	Buffer empty Ratio								
	4	(MSB)	Bus Inactivity Limit						_____	
	5							(LSB)		
	6	(MSB)	Disconnect time Limit						_____	
	7							(LSB)		
	8	(MSB)	Connect Time Limit						_____	
	9							(LSB)		
	10	(MSB)	Maximum Burst Size						_____	
	11							(LSB)		
	12	Reserved						DTDC		
	13	Reserved								
	14	Reserved								
	15	Reserved								

The following parameters in this page are supported:

Maximum Burst Size

This value specifies the maximum amount a data that will be transferred without disconnecting. A value of 0 sets no limit. This value is in units of 512 bytes. For example, a value of 8 means 4k bytes. Values that are not multiples of 8 are rounded up to the closest multiple of 8.

Data Transfer Disconnect Control (DTDC)

This option is not supported, so this field will be 0.

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.8.1.5 Medium Partition Page (11h)

The drive supports the medium partitions parameter page, which has the following format:

Figure 6–63 Medium Partition Page Format

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	PS	0	PageCode(11h)					
	1	Additional Page Length (06)							
	2	Maximum Additional Partitions							
	3	Additional Partitions Defined							
	4	FDP	SDP	IDP	PSUM		Reserved		
	5	Medium Format Recognition (01)							
	6	Reserved							
	7	Reserved							

Maximum Additional Partitions

No additional partitions are supported, this field will be 0.

Additional Partitions Defined

The field specifies the number of additional partitions to be defined for the tape based on the settings of the SDP and IDP bits. The maximum allowed is the value returned in the maximum additional partitions field. Since only one partition is supported, this field will be 0.

Option Flags

FDP — The Fixed Data Partitions bit will be 0.

SDP — The Select Data Partitions bit will be 0.

IDP — The Initiator Defined Partitions bit will be 0.

PSUM — The Partition Size Unit of Measure field will be 0.

Medium Format Recognition

This field is set to 01h indicating that automatic format recognition is supported.

6.4.2.8.1.6 Read/Write Error Recovery Page (01h)

The drive shall support the error recovery page which has the following format:

Figure 6–64 Error Recovery Page Format

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	PS	0	Page Code(01h)						
	1	Additional Page Length (0Ah)								
	2	rsvd	rsvd	TB	rsvd	EER	PER	DTE	DCR	
	3	Read Retry Count								
	4	Reserved								
	5	Reserved								
	6	Reserved								
	7	Reserved								
	8	Write Retry Count								
	9	Reserved								
	10	Reserved								
	11	Reserved								

Option Flags

- TB — The transfer block (when not fully recovered) function is not supported.
- EER — The enable early recovery function is always enabled.
- PER — The post error bit turns on reporting of CHECK CONDITION to report recovered read/write errors. The default setting of this bit is off.
- DTE — The disable transfer on error feature is not supported so this bit will be 0.
- DCR — The disable ECC correction bit feature is not supported so this bit will be 0.

Read Retry Count

This field reports the maximum number of rereads that are done before declaring an unrecoverable error.

Write Retry Count

This field reports the maximum number of overwrite retries that will be performed before declaring an unrecoverable error.

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.8.2 MODE SENSE — 8mm Emulation MODE SENSE allows the drive to report its media, current or changeable configuration parameters to the host. It is a complementary command to MODE SELECT.

Figure 6–65 MODE SENSE CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (1Ah)							
	1	Logical Unit Number			Reser.	DBD	Reserved		
	2	PC		Page Code					
	3	Reserved							
	4	Allocation Length							
	5	Unused		Reserved				Flag	Link

Allocation Length

The allocation length field specifies the number of bytes that the host has allocated for returned MODE SENSE data. An allocation length of 0 means that the drive will return no MODE SENSE data. This is not considered an error and GOOD status is returned.

6.4.2.8.2.1 MODE SENSE Parameter List

The MODE SENSE data contains a 4-byte header followed by one 8-byte block descriptor, followed by zero or more variable length pages, depending on the page code and the allocation length:

Figure 6–66 MODE SENSE Data Header

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Sense Data Length							
	1	Medium Type							
	2	WP	Buffered Mode				Speed		
	3	Block Descriptor Length (08h)							

Figure 6–67 MODE SENSE Block Descriptor

		Bit							
		7	6	5	4	3	2	1	0
0	Density Code								
1	(MSB)	Number of Blocks (000000h)							
2									
3									
	(LSB)								
4	Reserved								
5	(MSB)	Block Length							
6									
7									
	(LSB)								

Figure 6–68 MODE SENSE Page Descriptor

		Bit							
		7	6	5	4	3	2	1	0
0	CT	RSVD	ND	RSVD	NBE C	EBD	PE	NAL	
1	Reserved								
2	Motion Threshold								
3	Reconnect Threshold								
4	Gap Threshold								

SCSI Interface

6.4 Tape Drive SCSI Commands

Data Length

The sense data length specifies the length in bytes of the following MODE SENSE data that is available to be transferred during DATA IN phase. The sense data length does not include itself.

WP

A write-protected bit of 0 indicates that the tape is write-enabled. A write-protected bit of 1 indicates that the tape is write-protected.

Buffered Mode

The drive implements immediate reporting on WRITE commands through buffered mode.

If the field is 0, then the drive does not report a GOOD status on WRITE commands until the data blocks are actually written to tape. If the buffered mode field is 1, then the drive reports GOOD status on WRITE commands as soon as the data block has been transferred to the buffer. This is the default configuration for the drive. If buffered mode is not used, the tape drive will suffer a significant degradation in performance, but not capacity.

Speed

The tape drive supports only one speed, the default speed.

Block Descriptor Length

This specifies the length in bytes of all the block descriptors. Since the drive only allows one block descriptor, this value will be 8.

Density Code

This field is returned as 0.

Number of Blocks

This field will be sent as 0, indicating that all of the remaining logical blocks on the tape will have the medium characteristics specified by the block descriptor.

Block Length

This specifies the length in bytes of each logical block transferred over the SCSI bus. A block length of 0 indicates that the length is variable (for example, is specified in the I/O command). Any other value indicates the number of bytes per block that will be used for read, write and verify type commands that specify a "Fixed" bit of 1 (for example, fixed block mode).

6.4.2.8.3 MODE SENSE — AS400 Attachment MODE SENSE allows the drive to report its media, current or changeable configuration parameters to the host. It is a complementary command to MODE SELECT.

Figure 6–69 MODE SENSE CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (1Ah)							
	1	Logical Unit Number			PF	DBD	Reserved		
	2	PC		Page Code					
	3	Reserved							
	4	Allocation Length							
	5	Unused		Reserved				Flag	Link

PF

The Page Format bit when set indicates that the mode sense parameters after the block descriptors, are structured. The Page Format bit when cleared indicates that the mode sense parameters after the block descriptors, are vendor specific.

DBD

If the Disable Block Descriptors bit is 0, the device returns the block descriptor data. If set, then the block descriptor information is not returned.

PC

The page control field indicates the type of page parameter values to be returned to the host as shown in the following table:

Figure 6–70 MODE SENSE Page Control Definition

PC	Description
0 0	Report Current Values
0 1	Report Changeable Values
1 0	Report Default Values
1 1	Report Saved Values

The additional page length field of each page returned by the drive indicates the number of bytes supported for that page.

Page Code

This allows the host to select any specific page, or all the pages supported by the drive.

Allocation Length

The allocation length field specifies the number of bytes that the host has allocated for returned MODE SENSE data. An allocation length of 0 means that the drive will return no MODE SENSE data. This is not considered an error and GOOD status is returned.

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.8.3.1 MODE SENSE Parameter List

The MODE SENSE data contains a 4-byte header followed by one 8-byte block descriptor, followed by zero or more variable length pages, depending on the page code and the allocation length:

Figure 6–71 MODE SENSE Data Header

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Sense Data Length							
	1	Medium Type							
	2	WP	Buffered Mode				Speed		
	3	Block Descriptor Length (08h)							

Figure 6–72 MODE SENSE Block Descriptor

		Bit							
		7	6	5	4	3	2	1	0
0	Density Code								
1	(MSB)								
2	Number of Blocks (000000h)								
3	(LSB)								
4	Reserved								
5	(MSB)								
6	Block Length								
7	(LSB)								

Figure 6–73 MODE SENSE Page Descriptor

		Bit							
		7	6	5	4	3	2	1	0
0	CT	RSVD	ND	RSVD	NBE C	EBD	PE	NAL	
1	Reserved								
2	Motion Threshold								
3	Reconnect Threshold								
4	Gap Threshold								

Data Length

The sense data length specifies the length in bytes of the following MODE SENSE data that is available to be transferred during DATA IN phase. The sense data length does not include itself.

WP

A write-protected bit of 0 indicates that the tape is write-enabled. A write-protected bit of 1 indicates that the tape is write-protected.

Buffered Mode

The drive implements immediate reporting on WRITE commands through buffered mode.

If the field is 0, then the drive does not report a GOOD status on WRITE commands until the data blocks are actually written to tape. If the buffered mode field is 1, then the drive reports GOOD status on WRITE commands as soon as the data block has been transferred to the buffer. This is the default configuration for the drive. If buffered mode is not used, the tape drive will suffer a significant degradation in performance, but not capacity.

Speed

The tape drive supports only one speed, the default speed.

Block Descriptor Length

This specifies the length in bytes of all the block descriptors. Since the drive only allows one block descriptor, this value will be 8.

Density Code

This field matches the current density of the media, or 0 if the density is unknown.

- 00h — use default density
- 0Ah — 6667 bpi MF M serial cartridge tape X3B5/86-199 (read only)
- 16h — 10000 bpi MF M serial cartridge tape X3.193-1990 (read only)
- 17h — 42500 bpi MF M serial cartridge tape X3B5/91-174
- 18h — 42500 bpi MF M serial cartridge tape

Number of Blocks

This field will be sent as 0, indicating that all of the remaining logical blocks on the tape will have the medium characteristics specified by the block descriptor.

Block Length

This specifies the length in bytes of each logical block transferred over the SCSI bus. A block length of 0 indicates that the length is variable (for example, is specified in the I/O command). Any other value indicates the number of bytes per block that will be used for read, write and verify type commands that specify a "Fixed" bit of 1 (for example, fixed block mode).

SCSI Interface

6.4 Tape Drive SCSI Commands

6.4.2.8.3.2 MODE SENSE Pages

Following the block descriptor are the MODE SELECT pages, which set the device parameters. Each page has a 2-byte header which identifies the page code and indicates the number of bytes in that page.

The page codes that are supported as follows:

Figure 6–74 MODE SENSE Pages Supported

Page Code	Description	Sense/Select
00h	No requested page	Sense
10h	Device Configuration	both
02h	Disconnect/Reconnect	both
01h	Error Recovery Page	both
11h	Medium partition Parameters	both
3Eh	EEPROM Parameter Select	Select
3Fh	All pages	Sense

PS Bit

A Parameters Saveable (PS) bit of 1 indicates that the page can be saved in nonvolatile memory by the drive. If the PS bit is 0, the supported parameters cannot be saved. (Saveable pages are not supported.)

Additional Page Length

This indicates the number of bytes in that page. However, the value does not include bytes 0 and 1. The length is returned on MODE SENSE and must subsequently be set to the same value when performing MODE SELECT.

6.4.2.8.3.3 Device Configuration Page (10h)

The drive shall support the device configuration page which has the following format:

Figure 6–75 Device Configuration Page Format

		Bit													
		7	6	5	4	3	2	1	0						
Byte	0	PS	0	Page Code(10h)											
	1	Additional Page Length (0Eh)													
	2	Res	CAP	CAF	Active Format										
	3	Active Partition													
	4	Write Buffer Full Ratio													
	5	Read Buffer Empty Ratio													
	6	Write Delay Time													
	7									(MSB)					
	8	DBR	BIS	RSmk	AVC	SOCF		RBO	REW						
	9	Gap Size													
	10	EOD Defined			EEG	SEW	Reserv ed								
	11	Buffer Size at Early Warning (optional)													
	12														
	13														
	14	Select Data Compression Algorithm													
15	Reserved														

PS

In this page, only the write delay parameter is changeable.

Set if the parameters are saveable.

CAP, CAF, Active Format

These fields are not supported and will be 0.

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6.4 Tape Drive SCSI Commands

Active Partition

Only partition 0 is supported.

Write Buffer Full Ratio and Read Buffer Empty Ratio

These indicate how full/empty the buffer memory should be before restarting the writing/reading of the media. THZ02 will set these fields to 0 (unused) because it uses an automatic, adaptive mechanism to dynamically adjust its full/empty ratios according to the average data rates over the SCSI bus.

Write Delay Time

This indicates the maximum time that the drive will wait with a partially full buffer before forcing the data to tape (100 ms increments). Note that the buffer full/empty ratio, which is dynamic, can cause data to be written sooner than the write delay time would indicate. The write delay time defaults to 50 (32h). This causes the buffer to be flushed in 5 seconds. Maximum value is 6500 (1964h) and the minimum is 10 (0Ah). This represents delays from almost 11 minutes down to 1 second.

Byte 8:

DBR — set to 0 (data buffer recovery not supported)
BIS — set to 1 (block identifiers supported in media format)
RSmk — set to 0 (setmarks not supported)
AVC — set to 0
SOCF — set to 0
RBO — set to 0
REW — set to 0 (don't report early warning EOM on reads)

Gap Size

This field is not used and is set to 0.

EOD Defined

This field is set to 00h.

EEG

The Enable EOD Generation bit is set to indicate that the drive will generate an EOD. The drive generates an EOD mark before any change of direction following a write-type operation.

SEW and Buffer Size At Early Warning

The Synchronize at Early Warning bit and buffer size at EW fields are not supported and will be 0.

Select Data Compression Algorithm

This field is not used and will be 0.

6.4.2.8.3.4 Disconnect/Reconnect Page (02h)

The drive shall support the disconnect/reconnect page which has the following format:

Figure 6–76 Disconnect/Reconnect Page Format

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	PS	0	Page Code(02h)						
	1	Additional Page Length (0Eh)								
	2	Buffer Full Ratio								
	3	Buffer empty Ratio								
	4	(MSB)	Bus Inactivity Limit						_____	
	5								(LSB)	
	6	(MSB)	Disconnect time Limit						_____	
	7								(LSB)	
	8	(MSB)	Connect Time Limit						_____	
	9								(LSB)	
	10	(MSB)	Maximum Burst Size						_____	
	11								(LSB)	
	12	Reserved						DTDC		
	13	Reserved								
	14	Reserved								
	15	Reserved								

The following parameters in this page are supported:

Maximum Burst Size

This value specifies the maximum amount a data that will be transferred without disconnecting. A value of 0 sets no limit. This value is in units of 512 bytes. For example, a value of 8 means 4k bytes. Values that are not multiples of 8 are rounded up to the closest multiple of 8.

Data Transfer Disconnect Control (DTDC)

This option is not supported, so this field will be 0.

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6.4 Tape Drive SCSI Commands

6.4.2.8.3.5 Medium Partition Page (11h)

The drive supports the medium partitions parameter page, which has the following format:

Figure 6–77 Medium Partition Page Format

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	PS	0	PageCode(11h)					
	1	Additional Page Length (06)							
	2	Maximum Additional Partitions							
	3	Additional Partitions Defined							
	4	FDP	SDP	IDP	PSUM		Reserved		
	5	Medium Format Recognition (01)							
	6	Reserved							
	7	Reserved							

Maximum Additional Partitions

No additional partitions are supported, this field will be 0.

Additional Partitions Defined

The field specifies the number of additional partitions to be defined for the tape based on the settings of the SDP and IDP bits. The maximum allowed is the value returned in the maximum additional partitions field. Since only one partition is supported, this field will be 0.

Option Flags

FDP — The Fixed Data Partitions bit will be 0.

SDP — The Select Data Partitions bit will be 0.

IDP — The Initiator Defined Partitions bit will be 0.

PSUM — The Partition Size Unit of Measure field will be 0.

Medium Format Recognition

This field is set to 01h indicating that automatic format recognition is supported.

6.4.2.8.3.6 Read/Write Error Recovery Page (01h)

The drive shall support the error recovery page which has the following format:

Figure 6–78 Error Recovery Page Format

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	PS	0	Page Code(01h)						
	1	Additional Page Length (0Ah)								
	2	rsvd	rsvd	TB	rsvd	EER	PER	DTE	DCR	
	3	Read Retry Count								
	4	Reserved								
	5	Reserved								
	6	Reserved								
	7	Reserved								
	8	Write Retry Count								
	9	Reserved								
	10	Reserved								
	11	Reserved								

Option Flags

- TB — The transfer block (when not fully recovered) function is not supported.
- EER — The enable early recovery function is always enabled.
- PER — The post error bit turns on reporting of CHECK CONDITION to report recovered read/write errors. The default setting of this bit is off.
- DTE — The disable transfer on error feature is not supported so this bit will be 0.
- DCR — The disable ECC correction bit feature is not supported so this bit will be 0.

Read Retry Count

This field reports the maximum number of rereads that are done before declaring an unrecoverable error.

Write Retry Count

This field reports the maximum number of overwrite retries that will be performed before declaring an unrecoverable error.

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6.4 Tape Drive SCSI Commands

6.4.2.9 PREVENT/ALLOW MEDIUM REMOVAL (1Eh)

Figure 6–79 PREVENT/ALLOW MEDIUM REMOVAL CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (1Eh)							
	1	Logical Unit Number				Reserved			
	2	Reserved							
	3	Reserved							
	4	Reserved							Prevent
	5	Unused		Reserved				Flag	Link

This command enables or disables the unloading of the tape cartridge.

Prevent

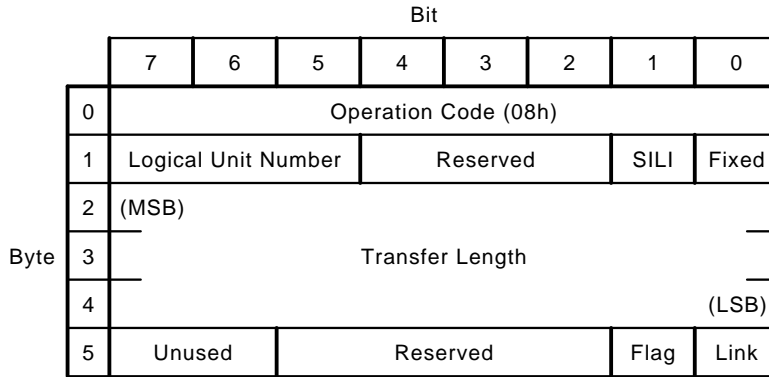
If this bit is set, the Unload button on the drive front panel is effectively disabled, and the UNLOAD command will not unload the media or the cartridge. Any buffered data is written to tape, along with EOD blocks.

When the Prevent bit is set to 0, the Unload button and UNLOAD commands are reenabled. By default after power up, hard reset, or BUS DEVICE RESET message, the prevent medium removal function is cleared.

If a media loader is present, the MOVE MEDIUM command will not be allowed to remove a cartridge if Prevent has been selected.

6.4.2.10 READ (08h)

Figure 6–80 READ CDB



READ transfers one or more data blocks to the initiator starting with the next block on the drive.

Fixed

This bit specifies the meaning of the transfer length field and whether fixed-length or variable-length blocks are to be transferred.

If the Fixed bit is set to 0, a variable block mode is requested. A single block is transferred with the transfer length specifying the maximum number of bytes the initiator has allocated for the returned data.

If the Fixed bit is set to 1, the transfer length specifies the number of blocks to be transferred to the initiator. This is valid only if the logical unit is currently operating in fixed block mode.

When the transfer length is 0, no data is transferred and the current position on the logical unit is not changed.

A successful READ with the Fixed bit set to 1 transfers (current block length)×(transfer length) bytes of data to the host. Upon termination of READ, the media is logically positioned after the last block transferred (EOM side).

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6.4 Tape Drive SCSI Commands

SILI

If the Suppress Incorrect Length Indicator bit is set the target will not return CHECK CONDITION status if the only error is that the transfer length is not equal to the actual block length recorded on the media. All other error conditions are still reported.

If the SILI bit is not set and the actual block length is different from the specified transfer length, a CHECK CONDITION status is returned. Within the sense data, the Incorrect Length Indicator (ILI) bit and Valid bit will be set to 1. The sense key field will be set to NO SENSE. The information bytes will be set to the difference (residue) between the requested transfer length and the actual block length, or in fixed blocked mode, the difference (residue) between the requested number of blocks and the actual number of blocks read. No more than transfer length bytes are transferred to the initiator and the tape is logically positioned after the block (EOM side).

If the drive reads a filemark, it will return a CHECK CONDITION status. Within the sense data, the filemark and valid bits are set and the sense key field is set to NO SENSE. The information fields contain the residue count. The additional sense code and additional sense code qualifier fields are set to filemark detected. Upon termination, the media will be logically positioned after the filemark (EOM side).

If the drive detects EOD during the READ, the drive will return a CHECK CONDITION status. Within the sense data, the Valid bit is set and the sense key field is set to BLANK CHECK. The EOM bit may be set if the drive determines that the tape is positioned past the PSEN marker. The information fields contain the residue count. The additional sense code and additional sense code qualifier fields are set. Upon termination, the media will be physically positioned before EOD and after the last block on tape.

The meaning of EOM is different for a read than for a write type of command. EOM is only reported when the physical EOM/P is encountered. The drive returns a CHECK CONDITION status. The EOM and Valid bits are set and the sense key is set to MEDIUM ERROR. The information fields contain the residue count and the additional sense code and additional sense code qualifier fields are set to EOM/P detected. The tape is physically positioned at EOM/P.

If any READ command cannot be completed successfully the drive returns a CHECK CONDITION status. Further commands should attempt to move past the error and complete successfully.

6.4.2.11 READ BLOCK LIMITS (05h)

Figure 6–81 READ BLOCK LIMITS CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (05h)							
	1	Logical Unit Number				Reserved			
	2	Reserved							
	3	Reserved							
	4	Reserved							
	5	Unused				Reserved			Flag

READ BLOCK LIMITS tells the drive to return its limits for block length. The READ BLOCK LIMITS data shown below is sent during the DATA IN phase of the command. The command does not reflect the currently selected block size, only the available limits. MODE SENSE returns the current block size.

Figure 6–82 READ BLOCK LIMITS Data

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Reserved							
	1	(MSB)							
	2	Maximum block length							
	3	(LSB)							
	4	(MSB)							
5	Minimum block length (0001h)								
		(LSB)							

Maximum Block Length

This field indicates the maximum block size. The device supports a maximum block length of 256k bytes.

Minimum Block Size

This field indicates the minimum block size. The device supports a minimum block length of 1 byte.

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6.4 Tape Drive SCSI Commands

6.4.2.12 READ BUFFER (3Ch)

Figure 6–83 READ BUFFER CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (3Ch)							
	1	Logical Unit Number			Reserved			Mode	
	2	Buffer ID							
	3	(MSB)							
	4	Buffer Offset							
	5	(LSB)							
	6	(MSB)							
	7	Allocation Length							
	8	(LSB)							
	9	Unused	Reserved			Flag	Link		

READ BUFFER is used in conjunction with WRITE BUFFER as a diagnostic function for testing the drive's data buffer and the SCSI bus integrity.

Mode

The drive supports the following values within the field. If any nonsupported value is set, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST sense key set.

Figure 6–84 READ BUFFER Modes Supported

Mode	Description
000b	Combined Header and Data
010b	Data
011b	Descriptor

Buffer ID and Offset

The drive only supports a single buffer ID field of 0, and offsetting of data is not supported. If these fields are non-0, the drive returns a CHECK CONDITION status with an ILLEGAL REQUEST sense key set.

Allocation Length

The allocation length specifies the maximum number of bytes that the initiator has allocated for returned data.

6.4.2.12.1 Combined Header and Data Mode In this mode, the drive returns a 4-byte header followed by the data bytes. The drive terminates the DATA IN phase when allocation length bytes of header and data have been transferred, or when all available data has been transferred to the initiator, whichever is less. The 4-byte READ BUFFER header is followed by data bytes from the targets data buffer. The header has the following format:

Figure 6–85 READ BUFFER Data Header



Available Length

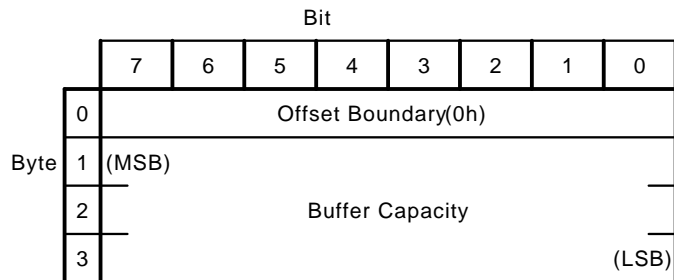
The available length field specifies the total number of data bytes available in the target’s buffer. This number is not reduced to reflect the allocation length, nor is it reduced to reflect the actual number of bytes written using the WRITE BUFFER command. Following the READ BUFFER header, the target will transfer data from its data buffer.

6.4.2.12.2 Data Mode In this mode, the DATA IN phase only contains buffer data.

6.4.2.12.3 Descriptor Mode In this mode, a maximum of four bytes of READ BUFFER descriptor information are returned. The drive returns the descriptor information for the buffer specified by the buffer ID. In this mode, the drive does not reject the valid buffer IDs with a CHECK CONDITION status, but returns all 0s in the READ BUFFER descriptor.

The offset boundary is 12 (0Ch), indicating buffer offsets should be integral multiples of 4k.

Figure 6–86 READ BUFFER Descriptor



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6.4 Tape Drive SCSI Commands

6.4.2.13 READ POSITION (34h)

Figure 6–87 READ POSITION CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (34h)							
	1	Logical Unit Number			Reserved				BT
	2	Reserved							
	3	Reserved							
	4	Reserved							
	5	Reserved							
	6	Reserved							
	7	Reserved							
	8	Reserved							
	9	Unused		Reserved				Flag	Link

The READ POSITION command is used to read a position identifier, or SCSI logical block address. The LOCATE command uses this identifier to position back to this same logical position, in a high performance fashion.

BT

The Block Type bit indicates how the position is interpreted. Since this device uses the same logical block address whether this bit is set or not, the setting of BT is ignored. The logical block address values include all recorded objects: blocks and filemarks.

SCSI Interface 6.4 Tape Drive SCSI Commands

6.4.2.13.1 READ POSITION Data Format The BOP and EOP bits will be set as appropriate. The Block Position Unknown (BPU) bit is never set since the setting of the BT bit in the read position CDB does not affect the block address values returned.

Figure 6–88 READ POSITION Data Format

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	BOP	EOP	Reserved			BPU	Reserved		
	1	Partition Number								
	2	Reserved								
	3	Reserved								
	4	(MSB)	First Block Location						(LSB)	
	5									
	6									
	7									
	8	(MSB)	Last Block Location						(LSB)	
	9									
	10									
	11									
	12	Reserved								
	13	(MSB)	Number of Blocks in Buffer						(LSB)	
	14									
	15									
	16	(MSB)	Number of Bytes in Buffer						(LSB)	
	17									
	18									
19										

First Block Location

The block address associated with the current logical position; the next block to be transferred between the target and initiator if a READ or WRITE command is issued.

Last Block Location

The block address associated with the current physical position; the next block to be transferred to the media and from the target's buffer. If the buffer is empty, or has only a partial block, the same value as first block location will be reported. The first block or filemark written onto the media is at address 0.

Number of Blocks in Buffer

The number of data blocks and filemarks in the target's buffer.

SCSI Interface

6.4 Tape Drive SCSI Commands

Number of Bytes in Buffer The number of data bytes and filemarks in the buffer that have not been written to the medium.

6.4.2.14 RECEIVE DIAGNOSTICS RESULTS (1Ch)

Figure 6–89 RECEIVE DIAGNOSTICS RESULTS CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (1Ch)							
	1	Logical Unit Number				Reserved			
	2	Reserved							
	3	(MSB) Allocation Length							
	4	(LSB)							
	5	Unused		Reserved				Flag	Link

RECEIVE DIAGNOSTIC RESULTS tells the drive to send analysis data to the initiator after completion of a SEND DIAGNOSTIC command. The following data will be returned by this command. A REQUEST SENSE command should be issued to obtain more detailed information following a CHECK CONDITION on a SEND DIAGNOSTIC command.

Figure 6–90 Receive Diagnostic Result Data Format

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Controller Present flag							
	1	Controller Error flag							
	2	Drive Present flag							
	3	Drive Error flag							
	4	Media Loader Present flag							
	5	Media Loader Error flag							

This information simply indicates which of the main components of the subsystem has failed testing.

6.4.2.15 RELEASE UNIT (17h)

Figure 6–91 RELEASE UNIT CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (17h)							
	1	Logical Unit Number			3rdPty	Third Party Device ID			Rsvd
	2	Reserved							
	3	Reserved							
	4	Reserved							
	5	Unused			Reserved			Flag	Link

RELEASE UNIT releases the drive if it is currently reserved by the requesting initiator.

It is not an error to attempt to release the drive if it is not currently reserved by the requesting initiator. However, if it reserved by other initiator, the drive is not released.

3rdPty

The third-party release option for RELEASE UNIT allows an initiator to release a logical unit that was previously reserved using the third-party reservation option. If the third-party (3rdPty) bit is 0, then the third-party release option is not requested. If the 3rdPty bit is 1, the drive is released if it was originally reserved by the same initiator using the third-party reservation option, and if the device is the same SCSI device that was specified in the third-party device ID field.

6.4.2.15.1 Medium Changer Considerations The optional element reservation feature defined for medium changer devices in SCSI-2 is not supported, so the RELEASE command is defined the same as for the tape drive: Only the whole loader unit can be released. Reserve/release of the loader and drive LUNs are handled independently.

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6.4 Tape Drive SCSI Commands

6.4.2.16 REQUEST SENSE (03h)

The REQUEST SENSE command implementation is dependent upon the type of firmware that is loaded in the THZ02 controller. Refer to Table 6–12 for the appropriate section for your type of code.

Table 6–12 Request Sense Command Sections

Code Type	Description	Section
Type 1	SCSI II	Section 6.4.2.16.1
Type 2	8mm emulation	Section 6.4.2.16.2
Type 3	AS400 attachment	Section 6.4.2.16.3

6.4.2.16.1 REQUEST SENSE — SCSI II REQUEST SENSE tells the target to transfer sense data to the initiator.

Figure 6–92 REQUEST SENSE CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (03h)							
	1	Logical Unit Number				Reserved			
	2	Reserved							
	3	Reserved							
	4	Allocation Length							
	5	Unused		Reserved				Flag	Link

The sense data is valid for a CHECK CONDITION or RESERVATION CONFLICT status returned on the previous command. The sense data bytes are preserved by the target until retrieved by the REQUEST SENSE command, or until the receipt of any other command from the same initiator.

If the drive receives an unsolicited REQUEST SENSE, then it returns sense data with the appropriate values in the EOM, sense key, additional sense code, and additional sense code qualifier. The positional information provided reflects the logical position of the drive. The drive returns information based on the (nondiagnostic) data still in its buffer as well as the data on tape.

REQUEST SENSE does not cause the drive to flush its buffered data to tape. Therefore, if the host requires the exact physical positioning of the media, it should precede the REQUEST SENSE with a WRITE FILEMARKS with length 0 (Immed = 0) command, which forces the drive to flush any currently buffered data to tape. A subsequent REQUEST SENSE will return the actual physical (and logical) position of the drive to the initiator.

Allocation Length

The allocation length specifies the maximum number of sense bytes to be returned. The drive terminates the transfer when allocation length bytes have been transferred or when all available sense data has been transferred to the host, whichever is less.

6.4.2.16.1.1 Sense Information Format

Figure 6–93 REQUEST SENSE Data

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Valid	Error Code						
	1	Segment Number							
	2	Filemkr	EOM	ILI	Reservd	Sense Key			
	3	(MSB)							
	4	Information Bytes							
	5								
	6								
	7	Additional Sense Length							
	8	(MSB)							
	9	Command Specific Information Bytes							
	10								
	11								
	12	Additional Sense Code							
	13	Additional Sense Code Qualifier							
	14	Sub-Assembly Code							
	15	SKSV	C/D	Reserved	BPV	Bit Pointer			
	16	(MSB)							
	17	Field Pointer							
	17								
18	Internal Status Code (VU)								

Valid

A Valid bit of 1 indicates that the information bytes contain valid information as defined in the SCSI specification.

Error-Code

A value of 70h indicates a current error — the report is associated with the most recently received command.

A value of 71h indicates a deferred error — the report is associated with a previous command and not as a result of the current command.

No other values will be returned.

Segment Number

This byte is always 0.

Filemark

This bit indicates that the current command has read a filemark.

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6.4 Tape Drive SCSI Commands

EOM

This bit indicates that an end-of-medium condition (end of partition or beginning of partition) exists. The warning is also given by setting the sense key to NO SENSE and the additional sense code qualifier to end of partition or beginning of partition.

For write-type operations, the drive returns a CHECK CONDITION on any operation which occurs after detection of the early warning EOP marker. The EOM and additional sense code fields will be set. For read-type operations, the drive does not return a CHECK CONDITION until the drive encounters the physical EOP.

ILI

The Incorrect Length Indicator bit indicates that the requested logical block length did not match the logical block length of the data on the tape. Only READ or VERIFY may cause this bit to be set.

Sense Key

In most cases, additional sense code and/or qualifier information is available. See the tables later in this section.

Information Bytes

These bytes contain the differences (residue) of the requested length minus the actual length in either bytes, blocks, or filemarks, as determined by the command. Negative values are indicated by two's complement notation. The bytes are valid for all read, write, space and verify tape commands for which a CHECK CONDITION status has been generated. The information bytes are 0 for MODE SELECT/SENSE, INQUIRY, READ BLOCK LIMITS and TEST UNIT READY.

Additional Sense Length

This specifies the number of additional sense bytes to follow. If the allocation length of the command descriptor block is too small to transfer all of the additional sense bytes, the additional sense length is not adjusted to reflect the truncation.

Command Specific Information Bytes

Command Specific bytes are handled as device specific and can be logged by the operating system on error conditions. On media errors, this usually contains the current SCSI logical block address.

Additional Sense Code (ASC) and ASC Qualifier

These two bytes provide additional information about the sense key and cause of the CHECK CONDITION status. See the tables later in this section.

Sub-Assembly Code

Unused at present, returned as 0.

Field Pointer Bytes

C/D — When set, indicates that the illegal parameter is in the CDB. A C/D of 0 indicates that the illegal parameter is in the parameter list from the initiator.

BPV — When the Bit Pointer Valid bit is set, it indicates that the bit pointer field is valid and designates which bit of the byte designated by the field pointer is in error. For a multi-bit field, it points to the most significant bit of the field.

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6.4 Tape Drive SCSI Commands

Field Pointer — Indicates which byte of the CDB or parameter list was in error. For a multi-byte field, the most significant byte is indicated.

Table 6–13 Sense Keys Used

Sense Key	Description
0h	No Sense. Check the filemark/EOM/ILI bits and the ASC/Q bytes.
1h	Recovered Error. This can be caused by rounding of mode parameters on a MODE SELECT, or to report that R/W error rates are reaching subsystem specification limits for optimal operation, however, the device may still be able to continue to function without any unrecovered errors for a long period of time.
2h	Not Ready. The media is not ready for tape operation commands. Media might not be present in the drive, or may be in the process of loading or calibrating.
3h	Medium Error. An unrecoverable write, read or positioning error has occurred. Detailed device specific information may be available.
4h	Hardware Error. The additional sense code/qualifier fields may provide more specific information.
5h	Illegal Request. The CDB or supplied parameter data had an unsupported or illegal operation specified. Check bytes 15, 16 and 17.
6h	Unit Attention. Unit attentions are created after a device reset, if the media asynchronously become ready to this initiator, if another initiator changes mode parameters, and if the firmware is updated.
7h	Data Protected. The current media is write protected. This can be due to the Write Protect switch on the cartridge, or if the media is not CompactTape III type.
8h	Blank Check. An EOD or LongGap has been encountered.
Bh	Command Aborted. Generated when a command has been aborted by the tape device for some reason. Check the ASC/Q bytes.
Dh	Volume Overflow. Physical end of media has been reached during writing. The initiator ignored the EOM condition and continued writing.
Eh	Miscompare. A compare error occurred during reading by the self-tests invoked during execution of a send diagnostic.

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6.4 Tape Drive SCSI Commands

Table 6–14 Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
00h		No additional sense code
	00h	No additional sense qualifier
	01h	Unexpected FM encountered
	02h	End of medium encountered
	03h	Setmark encountered
	04h	Beginning of medium encountered
	05h	EOD encountered
	06h	I/O process terminated
03h		Peripheral device write error
	00h	Peripheral device write fault
	01h	No write current
	02h	Excessive write errors
04h		Unit not ready
	00h	Cause nonreportable
	01h	Calibration in process
	02h	LOAD command needed
	03h	Manual intervention needed
05h	00h	LUN doesn't respond to selection
07h	00h	Multiple LUNs selected
08h	00h	LUN communications failure
	01h	LUN communications timeout
	02h	LUN communications parity error
0Ah	00h	Error log overflow
0Ch	00h	Write error
11h	00h	Unrecovered read error
	01h	Read retries exhausted
	02h	Error too long to correct
	03h	Multiple read errors
	08h	Incomplete block read
	09h	No gap found
	0Ah	Miscorrected error
14h	00h	Recorded entity not found
	01h	Filemark not found
	02h	FM or setmark not found
	03h	EOD blocks not found
	04h	Block sequence error
15h	00h	Random positioning error
	01h	Mech position error
	02h	Detected by read of media
17h	00h	Recovered data without ECC
	01h	With retries
18h	00h	Recovered ECC error
1Ah	00h	Parameter list length error
1Dh	00h	Miscompare during verify operation
20h	00h	Illegal opcode
21h	01h	Invalid element address
24h	00h	Invalid CDB field
	81h	Invalid mode on write buffer
	82h	Media in drive
	83h	Command queue not empty
	84h	Insufficient resources
	85h	Invalid buffer ID

(continued on next page)

Table 6–14 (Cont.) Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
	86h	Invalid offset
	87h	Invalid size
	88h	Out of sequence
	89h	Image data over limit
	8Ah	Update in progress
	8Bh	Image/personality is bad
	8Ch	Not immediate command
25h	00h	Illegal LUN
26h		Parameter list error
	00h	Invalid field
	01h	Parameter not supported
	02h	Parameter value invalid
27h	00h	Write protected
	80h	Hardware write protect
	81h	Software write protect
	82h	Data safety write protect
28h	00h	Not ready to ready
29h	00h	Reset occurred
2Ah	00h	Parameters changed
	01h	Mode parameters changed
	02h	Log parameters changed
2Bh	00h	Copy command without disconnect privilege
2Ch	00h	Command sequence error
2Fh	00h	Commands cleared by another initiator
30h	00h	Can't read medium
	01h	Unknown format
37h	00h	Rounded parameter
39h	00h	Saving parameters not supported
3Ah	00h	Media not present
	80h	VU cartridge missing
3Bh	00h	Sequential positioning error
	01h	Tape position error at BOM
	02h	Tape position error at EOM
	08h	Reposition error
	0Dh	Media destination element full
	0Eh	Media source element empty
3Dh	00h	Invalid bits in ID message
3Fh	00h	Target operating conditions changed
	01h	Microcode has been changed
	03h	Inquiry data has changed
40h	00h	Diagnostic/POST failed
	80h	ROM EDC failure
	81h	RAM failure
	82h	Bad drive status
	83h	Loader diags failed
43h	00h	Message error
44h	00h	Internal target failure
	80h	Unexpected select interrupt
	81h	EDC error detected by port
45h	00h	Select/reselect failure
47h	00h	SCSI parity error
48h	00h	IDE message received

(continued on next page)

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6.4 Tape Drive SCSI Commands

Table 6–14 (Cont.) Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
49h	00h	Invalid message error
4Ah	00h	Command phase error
4Bh	00h	Data phase error
4Eh	00h	Overlapped commands attempted
50h	00h	Write append error
	01h	Write append position error
	02h	Position error related to timing
51h	00h	Erase failure
52h	00h	Cartridge fault
53h	00h	Media load/eject failure
	01h	Unload tape failure
	02h	Media removal prevented
5Ah	00h	Operator request/state change input
	01h	Operator media removal request
	02h	Operator selected write protect
	03h	Operator selected write permit
5Bh	00h	Log exception
	01h	Threshold condition met
	02h	Log counter at maximum
	03h	Log list codes exhausted
80h	00h	Calibration error
81h	00h	Directory read error

6.4.2.16.2 REQUEST SENSE — 8mm Emulation REQUEST SENSE tells the target to transfer sense data to the initiator.

Figure 6–94 REQUEST SENSE CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (03h)							
	1	Logical Unit Number			Reserved				
	2	Reserved							
	3	Reserved							
	4	Allocation Length							
	5	Unused			Reserved			Flag	Link

The sense data is valid for a CHECK CONDITION or RESERVATION CONFLICT status returned on the previous command. The sense data bytes are preserved by the target until retrieved by the REQUEST SENSE command, or until the receipt of any other command from the same initiator.

If the drive receives an unsolicited REQUEST SENSE, then it returns sense data with the appropriate values in the EOM, sense key, additional sense code, and additional sense code qualifier. The positional information provided reflects the logical position of the drive. The drive returns information based on the (nondiagnostic) data still in its buffer as well as the data on tape.

REQUEST SENSE does not cause the drive to flush its buffered data to tape. Therefore, if the host requires the exact physical positioning of the media, it should precede the REQUEST SENSE with a WRITE FILEMARKS with length 0 (Immed =0) command, which forces the drive to flush any currently buffered data to tape. A subsequent REQUEST SENSE will return the actual physical (and logical) position of the drive to the initiator.

Allocation Length

The allocation length specifies the maximum number of sense bytes to be returned. The drive terminates the transfer when allocation length bytes have been transferred or when all available sense data has been transferred to the host, whichever is less.

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6.4 Tape Drive SCSI Commands

6.4.2.16.2.1 Sense Information Format

Figure 6–95 REQUEST SENSE Data

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Valid	Error Code						
	1	Reserved							
	2	Filemkr	EOM	ILI	Reservd	Sense Key			
	3	(MSB)							
	4								
	5	Information Bytes							
	6								(LSB)
	7	Additional Sense Length							
	8	(MSB)							
	9								
	10	Reserved							
	11								(LSB)
	12	Additional Sense Code							
	13	Additional Sense Code Qualifier							
	14	Reserved							
	15	Reserved							
	16	(MSB)							
	17	Read/Write Error Counter							
	18								(LSB)
	19	PF	BPE	FPE	ME	ECO	TME	TNP	BOT
	20	XFR	TMD	WP	FMKE	URE	WE1	SSE	FE
	21	Reserved					PEOT	WSEB	WSEO
	22	Reserved							
	23	(MSB)							
	24	Tape Remaining							
	25								(LSB)

Valid

A Valid bit of 1 indicates that the information bytes contain valid information as defined in the SCSI specification.

Error-Code

A value of 70h indicates a current error — the report is associated with the most recently received command.

A value of 71h indicates a deferred error — the report is associated with a previous command and not as a result of the current command.

No other values will be returned.

Filemark

This bit indicates that the current command has read a filemark.

EOM

This bit indicates that an end-of-medium condition (end of partition or beginning of partition) exists. The warning is also given by setting the sense key to NO SENSE and the additional sense code qualifier to end of partition or beginning of partition.

For write-type operations, the drive returns a CHECK CONDITION on any operation which occurs after detection of the early warning EOP marker. The EOM and additional sense code fields will be set. For read-type operations, the drive does not return a CHECK CONDITION until the drive encounters the physical EOP.

ILI

The Incorrect Length Indicator bit indicates that the requested logical block length did not match the logical block length of the data on the tape. Only READ or VERIFY may cause this bit to be set.

Sense Key

In most cases, additional sense code and/or qualifier information is available. See the tables later in this section.

Information Bytes

These bytes contain the differences (residue) of the requested length minus the actual length in either bytes, blocks, or filemarks, as determined by the command. Negative values are indicated by two's complement notation. The bytes are valid for all read, write, space and verify tape commands for which a CHECK CONDITION status has been generated. The information bytes are 0 for MODE SELECT/SENSE, INQUIRY, READ BLOCK LIMITS and TEST UNIT READY.

Additional Sense Length

This specifies the number of additional sense bytes to follow. If the allocation length of the command descriptor block is too small to transfer all of the additional sense bytes, the additional sense length is not adjusted to reflect the truncation.

Additional Sense Code (ASC) and ASC Qualifier

These two bytes provide additional information about the sense key and cause of the CHECK CONDITION status. See the tables later in this section.

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6.4 Tape Drive SCSI Commands

Table 6–15 Sense Keys Used

Sense Key	Description
0h	No Sense. Check the filemark/EOM/ILI bits and the ASC/Q bytes.
1h	Recovered Error. This can be caused by rounding of mode parameters on a MODE SELECT, or to report that R/W error rates are reaching subsystem specification limits for optimal operation, however, the device may still be able to continue to function without any unrecovered errors for a long period of time.
2h	Not Ready. The media is not ready for tape operation commands. Media might not be present in the drive, or may be in the process of loading or calibrating.
3h	Medium Error. An unrecoverable write, read or positioning error has occurred. Detailed device specific information may be available.
4h	Hardware Error. The additional sense code/qualifier fields may provide more specific information.
5h	Illegal Request. The CDB or supplied parameter data had an unsupported or illegal operation specified. Check bytes 15, 16 and 17.
6h	Unit Attention. Unit attentions are created after a device reset, if the media asynchronously become ready to this initiator, if another initiator changes mode parameters, and if the firmware is updated.
7h	Data Protected. The current media is write protected. This can be due to the Write Protect switch on the cartridge, or if the media is not CompactTape III type.
8h	Blank Check. An EOD or longgap has been encountered.
Bh	Command Aborted. Generated when a command has been aborted by the tape device for some reason. Check the ASC/Q bytes.
Dh	Volume Overflow. Physical end of media has been reached during writing. The initiator ignored the EOM condition and continued writing.
Eh	Miscompare. A compare error occurred during reading by the self-tests invoked during execution of a send diagnostic.

Table 6–16 Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
00h		No additional sense code
	00h	No additional sense qualifier
	01h	Unexpected FM encountered
	02h	End of medium encountered
	03h	Setmark encountered
	04h	Beginning of medium encountered
	05h	EOD encountered
	06h	I/O process terminated
03h		Peripheral device write error
	00h	Peripheral device write fault
	01h	No write current
	02h	Excessive write errors
04h		Unit not ready
	00h	Cause nonreportable
	01h	Calibration in process
	02h	LOAD command needed
	03h	Manual intervention needed

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Table 6–16 (Cont.) Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
05h	00h	LUN doesn't respond to selection
07h	00h	Multiple LUNs selected
08h	00h	LUN communications failure
	01h	LUN communications timeout
	02h	LUN communications parity Error
0Ah	00h	Error log overflow
0Ch	00h	Write error
11h	00h	Unrecovered read error
	01h	Read retries exhausted
	02h	Error too long to correct
	03h	Multiple read errors
	08h	Incomplete block read
	09h	No gap found
	0Ah	Miscorrected error
14h	00h	Recorded entity not found
	01h	Filemark not found
	02h	FM or setmark not found
	03h	EOD blocks not found
	04h	Block sequence error
15h	00h	Random positioning error
	01h	Mech position error
	02h	Detected by read of media
17h	00h	Recovered data without ECC
	01h	With retries
18h	00h	Recovered ECC error
1Ah	00h	Parameter list length error
1Dh	00h	Miscompare during verify operation
20h	00h	Illegal opcode
21h	01h	Invalid element address
24h	00h	Invalid CDB field
	81h	Invalid mode on write buffer
	82h	Media in drive
	83h	Command queue not empty
	84h	Insufficient resources
	85h	Invalid buffer ID
	86h	Invalid offset
	87h	Invalid size
	88h	Out of sequence
	89h	Image data over limit
	8Ah	Update in progress
	8Bh	Image/personality is bad
	8Ch	Not immediate command
25h	00h	Illegal LUN
26h		Parameter list error
	00h	Invalid field
	01h	Parameter not supported
	02h	Parameter value invalid
27h	00h	Write protected
	80h	Hardware write protect
	81h	Software write protect
	82h	Data safety write protect
28h	00h	Not ready to ready

(continued on next page)

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6.4 Tape Drive SCSI Commands

Table 6–16 (Cont.) Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
29h	00h	Reset occurred
2Ah	00h	Parameters changed
	01h	Mode parameters changed
	02h	Log parameters changed
2Bh	00h	Copy command without disconnect privilege
2Ch	00h	Command sequence error
2Fh	00h	Commands cleared by another initiator
30h	00h	Can't read medium
	01h	Unknown format
37h	00h	Rounded parameter
39h	00h	Saving parameters not supported
3Ah	00h	Media not present
	80h	VU cartridge missing
3Bh	00h	Sequential positioning error
	01h	Tape position error at BOM
	02h	Tape position error at EOM
	08h	Reposition error
	0Dh	Media destination element full
	0Eh	Media source element empty
3Dh	00h	Invalid bits in ID message
3Fh	00h	Target operating conditions changed
	01h	Microcode has been changed
	03h	Inquiry data has changed
40h	00h	Diagnostic/POST failed
	80h	ROM EDC failure
	81h	RAM failure
	82h	Bad drive status
	83h	Loader diags failed
43h	00h	Message error
44h	00h	Internal target failure
	80h	Unexpected select interrupt
	81h	EDC error detected by port
45h	00h	Select/reselect failure
47h	00h	SCSI parity error
48h	00h	IDE message received
49h	00h	Invalid message error
4Ah	00h	Command phase error
4Bh	00h	Data phase error
4Eh	00h	Overlapped commands attempted
50h	00h	Write append error
	01h	Write append position error
	02h	Position error related to timing
51h	00h	Erase failure
52h	00h	Cartridge fault
53h	00h	Media load/eject failure
	01h	Unload tape failure
	02h	Media removal prevented
5Ah	00h	Operator request/state change input
	01h	Operator media removal request
	02h	Operator selected write protect
	03h	Operator selected write permit
5Bh	00h	Log exception

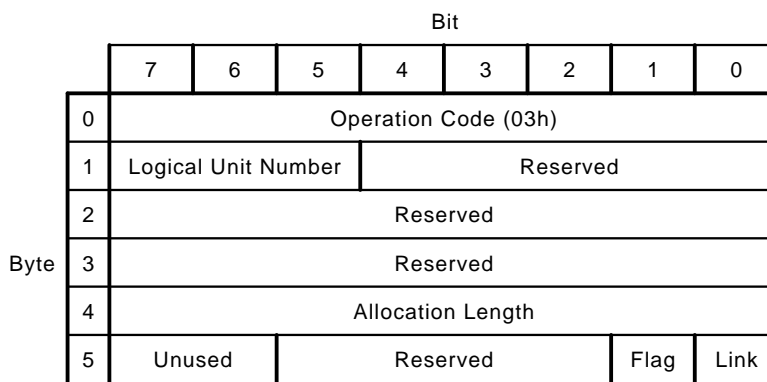
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Table 6–16 (Cont.) Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
	01h	Threshold condition met
	02h	Log counter at maximum
	03h	Log list codes exhausted
80h	00h	Calibration error
81h	00h	Directory read error

6.4.2.16.3 REQUEST SENSE — AS400 Attachment REQUEST SENSE tells the target to transfer sense data to the initiator.

Figure 6–96 REQUEST SENSE CDB



The sense data is valid for a CHECK CONDITION or RESERVATION CONFLICT status returned on the previous command. The sense data bytes are preserved by the target until retrieved by the REQUEST SENSE command, or until the receipt of any other command from the same initiator.

If the drive receives an unsolicited REQUEST SENSE, then it returns sense data with the appropriate values in the EOM, sense key, additional sense code, and additional sense code qualifier. The positional information provided reflects the logical position of the drive. The drive returns information based on the (nondiagnostic) data still in its buffer as well as the data on tape.

REQUEST SENSE does not cause the drive to flush its buffered data to tape. Therefore, if the host requires the exact physical positioning of the media, it should precede the REQUEST SENSE with a WRITE FILEMARKS with length 0 (Immed=0) command, which forces the drive to flush any currently buffered data to tape. A subsequent REQUEST SENSE will return the actual physical (and logical) position of the drive to the initiator.

Allocation Length

The allocation length specifies the maximum number of sense bytes to be returned. The drive terminates the transfer when allocation length bytes have been transferred or when all available sense data has been transferred to the host, whichever is less.

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6.4 Tape Drive SCSI Commands

6.4.2.16.3.1 Sense Information Format

Figure 6–97 REQUEST SENSE Data

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Valid	Error Code						
	1	Reserved							
	2	Filemkr	EOM	ILI	Reservd	Sense Key			
	3	(MSB)							
	4								
	5	Information Bytes							
	6								(LSB)
	7	Additional Sense Length							
	8	(MSB)							
	9								
	10	Reserved							
	11								(LSB)
	12	Additional Sense Code							
	13	Additional Sense Code Qualifier							
	14	Reserved							
	15	Reserved							
	16	(MSB)							
	17	Read/Write Error Counter							
	18								(LSB)
	19	PF	BPE	FPE	ME	ECO	TME	TNP	BOT
	20	XFR	TMD	WP	FMKE	URE	WE1	SSE	FE
	21	Reserved					PEOT	WSEB	WSEO
	22	Reserved							
	23	(MSB)							
	24	Tape Remaining							
	25								(LSB)

Valid

A Valid bit of 1 indicates that the information bytes contain valid information as defined in the SCSI specification.

Error-Code

A value of 70h indicates a current error — the report is associated with the most recently received command.

A value of 71h indicates a deferred error — the report is associated with a previous command and not as a result of the current command.

No other values will be returned.

Filemark

This bit indicates that the current command has read a filemark.

EOM

This bit indicates that an end-of-medium condition (end of partition or beginning of partition) exists. The warning is also given by setting the sense key to NO SENSE and the additional sense code qualifier to end of partition or beginning of partition.

For write-type operations, the drive returns a CHECK CONDITION on any operation which occurs after detection of the early warning EOP marker. The EOM and additional sense code fields will be set. For read-type operations, the drive does not return a CHECK CONDITION until the drive encounters the physical EOP.

ILI

The Incorrect Length Indicator bit indicates that the requested logical block length did not match the logical block length of the data on the tape. Only READ or VERIFY may cause this bit to be set.

Sense Key

In most cases, additional sense code and/or qualifier information is available. See the tables later in this section.

Information Bytes

These bytes contain the differences (residue) of the requested length minus the actual length in either bytes, blocks, or filemarks, as determined by the command. Negative values are indicated by two's complement notation. The bytes are valid for all read, write, space and verify tape commands for which a CHECK CONDITION status has been generated. The information bytes are 0 for MODE SELECT/SENSE, INQUIRY, READ BLOCK LIMITS and TEST UNIT READY.

Additional Sense Length

This specifies the number of additional sense bytes to follow. If the allocation length of the command descriptor block is too small to transfer all of the additional sense bytes, the additional sense length is not adjusted to reflect the truncation.

Additional Sense Code (ASC) and ASC Qualifier

These two bytes provide additional information about the sense key and cause of the CHECK CONDITION status. See the tables later in this section.

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6.4 Tape Drive SCSI Commands

Table 6–17 Sense Keys Used

Sense Key	Description
0h	No Sense. Check the filemark/EOM/ILI bits and the ASC/Q bytes.
1h	Recovered Error. This can be caused by rounding of mode parameters on a MODE SELECT, or to report that R/W error rates are reaching subsystem specification limits for optimal operation, however, the device may still be able to continue to function without any unrecovered errors for a long period of time.
2h	Not Ready. The media is not ready for tape operation commands. Media might not be present in the drive, or may be in the process of loading or calibrating.
3h	Medium Error. An unrecoverable write, read or positioning error has occurred. Detailed device specific information may be available.
4h	Hardware Error. The additional sense code/qualifier fields may provide more specific information.
5h	Illegal Request. The CDB or supplied parameter data had an unsupported or illegal operation specified. Check bytes 15, 16 and 17.
6h	Unit Attention. Unit attentions are created after a device reset, if the media asynchronously become ready to this initiator, if another initiator changes mode parameters, and if the firmware is updated.
7h	Data Protected. The current media is write protected. This can be due to the Write Protect switch on the cartridge, or if the media is not CompactTape III type.
8h	Blank Check. An EOD or longgap has been encountered.
Bh	Command Aborted. Generated when a command has been aborted by the tape device for some reason. Check the ASC/Q bytes.
Dh	Volume Overflow. Physical end of media has been reached during writing. The initiator ignored the EOM condition and continued writing.
Eh	Miscompare. A compare error occurred during reading by the self-tests invoked during execution of a send diagnostic.

Table 6–18 Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
00h		No additional sense code
	00h	No additional sense qualifier
	01h	Unexpected FM encountered
	02h	End of medium encountered
	03h	Setmark encountered
	04h	Beginning of medium encountered
	05h	EOD encountered
	06h	I/O process terminated
03h		Peripheral device write error
	00h	Peripheral device write fault
	01h	No write current
	02h	Excessive write errors
04h		Unit not ready
	00h	Cause nonreportable
	01h	Calibration in process
	02h	LOAD command needed
	03h	Manual intervention needed

(continued on next page)

Table 6–18 (Cont.) Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
05h	00h	LUN doesn't respond to selection
07h	00h	Multiple LUNs selected
08h	00h	LUN communications failure
	01h	LUN communications timeout
	02h	LUN communications parity error
0Ah	00h	Error log overflow
0Ch	00h	Write error
11h	00h	Unrecovered read error
	01h	Read retries exhausted
	02h	Error too long to correct
	03h	Multiple read errors
	08h	Incomplete block read
	09h	No gap found
	0Ah	Miscorrected error
14h	00h	Recorded entity not found
	01h	Filemark not found
	02h	FM or setmark not found
	03h	EOD blocks not found
	04h	Block sequence error
15h	00h	Random positioning error
	01h	Mech position error
	02h	Detected by read of media
17h	00h	Recovered data without ECC
	01h	With retries
18h	00h	Recovered ECC error
1Ah	00h	Parameter list length error
1Dh	00h	Miscompare during verify operation
20h	00h	Illegal opcode
21h	01h	Invalid element address
24h	00h	Invalid CDB field
	81h	Invalid mode on write buffer
	82h	Media in drive
	83h	Command queue not empty
	84h	Insufficient resources
	85h	Invalid buffer ID
	86h	Invalid offset
	87h	Invalid size
	88h	Out of sequence
	89h	Image data over limit
	8Ah	Update in progress
	8Bh	Image/personality is bad
	8Ch	Not immediate command
25h	00h	Illegal LUN
26h		Parameter list error
	00h	Invalid field
	01h	Parameter not supported
	02h	Parameter value invalid
27h	00h	Write protected
	80h	Hardware write protect
	81h	Software write protect
	82h	Data safety write protect
28h	00h	Not ready to ready

(continued on next page)

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6.4 Tape Drive SCSI Commands

Table 6–18 (Cont.) Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
29h	00h	Reset occurred
2Ah	00h	Parameters changed
	01h	Mode parameters changed
	02h	Log parameters changed
2Bh	00h	Copy command without disconnect privilege
2Ch	00h	Command sequence error
2Fh	00h	Commands cleared by another initiator
30h	00h	Can't read medium
	01h	Unknown format
37h	00h	Rounded parameter
39h	00h	Saving parameters not supported
3Ah	00h	Media not present
	80h	VU cartridge missing
3Bh	00h	Sequential positioning error
	01h	Tape position error at BOM
	02h	Tape position error at EOM
	08h	Reposition error
	0Dh	Media destination element full
	0Eh	Media source element empty
3Dh	00h	Invalid bits in ID message
3Fh	00h	Target operating conditions changed
	01h	Microcode has been changed
	03h	Inquiry data has changed
40h	00h	Diagnostic/POST failed
	80h	ROM EDC failure
	81h	RAM failure
	82h	Bad drive status
	83h	Loader diags failed
43h	00h	Message error
44h	00h	Internal target failure
	80h	Unexpected select interrupt
	81h	EDC error detected by port
45h	00h	Select/reselect failure
47h	00h	SCSI parity error
48h	00h	IDE message received
49h	00h	Invalid message error
4Ah	00h	Command phase error
4Bh	00h	Data phase error
4Eh	00h	Overlapped commands attempted
50h	00h	Write append error
	01h	Write append position error
	02h	Position error related to timing
51h	00h	Erase failure
52h	00h	Cartridge fault
53h	00h	Media load/eject failure
	01h	Unload tape failure
	02h	Media removal prevented
5Ah	00h	Operator request/state change input
	01h	Operator media removal request
	02h	Operator selected write protect
	03h	Operator selected write permit
5Bh	00h	Log exception

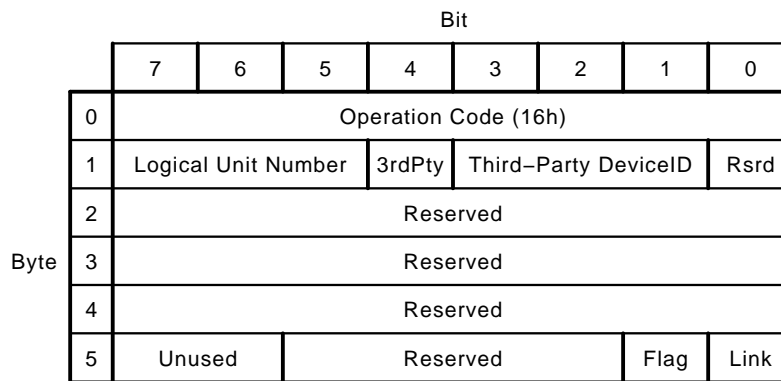
(continued on next page)

Table 6–18 (Cont.) Additional Sense Codes/Qualifiers Used

ASC	ASCQ	Description
	01h	Threshold condition met
	02h	Log counter at maximum
	03h	Log list codes exhausted
80h	00h	Calibration error
81h	00h	Directory read error

6.4.2.17 RESERVE UNIT (16h)

Figure 6–98 RESERVE UNIT CDB



RESERVE UNIT reserves the specified drive for exclusive use by the requesting initiator or for another specified SCSI device. The reservation remains in effect until one of the following conditions is met:

- The initiator that made the reservation sends another RESERVE UNIT command.
- The drive is released by RELEASE UNIT from the same initiator.
- A BUS DEVICE RESET message is received from any initiator.
- A hard reset occurs.

The occurrence of the last two conditions is indicated by the drive returning a CHECK CONDITION status with a sense key of UNIT ATTENTION on the next command following the condition. It is not an error to issue RESERVE UNIT to a drive that is currently reserved to the requesting initiator.

If the logical unit has previously been reserved by another initiator, the target returns a RESERVATION CONFLICT status.

If, after honoring the reservation, any other initiator attempts to perform any command except INQUIRY, REQUEST SENSE, or RELEASE UNIT, the command is rejected with a RESERVATION CONFLICT status. A RELEASE UNIT command issued by another initiator is ignored by that reserved logical unit.

SCSI Interface

6.4 Tape Drive SCSI Commands

3rdPty

The third-party reservation option for RESERVE UNIT allows an initiator to reserve a logical unit for another SCSI device. This option is intended for systems that use COPY, and is implemented by the drive.

If the third-party (3rdPty) bit is 0, then the third-party reservation option is not requested. If the 3rdPty bit is 1, RESERVE UNIT reserves the logical unit for the SCSI device specified in the third-party device ID field. The drive preserves the reservation until any one of the four conditions mentioned above occurs. The drive ignores any attempt made by any other initiator to release the reservation and returns a GOOD status.

An initiator that holds a current reservation may modify that reservation (for example, to switch third-parties) by issuing another RESERVE UNIT to the drive.

6.4.2.17.1 Medium Changer Considerations The optional element reservation feature defined for medium changer devices in SCSI-2 is not supported, so the RESERVE command is defined the same as for the tape drive: Only the whole loader unit can be reserved. This is separate from a reservation of the tape drive.

The RESERVE/RELEASE commands operate on a LUN basis; so the medium changer and tape drive are generally handled as different devices. But in the case of a reserved drive LUN, a MOVE MEDIUM command issued to the loader LUN can **not** insert/remove a cartridge on the drive, unless the drive is reserved by the same initiator.

6.4.2.18 REWIND (01h)

Figure 6–99 REWIND CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (01h)							
	1	Logical Unit Number			Reserved				Immed
	2	Reserved							
	3	Reserved							
	4	Reserved							
	5	Unused	Reserved				Flag	Link	

REWIND tells the drive to position the tape at the beginning of the currently active partition. Before rewinding, the drive writes any write data that is buffered to the tape, and appends an EOD marker.

Immed

If the Immed (immediate) bit is set, the drive first writes any remaining buffered data to tape followed by an EOD marker. It then returns status to the host before beginning the actual rewind operation. If the Immed bit is not set, status will be returned after the rewind has completed.

6.4.2.19 SEND DIAGNOSTIC (1Dh)

Figure 6–100 SEND DIAGNOSTIC CDB

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	Operation Code (1Dh)								
	1	Logical Unit Number			PF	Rsv'd	Selfst	Dev OfL	UnitOfL	
	2	Reserved								
	3	(MSB)	Parameter List Length							
	4								(LSB)	
	5	Unused	Reserved				Flag	Link		

SEND DIAGNOSTIC tells the drive to perform diagnostic tests on itself.

The page format field is not supported and must be 0.

Two separate types of unit resident tests can be accessed:

- **Electronics Self-Test** — (level 1 test) In order for for the diagnostic to be invoked, a good portion of the controller hardware and software must be functioning properly. This is the premise this test is based on: that full power-up testing is not necessary. Therefore, this test does an extension of the power-up self-tests. The code ROM EDC is verified, two queues used by much of the controller software is checked by dequeuing and enqueueing items. If there is a loader attached, a software reset is done on it. This test does not attempt to write or read data to or from media. When complete, any errors are posted in the extended sense data bytes. This test has an execution time of approximately 5 seconds.

This test is specified by setting just the Selftest bit (Dev OfL, and UnitOfL both 0).

- **Write/Read Functionality Test** — (level 2 test) The level 2 test for the THZ02 is a NOP. GOOD status will be returned if this is requested, but no test will be performed.

If the specified test passes, a GOOD status is returned. Otherwise, a CHECK CONDITION is generated, and the sense data will contain information about the failure.

Table 6–19 Sense Keys Used

Sense Key	Description
3h	Medium Error. A positioning error has occurred where the returned position does not match the expected.
4h	Hardware Error. The additional sense code/qualifier fields will provide more specific information.
5h	Illegal Request. Illegal bit settings in the SEND DIAGNOSTIC command.
Eh	Miscompare. A compare error occurred during a read.

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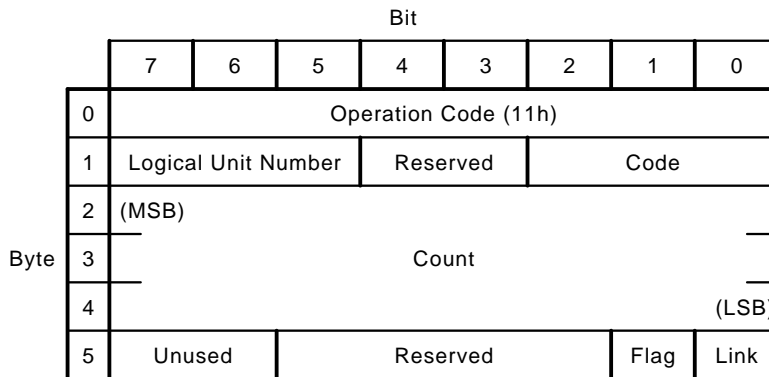
6.4 Tape Drive SCSI Commands

Table 6–20 Additional Sense Codes

Additional Sense Code	Additional Sense Qualifier	Description
15h	2h	A positioning error has occurred where the returned position does not match the expected.
40h	80h	Level 1 ROM test failed.
40h	81h	Level 1 RAM test failed.
40h	82h	Level 1 test failed. Bad drive status.
40h	83h	Level 1 test failed. Loader reset failed.

6.4.2.20 SPACE (11h)

Figure 6–101 SPACE CDB



SPACE provides a variety of positioning functions that are determined by code and count fields in the command descriptor block. Both forward (towards EOM/P) and reverse (towards BOM/P) positioning are provided.

Code

The code is defined as follows:

Figure 6–102 SPACE Code Definition

Space Code	Space by:
0	Blocks
1	Filemarks
2	Sequential Filemarks
3	End-of-Data

Spacing by sequential filemarks is supported for count values of 0, 1 and 2 only.

Count

When spacing over blocks or marks, the count field is interpreted as follows:

- A positive value *n* causes forward movement over *n* blocks or marks. The tape is logically positioned after the *n*th block or mark on the EOM/P side.
- A 0 value causes no change in the logical position.
- A negative value *-n* (two's complement notation) causes reverse movement over *n* blocks or marks. The tape is logically positioned on the BOM/P side of the *n*th block or mark.
- When spacing to EOD, the count field is ignored. Forward movement occurs until the drive encounters EOD. The position is such that a subsequent WRITE command would append data after the last object that has been written to tape before EOD.

When executing SPACE, the drive implements the following hierarchy:

Blocks — lowest
Filemarks
EOD
BOM/P or EOM/P — highest

Therefore, SPACE *n* blocks will halt with GOOD status after the *n*th block, or with CHECK CONDITION status on any occurrence of filemark, EOD, BOM/P, or EOM/P. A space *n* filemarks will halt on the *n*th filemark or on any occurrence of EOD, BOM/P or EOM/P, and so on.

Depending on the size of blocks, read ahead data in the buffer allows some spacing requests to be satisfied without tape movement.

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6.4 Tape Drive SCSI Commands

6.4.2.21 TEST UNIT READY (00h)

Figure 6–103 TEST UNIT READY CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (00h)							
	1	Logical Unit Number			Reserved				
	2	Reserved							
	3	Reserved							
	4	Reserved							
	5	Unused			Reserved			Flag	Link

TEST UNIT READY checks if the drive unit is ready for commands involving tape movement. If the drive has a tape loaded, the command returns a GOOD status. Otherwise, CHECK CONDITION is reported.

6.4.2.21.1 Medium Changer Considerations When directed at the media loader LUN, this command will return CHECK CONDITION sense key of not ready if:

- The keyswitch is in the Service position, and there is no 24 volts signal (usually means that the loader assembly has been moved out of its sleeve enough to trip the 24 V interlock.

6.4.2.22 VERIFY (13h)

Figure 6–104 VERIFY CDB

		Bit								
		7	6	5	4	3	2	1	0	
Byte	0	Operation Code (13h)								
	1	Logical Unit Number			Reserved		Immed	BC	Fixed	
	2	(MSB)								
	3	Verification Length								
	4									(LSB)
	5	Unused			Reserved			Flag	Link	

VERIFY verifies one or more blocks beginning with the next block on the tape. Both CRC and EDCs are validated.

Immed

If this bit is set, the VERIFY command will complete before any media movement is done (for example, when processing has been initiated).

BC

This bit selects an CRC/ECC verification or a byte-by-byte compare. If the BC bit is cleared, device is instructed to perform an internal CRC/ECC check of the data.

If this bit is set the command will be rejected.

Fixed

This bit operates in the same fashion as with the READ command.

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6.4 Tape Drive SCSI Commands

6.4.2.23 WRITE (0Ah)

Figure 6–105 WRITE CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (0Ah)							
	1	Logical Unit Number			Reserved				Fixed
	2	(MSB)							
	3	Transfer Length							
	4	(LSB)							
	5	Unused		Reserved				Flag	Link

WRITE transfers one or more blocks from the host to the current logical position. When in buffered mode (see MODE SELECT), the tape drive reports a GOOD status on WRITE commands as soon as this data block has been transferred to the data buffer.

The drive flushes the write buffer to tape under the following conditions:

- The write hold-off time limit is exceeded. (See MODE SELECT command.)
- Receipt of the following nonwrite commands:
 - LOAD-UNLOAD
 - REWIND
 - ERASE
 - LOCATE
- A WRITE FILEMARKS command with the Immediate bit cleared.

If buffered mode is not selected, the buffer will flush after every write-type command. Buffered mode can be configured through MODE SELECT, and if it is not used, the tape drive suffers a significant degradation in performance with respect to transfer rate and therefore loss of streaming.

FIXED

The Fixed bit specifies both the meaning of the transfer length field and whether fixed-length or variable-length blocks are to be transferred. If the Fixed bit is set to 0, variable block mode is selected. A single block is transferred from the initiator and is written to the logical unit beginning at the current logical tape position. Upon successful termination, the tape is logically positioned after this block (EOM/P side). The transfer length specifies the number of bytes that the drive handshakes out from the initiator.

If the Fixed bit is set to 1, the transfer length field specifies the number of blocks to be transferred to the host beginning at the current tape position. This form of WRITE is valid only if the logical unit is currently operating in fixed block mode, in other words, when it has been instructed to use fixed-length blocks with MODE SELECT. The current block length is the block length defined in the MODE SELECT command. Upon termination, the tape is logically positioned after these blocks.

Transfer Length

This field contains the length of the data transfer in bytes or blocks, depending on whether fixed or variable block mode is selected.

If the transfer length is 0, no data is transferred and the current position on the logical unit is not changed.

Exception Conditions

If EOT is detected while writing, the drive will finish writing any buffered data. The command terminates with CHECK CONDITION status. Within the sense data, the EOM bit is set, the sense key field is set to NO SENSE, and the additional sense code and additional sense code qualifier fields are set to EOM/P detected. The drive attempts to complete any subsequent writes, returning a CHECK CONDITION status in each case.

If the drive encounters the physical EOM when attempting write, CHECK CONDITION status is returned. Within the sense data, the EOM and Valid bits are set, and the sense key field is set to MEDIUM ERROR. The information fields contain the residue count and the additional sense code and additional sense code qualifier fields are set to EOM/P detected. The tape is physically positioned at EOM/P.

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6.4 Tape Drive SCSI Commands

6.4.2.24 WRITE BUFFER (3Bh)

Figure 6–106 WRITE BUFFER CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (3Bh)							
	1	Logical Unit Number			Reserved			Mode	
	2	Buffer ID (00h)							
	3	(MSB)							
	4	Buffer Offset (000000h)							
	5	(LSB)							
	6	(MSB)							
	7	Parameter List/Data Length							
	8	(LSB)							
	9	Unused	Reserved				Flag	Link	

WRITE BUFFER is used in conjunction with READ BUFFER as a diagnostic function for testing the device data buffer, DMA engine, SCSI bus interface hardware, and the SCSI bus integrity. It is also used for downloading and updating controller microcode (firmware).

Mode

The drive supports the following values within the field. If any other value is set, the drive terminates the command with a CHECK CONDITION status and an ILLEGAL REQUEST sense key set.

Figure 6–107 WRITE BUFFER Modes Supported

Mode	Description
000b	Write combined header and data
010b	Write data
100b	Download Microcode
101b	Download Microcode and Save

For all modes, only a buffer ID of 0 is supported. If the buffer ID field is non-0, the command will be rejected. The target detects and rejects commands that would overrun the buffer.

6.4.2.24.1 Header and Data Mode The data to be transferred is preceded by a 4-byte header consisting entirely of reserved bytes. This header is discarded (not stored into the buffer). The buffer offset field must be 0 for this mode.

6.4.2.24.2 Write Data Similar to mode 000b, except there is no header in the data passed to the target. The buffer offset must be 0. Potential buffer overruns are detected and the command rejected.

6.4.2.24.3 Download Microcode Using buffer offsets, the host can download the firmware image into the target's buffer in pieces. These commands do not cause the new image to become active — a download and save mode WRITE BUFFER command must be issued.

The tape drive must be empty to allow downloading of an image. This is to safeguard against accidentally starting a firmware update. If a cartridge is loaded when all or part of a firmware image has been downloaded, another WRITE BUFFER with download mode will be rejected. Overlapping or nonconsecutive downloading of the image data is not supported. The firmware image must be downloaded in integral multiples of 4k bytes.

Any error on a WRITE BUFFER command causes any downloaded image data to be discarded, and the download must be restarted from the beginning.

6.4.2.24.4 Download Microcode and Save This mode can be used to download and save the entire image at once, or to download the image data and save it, or to cause a save operation after all the image data has been downloaded using the download only mode. This mode of the command causes the image data to be verified and the flash EEPROM firmware area to be updated. During the reprogramming, the Write Protect and Drive Activity LEDs on the drive's front panel will blink.

Note

During the actual reprogramming of the FLASH memory chips, if any type of powerfail occurs, or if the reprogramming fails part way through, the subsystem will be unusable, and the controller board will need to be replaced.

When the save operation is successfully completed, the firmware restarts itself, causing POST to be rerun, and two unit attention conditions are generated: power-up reset, and operating code has changed.

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6.4 Tape Drive SCSI Commands

6.4.2.25 WRITE FILEMARKS (10h)

Figure 6–108 WRITE FILEMARKS CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (10h)							
	1	Logical Unit Number			Reserved			WSmk	Immed
	2	(MSB)							
	3	Number of Filemarks							
	4								
	5	Unused		Reserved			Flag	Link	

WRITE FILEMARKS causes the specified number of filemarks to be written beginning at the current logical position on tape. If the Immed bit is not set, any data or filemarks in the write cache buffer are written to tape.

WSmk

If this bit is set, the tape drive writes a save-set mark to tape instead of a filemark. Since setmarks are not supported by the THZ02, this field must be 0.

Immed

If this bit is set, the drive returns status as soon as the command descriptor block has been validated, unless the filemark count is 0, or greater than 1 (since both cause the write buffer to be flushed to media — see below).

An Immed bit of 0 indicates that the status will not be returned until the operation is complete.

Number of Filemarks

This is the number of consecutive marks to be written to tape. A value of 0 is not considered an error and GOOD status is returned.

This command may be used to force the drive to write any buffered write data to the tape. If the drive is in buffered mode, and WRITE FILEMARKS is received the requested filemarks are appended to the data, and the write buffer is flushed to tape. A 0 value in the number of filemarks field indicates that no filemarks are to be written to the tape, but still flushes any write data to tape.

If EOT is detected while writing filemarks, the drive finishes writing any buffered data and terminates with CHECK CONDITION status. Within the sense data, the EOM bit is set, the sense key field is set to NO SENSE and the additional sense code and additional sense code qualifier fields are set to EOM/P detected. The drive will attempt to complete any subsequent WRITE FILEMARKS, returning a CHECK CONDITION status in each case. If the drive encounters the physical EOM when attempting a WRITE FILEMARKS, CHECK CONDITION status is returned.

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5 Supported SCSI-2 Medium Changer Device Commands

On the medium changer LUN, only commands defined for this device type are allowed. The following commands are implemented:

Table 6–21 SCSI-2 Medium Changer Commands

Opcode	Command
07 ¹	INITIALIZE ELEMENT STATUS
12	INQUIRY
15 ²	MODE SELECT
1A ²	MODE SENSE
A5 ¹	MOVE MEDIUM
3C	READ BUFFER
B8 ¹	READ ELEMENT STATUS
1C	RECEIVE DIAG RESULTS
17	RELEASE
03	REQUEST SENSE
16	RESERVE
1D	SEND DIAGNOSTIC
00	TEST UNIT READY
3B	WRITE BUFFER

¹Medium changer specific commands

²Commands with significant medium changer specific content

The rest of this chapter covers medium changer unique commands.

Medium changer element address assignment is as follows:

Table 6–22 Medium Changer Element Addresses

Address	Comments
0	Default medium transport element
1	Medium transport element
2-0Fh	Reserved
10h	Data transfer element (tape drive)
11h-0FFh	reserved
100h	Medium storage element (Magazine slot 0)
101h	Medium storage element (Magazine slot 1)
102h	Medium storage element (Magazine slot 2)
103h	Medium storage element (Magazine slot 3)
104h	Medium storage element (Magazine slot 4)
105h	Medium storage element (Magazine slot 5)
106h	Medium storage element (Magazine slot 6)
107h-0FFFFh	Reserved

SCSI Interface

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.1 INITIALIZE ELEMENT STATUS (07h)

Figure 6–109 INITIALIZE ELEMENT STATUS CDB

		Bit							
		7	6	5	4	3	2	1	0
Byte	0	Operation Code (07h)							
	1	Logical Unit Number				Reserved			
	2	Reserved							
	3	Reserved							
	4	Reserved							
	5	Unused		Reserved				Flag	Link

This command is a NOP on the THZ02, since it always maintains a table of the current state of loader elements.

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.2 READ ELEMENT STATUS (B8h)

Figure 6–110 READ ELEMENT STATUS CDB

		Bit								
		7	6	5	4	3	2	1	0	
0	Operation Code (B8h)									
1	Logical Unit Number	VolTag			Element Type Code					
2	(MSB)	Starting Element Address							(LSB)	
3										
4	(MSB)	Number of Elements							(LSB)	
5										
6	Reserved									
7	(MSB)	Allocation Length							(LSB)	
8										
9										
10	Reserved									
11	Unused	Reserved					Flag	Link		

Figure 6–111 Element Type Code Definitions

Code	Description
0h	All element types reported (valid in CDB only)
1h	Medium Transport Element
2h	Storage Element (magazine slot)
3h	Import Export Element (not supported)
4h	Data Transfer Element (tape drive)
5h–Fh	reserved

The format of element status data is defined in the SCSI-2 specification. The following sections show the information returned for the THZ02. The element status data is made up of a header, and one or more status pages (for each element type). The status pages are made up of a header and one or more element descriptors (one for each element address). The data shown assumes the CDB was specified in such a way that all descriptors for a given element type would be returned.

The primary and alternate volume tag functions are not supported, so the flags indicating these functions in the element status pages (below) are always set to 0.

SCSI Interface

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.2.1 Element Status Data Header

Figure 6–112 Element Status Data Header

		Bit							
		7	6	5	4	3	2	1	0
0	(MSB)	First Element Address Reported							
1									
2	(MSB)	Number of Elements Reported							
3									
4		Reserved							
5	(MSB)	Byte Count of Report Available							
6									
7									

SCSI Interface

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.2.2 Medium Transport Element Status Page

Figure 6–113 Medium Transport Element Status Page

		Bit							
		7	6	5	4	3	2	1	0
0	Element Type Code (1 = Medium Transport)								
1	PVolTag	AVolTag	Reserved						
2	(MSB) _____								
3	Transport Element Descriptor Length (06h) _____								
	(LSB)								
4	Reserved								
5	(MSB) _____								
6	Byte Count of Descriptor Data Available (06h) _____								
7	(LSB)								

Descriptor:

8	(MSB) _____								
9	Transport Element Address (1h) _____								
	(LSB)								
10	Reserved						Except	rsvd	Full
11	Reserved								
12	Additional Sense Code								
13	Additional Sense Code Qualifier								
14	Reserved								
15	Reserved								
16	Reserved								
17	SValid	Invert	Reserved						
18	(MSB) _____								
19	Source Element Address _____								
	(LSB)								
20	Reserved								
21	Reserved								
22	Reserved								
23	Reserved								
24	Density code of Media (= 0 if empty) (VU)								
25	unused (VU)								

There is only one medium transport element, which can be addressed explicitly as element address 1, or implicitly as address 0.

PvolTag and AVolTag are always 0.

SCSI Interface

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.2.3 Storage Element Status Page

Figure 6–114 Storage Element Status Page

		Bit							
		7	6	5	4	3	2	1	0
0	Element Type Code (2h = Storage Element)								
1	PVolTag	AVolTag	Reserved						
2	(MSB)	Storage Element Descriptor Length (12h)							(LSB)
3									
4	Reserved								
5	(MSB)	Byte Count of Descriptor Data Available							(LSB)
6									
7									

Descriptor(s):

8	(MSB)	First Storage Element Address Reported							(LSB)
9									
10	Reserved				Access	Except	rsvd	Full	
11	Reserved								
12	Additional Sense Code								
13	Additional Sense Code Qualifier								
14	Reserved								
15	Reserved								
16	Reserved								
17	SValid	Invert	Reserved						
18	(MSB)	Source Element Address							(LSB)
19									
20	Reserved								
21	Reserved								
22	Reserved								
23	Reserved								
24	Density code of Media (= 0 if empty) (VU)								
25	unused (VU)								
25 to n	– descriptors for other Storage Elements reported								

6.5 Supported SCSI-2 Medium Changer Device Commands

There are seven storage elements, corresponding to the seven slots in a magazine.

PvolTag and AVolTag are always 0.

Access is always 1, and full is set to 1 if a media cartridge is in the corresponding magazine slot. Exception will be set to 1 if the magazine slot indicates a cartridge has been removed, but is not in the medium transport or data transfer elements.

The source element address will always be set to this element's address.

SCSI Interface

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.2.4 Data Transfer Element Status Page

Figure 6–115 Data Transfer Element Status Page

		Bit							
		7	6	5	4	3	2	1	0
0	Element Type Code (4h = Data Transfer Element)								
1	PVolTag	AVolTag	Reserved						
2	(MSB)	Data Transfer Element Descriptor Length (11h)							_____
3								(LSB)	_____
4	Reserved								
5	(MSB)	Byte Count of Descriptor Data Available (11h)							_____
6								(LSB)	_____
7									

Descriptor:

8	(MSB)	Data Transfer Element Address (10h)							_____
9								(LSB)	_____
10	Reserved				Access	Except	rsvd	Full	
11	Reserved								
12	Additional Sense Code								
13	Additional Sense Code Qualifier								
14	NotBus	rsvd	IDValid	LUValid	rsvd	Logical Unit Number			
15	SCSI Bus Address (same as tape drive's)								
16	Reserved								
17	SValid	Invert	Reserved						
18	(MSB)	Source Element Address							_____
19								(LSB)	_____
20	Reserved								
21	Reserved								
22	Reserved								
23	Reserved								
24	Density code of Media (= 0 if empty) (VU)								
25	unused (VU)								

6.5 Supported SCSI-2 Medium Changer Device Commands

PvolTag and AVolTag are always 0.

Access is always set, full is set if there is a cartridge in the tape drive.

IDValid and LUValid are always set; drive LUN is 0. The SCSI bus address field is the same as the tape drive's controller.

SValid is set if there is a cartridge in the drive, and source element address will indicate which magazine slot it came from.

SCSI Interface

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.3 MODE SENSE/SELECT

All three pages that are specific to medium changers are supported.

6.5.3.1 Device Capabilities Page

The drive shall support the device capabilities page which has the following format:

Figure 6–116 Device Capabilities Page Format

	Bit								
	7	6	5	4	3	2	1	0	
0	PS	0	Page Code (1Fh)						
1	Additional Page Length (0Eh)								
2	Reserved			StorDT	StorI/E	StorST	StorMT		
3	Reserved								
4	Reserved			MT → DT	MT → I/E	MT → ST	MT → MT		
5	Reserved			ST → DT	ST → I/E	ST → ST	ST → MT		
6	Reserved			IE → DT	IE → I/E	IE → ST	IE → MT		
7	Reserved			DT → DT	DT → I/E	DT → ST	DT → MT		
8	Reserved								
9	Reserved								
10	Reserved								
11	Reserved								
12	Reserved			MT ↔ DT	MT ↔ I/E	MT ↔ ST	MT ↔ MT		
13	Reserved			ST ↔ DT	ST ↔ I/E	ST ↔ ST	ST ↔ MT		
14	Reserved			IE ↔ DT	IE ↔ I/E	IE ↔ ST	IE ↔ MT		
15	Reserved			DT ↔ DT	DT ↔ I/E	DT ↔ ST	DT ↔ MT		

Bit Field Values

- Elements that can store media: StorDT, StorSt
- Valid Source->Destination pairs: ST->DT, DT->ST

All the "MT->XX" and the "XX->MT" entries are 0, since the THZ27 loader will not accept a medium transport element address as a source or destination.

All the "IE->XX" and the "XX->IE" entries are 0 since there is no import/export element.

Bytes 12 through 15 are all 0 as the THZ27 does not support the exchange medium command.

The THZ27 does not support "ST->ST" or "DT->DT".

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.3.2 Element Address Assignment Page

The drive shall support the element address assignment page which has the following format:

Figure 6–117 Element Address Assignment Page Format

		Bit							
		7	6	5	4	3	2	1	0
0	PS	0	Page Code(1Dh)						
1	Length (12h)								
2	(MSB)	1st Medium Transport Element Address (01h)							—
3								(LSB)	
4	(MSB)	Number of Medium Transport Elements (1)							—
5								(LSB)	
6	(MSB)	1st Storage Element Address (100h)							—
7								(LSB)	
8	(MSB)	Number of Storage Elements (07)							—
9								(LSB)	
10	(MSB)	1st Import/Export Element Address (00h)							—
11								(LSB)	
12	(MSB)	Number of Import/Export Elements (0)							—
13								(LSB)	
14	(MSB)	1st Data Transfer Element Address (10h)							—
15								(LSB)	
16	(MSB)	Number of Data Transfer Elements (01)							—
17								(LSB)	
18	Reserved								
19	Reserved								

SCSI Interface

6.5 Supported SCSI-2 Medium Changer Device Commands

6.5.3.3 Transport Geometry Parameters Page

The drive shall support the transport geometry page which has the following format:

Figure 6–118 Transport Geometry Page Format

		Bit							
		7	6	5	4	3	2	1	0
0	PS	0	Page Code(1Eh)						
1	Additional Page Length (02h)								
2	Reserved							Rotate	
3	Member Number in Transport Element Set (0)								

Rotation of media is not appropriate for this type of loader, so the Rotate bit is 0. There is only one medium transport element, so there is only one set, with one member.

6.5.4 MOVE MEDIUM (A5h)

Figure 6–119 MOVE MEDIUM CDB

		Bit								
		7	6	5	4	3	2	1	0	
0	Operation Code (A5h)									
1	Logical Unit Number	Reserved								
2	(MSB)	Transport Element Address								
3								(LSB)		
4	(MSB)	Source Address								
5								(LSB)		
6	(MSB)	Destination Address								
7								(LSB)		
8	Reserved									
9	Reserved									
10	Reserved							Invert		
11	Unused	Reserved				Flag	Link			

The MOVE MEDIUM command is used to move cartridges from the tape drive to the magazine slot it came from, or from any magazine slot to the tape drive.

The transport element address field must be 0 or 1.

Firmware Update Procedure (From Tape)

This section describes the procedure for updating the firmware (code) of the controller module of the THZ02 streaming cartridge tape subsystems, from a cartridge that has the firmware image stored on it. Firmware update from the host is also supported; see the section on the SCSI WRITE BUFFER command for details.

7.1 THZ02 Firmware Updates

On the THZ02 cartridge tape product family, updates of the controller board's firmware can be done automatically by the subsystem, directly from a tape with the appropriate information on it. The user uses the front panel to put the subsystem into firmware update mode, and then simply loads a tape with the THZ02 firmware image file stored on it. The subsystem will then automatically read and verify the information on the tape as a valid THZ02 firmware image. If the image data passes all the verifications, it is installed into the controller's nonvolatile code memory.

This chapter describes all the details of the firmware update procedure, so that users with little or no prior experience with the product can do the update.

Before walking through the procedure, here are a few things to keep in mind:

Caution

During the firmware update, when the new image is actually being programmed into the FLASH EEPROMs, a powerfail (but not bus reset) will cause the controller module to be unusable. When doing a firmware update, take reasonable precautions that a powerfail will not occur.

- The subsystem can be updated even when not attached to an SCSI bus (for example, stand-alone). However, since the power-on self-test (POST) needs to pass for an update to be possible, and POST needs a properly terminated bus to pass, if the user wants to do a firmware update on a standalone unit they should do the following:

Ensure that the termination packs on the controller board are in the "TERM" position, and the Term Power jumper in the "PWR" position. These positions are labeled on the PCB etch (as are the "NO TERM" and "NO PWR" positions).

Firmware Update Procedure (From Tape)

7.2 Creating a "Firmware Update Tape"

7.2 Creating a "Firmware Update Tape"

To do the firmware update, a piece of CompactTape media with a copy of the firmware image properly written to it must be available. This "FW Update Tape" can easily be created, if it is not already available.

7.2.1 On UNIX Systems

The FTP utility can be used to transfer the binary firmware image file onto the UNIX system; be sure to specify "type image" before doing the "get" or "put", otherwise extra characters may be added to the file, causing the image file to be invalid. The image file should be exactly 1024*256 bytes in size.

Use the ltf command with the -cfB options to copy the image file to the CompactTape media using 4k byte blocks.

For example:

```
#ltf -cfB /dev/rmt0h 4096 thz_v10.image
```

7.3 Firmware Update Procedure

Firmware updates are supported on the THZ02 with and without the media loader. The steps for performing the update are similar for each, and are given separately below.

7.3.1 Updating the Firmware on THZ02 (Drive Only Configuration)

1. Get or make a CompactTape with the firmware image of the desired revision level copied to it.
2. Put the THZ02 subsystem into firmware update mode.

This is done as follows:

- a. Remove any cartridge that is in the target THZ02 unit and close the handle (down position).
- b. Press the Unload button on the unit's front panel and hold it until the Write Protect LED begins blinking (about 6 seconds). This indicates that the THZ02 unit has recognized that the user is requesting firmware update mode, and is waiting for completion of the sequence.

If the Write Protect LED never starts blinking, the user should check that the device is in the proper state (no POST failures, no cartridge in drive, drive handle in proper position).

- c. The Unload button should then be released, and then pressed again within 4 seconds. Duration of the second press should be less than 1 second.
- d. The "Tape in Use" LED on the unit's front panel will begin flashing, as well as the Write Protect LED, indicating that the tape unit recognizes that firmware update mode has been selected.
- e. If not successful (for example, due to not pushing the button the second time properly) the Write Protect LED should stop blinking within several seconds. The procedure can then be tried again. If the drive and controller are not properly communicating, the user will be unable to select firmware update.

Firmware Update Procedure (From Tape)

7.3 Firmware Update Procedure

3. Once firmware update mode is selected, the next cartridge that is inserted into the drive (which will temporarily clear the two LEDs) will be automatically read and the data examined and verified to be a valid THZ02 firmware image. (A few minutes of tape movement will result from calibration and directory processing before data is actually read.) Firmware update mode is automatically cleared at this point.
4. If everything is okay, the controller's flash EEPROM memory will be automatically updated with the new firmware image.

7.3.1.1 Interpreting the Results

There are two possible results:

- The firmware update cartridge is unloaded: this indicates a successful update. On the THZ02, the media is placed into the cartridge, the door unlocked, and the green "Operate Handle" LED is turned on.
- The firmware update cartridge is *not* unloaded: this indicates an *unsuccessful* update.

The subsystem should still be usable, but this depends on why the update failed (power failure, bad image on the tape, no +12 V supplied to the controller PCB, broken Flash EEPROMs, etc.)

Additional details are covered below.

1. If the image is valid, the flash EEPROM containing the current firmware will be erased and the new image programmed in. The subsystem will complete the update in about 2 minutes.

When the update is complete, the tape unit will reset itself, going through power-on and self-test and automatically unload the tape containing the firmware image so that it can be removed. This indicates a successful firmware update.

2. If the tape is not a valid firmware update tape, or does not contain a valid image, no update will be attempted. The Write Protect and Tape In Use LEDs will not blink.

Caution

Be sure to wait a few minutes before doing this to ensure that an unusually long update is not in progress, since a dead controller could result if power is cycled prematurely!

If there is not a valid firmware image, the unit resets itself, and the tape will be left loaded.

3. If the tape contains a valid image, but for some reason the reprogramming of the flash memory fails, the controller will probably be unusable and will need to be replaced. The tape unit will reset itself and rerun POST, which will fail if the flash memory does not contain a valid image.

Firmware Update Procedure (From Tape)

7.3 Firmware Update Procedure

7.3.2 Updating the Firmware on THZ27 Loader Configuration

1. Get or make a CompactTape with the firmware image of the desired revision level copied to it.

2. Put the THZ27 subsystem into firmware update mode.

This is done as follows:

- a. Remove any magazine that is in the THZ27's loader receiver, and close the receiver.
- b. Put the keyswitch in the Service position (wrench icon).
- c. Press the Load-Unload button on the front panel and hold it until the Write Protect LED begins blinking (about 6 seconds). This indicates that the THZ27 unit has recognized that the user is requesting firmware update mode, and is waiting for completion of the sequence.

If the Write Protect LED never starts blinking, the user should check that the device is in the proper state (no POST failures, no cartridge in drive, no magazine in loader, receiver door closed, keyswitch in proper position, etc.).

- d. The Unload button should then be released, and then pressed again within 4 seconds. Duration of the second press should be less than 1 second.
 - e. The "Tape in Use" LED on the front panel will begin flashing, as well as the Write Protect LED, indicating that the subsystem recognizes that firmware update mode has been selected.
 - f. If not successful (for example, due to not pushing the button the second time properly) the Write Protect LED should stop blinking within several seconds. The procedure can then be tried again.
3. Once firmware update mode is selected, the EJECT button should be pressed twice, which will cause the receiver door to open. The Write Protect and Tape In Use LEDs will stop blinking also (but the subsystem is still in update mode).
 4. A magazine with the firmware update tape in the first nonempty slot should then be put into the loader receiver and the receiver closed. (The remainder of the update procedure will go faster if the magazine has only the firmware update cartridge in it, but it will work if other cartridges are also present.)
 5. The Load-Unload button should then be pressed to cause the firmware update tape to be loaded into the drive.
 6. The drive will automatically read the tape and the data examined and verified to be a valid THZ27 firmware image. (A few minutes of tape movement will result from calibration and directory processing before data is actually read.) Firmware update mode is automatically cleared at this point.
 7. If everything is okay, the controller's flash EEPROM memory will be automatically updated with the new firmware image.
 8. When done (okay or not) the subsystem resets itself. A full extended scan of the loader will take place. If the firmware update cartridge was the only one in the magazine this will go quickly. If there are six other cartridges present, the extended scan will take a minute or so extra.

Firmware Update Procedure (From Tape)

7.3 Firmware Update Procedure

7.3.2.1 Interpreting the Results

There are two possible results:

- The firmware update cartridge is unloaded: this indicates a successful update. On the THZ27, the cartridge is unloaded from the drive into the magazine slot it came from — and the next one loaded if there is one.
- The firmware update cartridge is *not* unloaded: this indicates an *unsuccessful* update.

The subsystem should still be usable, but this depends on why the update failed (power failure, bad image on the tape, no +12 V supplied to the controller PCB, broken flash EEPROMs, etc.).

Additional details are covered below.

1. If the image is valid, the flash EEPROM containing the current firmware will be erased and the new image programmed in. The subsystem will complete the update in about 2 minutes.

When the update is complete, the tape unit will reset itself, going through power-on self-test and automatically unload the tape containing the firmware image so that it can be removed. This indicates a successful firmware update.

2. If the tape is not a valid firmware update tape, or does not contain a valid image, no update will be attempted. The Write Protect and Tape In Use LEDs will not blink.

Caution

Be sure to wait a few minutes before doing this to ensure that an unusually long update is not in progress, since a dead controller could result if power is cycled prematurely.

If there is not a valid firmware image, the unit resets itself, and the tape will be left loaded.

3. If the tape contains a valid image, but for some reason the reprogramming of the flash memory fails, the controller will probably be unusable and will need to be replaced. The tape unit will reset itself and rerun POST, which will fail if the flash memory does not contain a valid image.

This chapter is intended to provide a general description of the diagnostic strategy for the THZ02 subsystem. The main purpose here is to address the global diagnostic issues.

The diagnostics consist of:

- Power-on self-tests (POST) in the controller and drive
- Microdiagnostics, invoked from the host via the SEND DIAGNOSTIC SCSI command.

The benefits of utilizing the embedded diagnostic approach is that because the diagnostics reside within the subsystem, as long as the capability to send flavors of the SEND DIAGNOSTIC command exist on any given host system, these tests will be able to run. For example, the boot ROMs on some host systems support this type of testing.

8.1 Test Goals

Coverage by testing is:

- 75% POST only
- 25% via resident microdiagnostics only
- Fault isolation to the FRU level only

With some overlap between POST and functional microdiagnostics and in combination with host-based testing, total diagnostic test coverage will be 98% detection of single stuck at faults, with 95% fault isolation to a single FRU.

Diagnostics

8.2 Resident Power-On Self-Test (POST) Diagnostics

8.2 Resident Power-On Self-Test (POST) Diagnostics

The purpose of the resident POST microdiagnostics is to perform a comprehensive self-test of the personality card logic, conforming to hardware size and cost goals. The POST microdiagnostics will execute at power-up, or in response to a bus device reset message from the host.

The POST package consists primarily of go/no-go tests. Controller POST is not intended to perform any testing on the drive transport or medium changer, nor will they be able to test much of the SCSI interface logic.

The POST tests cover:

- Diagnostic LED test (needs human to verify results)
- 68020 microprocessor register and instruction tests
- Local RAM tests
- NCR 53C96 chip tests
- EZ gate array tests
- GPSP4 gate array test
- Cache (EZ) RAM tests
- Flash code ROM tests
- Timer and other miscellaneous tests

POST testing will be completed, and the subsystem will respond normally to all commands within 5 seconds. However, it can take somewhat longer for the media (if loaded) to be made ready. After a bus reset the subsystem will be able to respond to selections after 1 second or less.

8.2.1 Failure Action

The controller includes one green and one amber on-board status LED for fault indication. On power-up, both lights will be lit. As the POST microdiagnostic goes through each test these LEDs will blink. If all tests pass then only the green light will be left lit.

If any test fails the green LED will be turned off. Communication over the SCSI bus may or may not be possible. Cycling the power will probably be required to get the subsystem to rerun the POST tests again.

8.3 Microdiagnostic Tests

These can be run using default parameter setting using vanilla versions of the SEND DIAGNOSTIC command. With an appropriate parameter list, the tests can be run with various parameter values (test pattern, pass count, block size, block count). See the SEND DIAGNOSTIC command description in this document.

8.3.1 Microdiagnostic Test Descriptions

The THZ02 controller microdiagnostic package consists of the following tests and utilities:

8.3.1.1 Level 1 Test

This test is similar to the POST tests (only electronics tested) and is relatively fast. Unlike POST, the drive and medium changer interfaces are tested if the devices are present.

8.3.1.2 Level 2 Test

This test is a NOP for the THZ02.

Technical Specifications

This chapter contains specifications of the THZ02 tape drive.

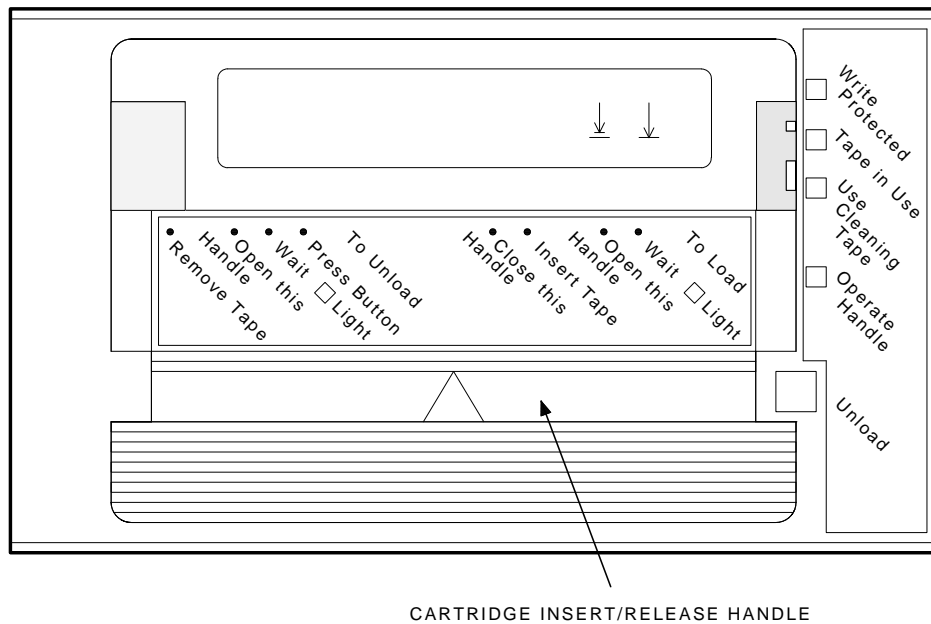
9.1 Physical Description

This section contains figures showing the front panel, top, side, and isometric views of the tape drive.

9.1.1 Front Panel

The following figure shows the front panel of the THZ02 tape drive.

Figure 9-1 THZ02 Front View



SHR-X0056G-91

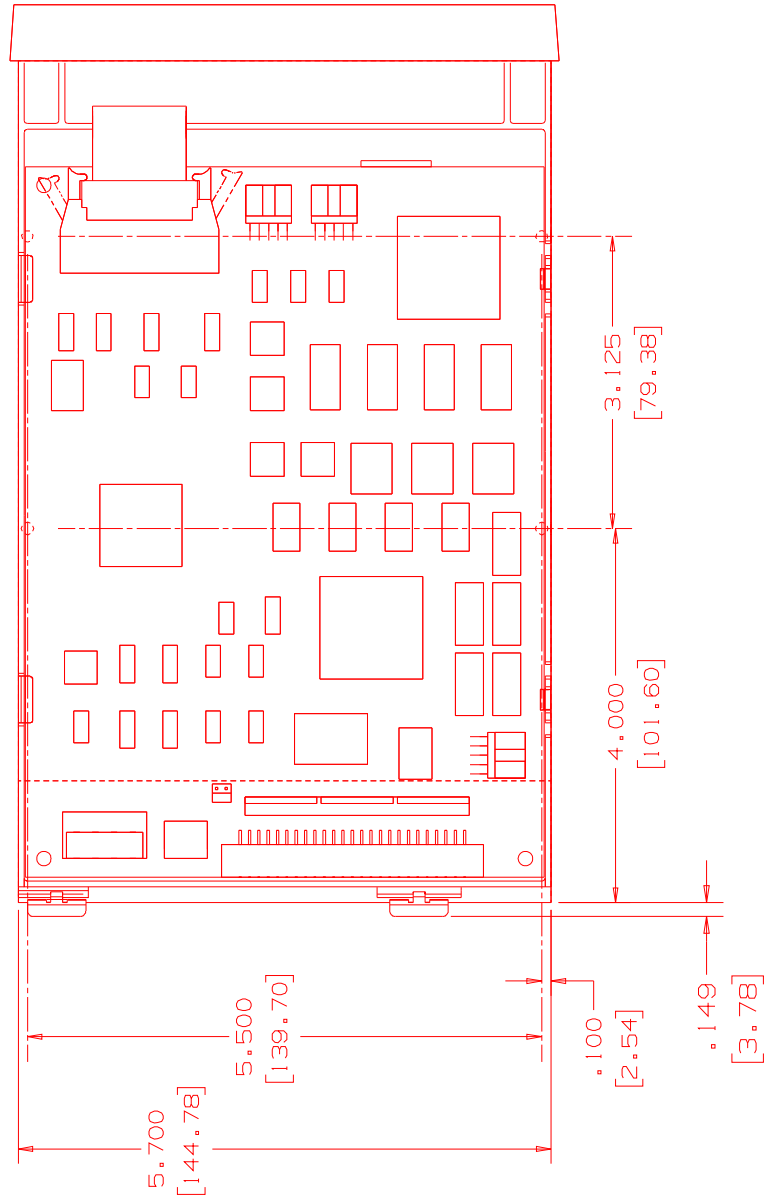
Technical Specifications

9.1 Physical Description

9.1.2 Top View

The following figure shows the THZ02 tape drive as seen from the top.

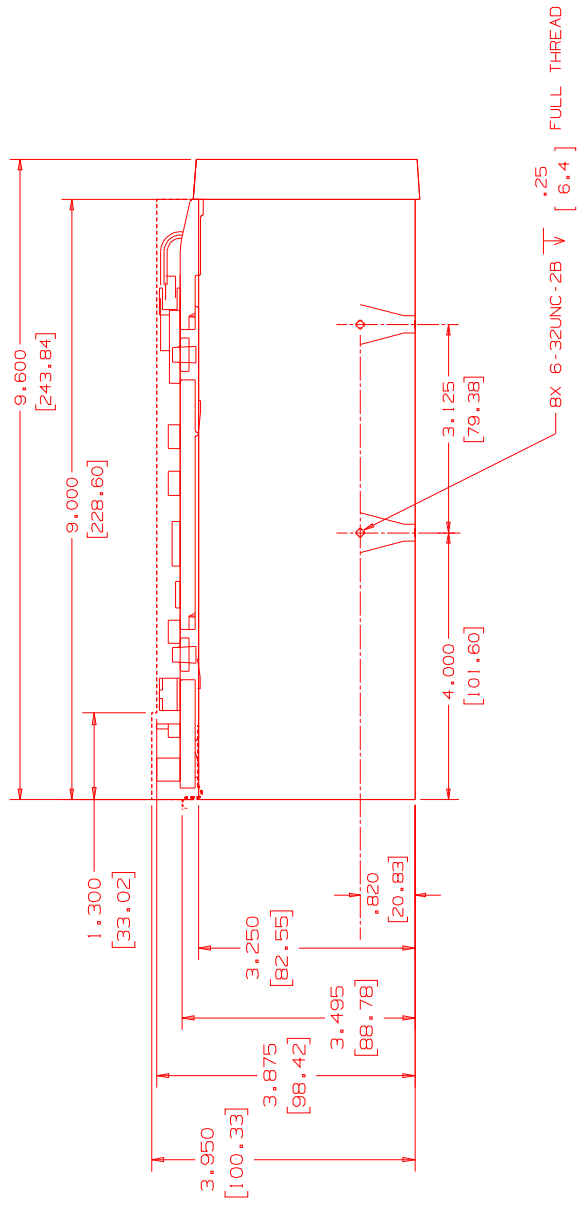
Figure 9–2 Top View



9.1.3 Side View

The following figure shows the THZ02 tape drive as seen from the side.

Figure 9–3 Side View



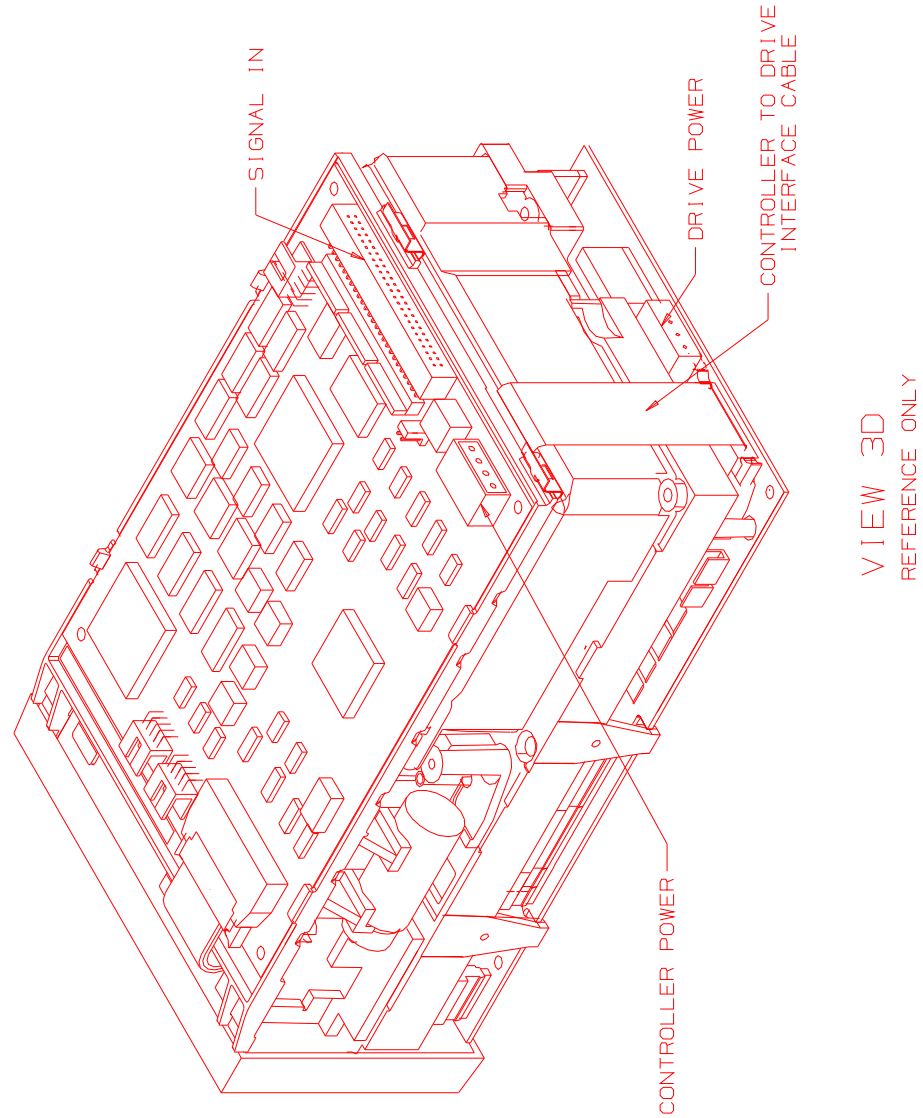
Technical Specifications

9.1 Physical Description

9.1.4 Isometric View

The following is an isometric view of the THZ02 tape drive.

Figure 9-4 Isometric View



9.2 Physical Dimensions

The tape drive width and height are standard 5-1/4 inch disk drive form factor measurements. Both dimensions hold tolerances of ± 0.020 inches. The depth dimensions have tolerances of +00, -0.040 in.

The following table lists basic size, depth, mounting holes, and weight.

Table 9–1 Size, Depth, Mounting Holes, Weight

Basic size	3.95 in high \times 5.70 in wide \times 9.00 in deep (from rear of bezel) (10.03 cm \times 14.47 cm \times 22.86 cm)
Bezel depth	0.60 inch (1.52 cm)
Mounting holes	Standard for 5¼-in tape drives
Unpacking weight	6.5 lb (2.95 kg)
Packed weight	9 lb (4.08 kg)

9.3 Performance Specifications

The following sections describe performance specifications.

9.3.1 Nominal Tape Tension

Nominal tape tension is as follows:

- 3.0 ± 1 oz when stationary
- 4.7 ± 1 oz at operating speed

9.3.2 THZ02 Timing Characteristics

The following table lists timing characteristics of the THZ02 tape drive:

Table 9–2 THZ02 Timing Characteristics

Tape speed	100 in/sec
Nominal rewind time	2 min
Maximum access time	3 min
Load to BOT — blank tape	75 sec
Load to BOT — used tape	60 sec
Unload from BOT	15 sec

Technical Specifications

9.3 Performance Specifications

9.3.3 THZ27 Media Loader Timing Characteristics

The following table lists timing characteristics of the THZ27 media loader.

Table 9–3 THZ27 Media Loader Timing Characteristics

Nominal magazine scan	12 sec
Move cartridge slot to drive	27 sec
Move cartridge drive to slot	25 sec
Error recovery	30 sec

9.4 Power Requirements

The THZ02 tape drive operates on +5 and +12 dc power. The tape drive may also be mounted in a tabletop enclosure or media loader that operate from ac power.

Refer to the following tables for power requirements.

9.4.1 THZ02 Power Requirements

The following tables list the power requirements of the drive itself.

Table 9–4 THZ02 Power Requirements ($\pm 5\%$)

	Steady State	Maximum
5 volts	3.50 A	4.50 A
12 volts	1.22 A	2.60 A
Wattage	35 W	40 W

9.4.2 THZ02 Tabletop Power Requirements

The power requirement of the drive when mounted in the tabletop enclosure is:

100-240 Vac
50/60 Hz
50 W

9.4.3 THZ27 Power Requirements

The power requirement of the drive when mounted in the media loader is:

100-120, 220-240 Vac (selectable)
50/60 Hz
100 W

9.5 Environmental Specifications

The tape drive conforms to modified Class B environment that includes general offices and workspaces with:

- Conditioned and marginally-conditioned areas with central or remote air-conditioning
- Complete temperature and humidity controls
- Moderate control tolerances
- Systems capable of maintaining comfort levels (for example, typical offices, general work areas, and so forth)
- Marginal heating or cooling apparatus
- No humidity conditioning
- Uncontrolled tolerances
- Systems inadequate to always maintain comfort levels (for example, marginal offices and work spaces, and so forth)

9.5.1 Temperature and Humidity

Refer to the following table for operating temperature and humidity ranges.

Table 9–5 Operating Ranges

Dry bulb temperature	10 to 40°C
Wet bulb temperature	25°C
Temperature gradient	11°C/h (across the range)
Temperature shock	10°C (over two min)
Relative humidity	20 to 80% noncondensing
Humidity gradient	10%/h

Refer to the following table for power-on ranges.

Table 9–6 Power-On Ranges — No Tape Loaded (Unpacked — 72 Hours)

Dry bulb temperature	10 to 40°C
Wet bulb temperature	25°C
Temperature gradient	15°C/h (across the range)
Temperature shock	15°C (over two min)
Relative humidity	10 to 90%
Humidity gradient	10%/h

Technical Specifications

9.5 Environmental Specifications

Refer to the following table for storage ranges.

Table 9–7 Storage Ranges (Unpacked or Packed)

Dry bulb temperature	-40 to 66°C
Wet bulb temperature	46°C
Temperature gradient	20°C/h with 5° margin (across the range)
Temperature shock	15°C with 5° margin (over two min)
Relative humidity	10 to 95% noncondensing
Humidity gradient	10%/h

Refer to the following table for shipment ranges.

Table 9–8 Shipment Ranges

Dry bulb temperature	-40 to 66°C
Wet bulb temperature	46°C
Temperature gradient	25°C/h with 5° margin (across the range)
Temperature shock	15°C with 5° margin (over two min)
Relative humidity	10 to 95% noncondensing
Humidity gradient	10%/h

9.5.2 Altitude

The tape drive operates in normal pressures from 60 to 8,000 feet.

9.6 Vibration and Shock Requirements

Refer to the following tables for operating and nonoperating vibration requirements:

Table 9–9 Operating Vibration Requirements (Within Specification — No Damage)

Frequency range	5-500-5 Hz
Peak acceleration	0.25 g
Waveshape	0.010 in double amplitude
Application	X, Y, Z axes — 2 sweeps/axis

Table 9–10 Nonoperating Vibration Requirements (Unpacked — No damage)

Frequency range	10-50-300 Hz
Peak acceleration (Vertical)	0.029 g^2/Hz
Peak acceleration (horizontal)	0.007 g^2/Hz
Waveshape	Random
Application	X, Y, Z axes — 2 sweeps/axis

Refer to the following tables for operating and nonoperating shock requirements:

Table 9–11 Operating Shock Requirements (Within Specification — No Damage)

Peak acceleration	10 Gs
Duration	10 ms
Waveshape	1/2 Sine pulses
Application	X, Y, Z axes — repeat 3 times

Table 9–12 Nonoperating Shock Requirements (Unpacked — No Damage)

Bench test	Four in freefall onto a wooden surface
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Technical Specifications

9.7 Electromagnetic Interference Susceptibility

9.7 Electromagnetic Interference Susceptibility

Electromagnetic interference (EMI) susceptibility includes:

- Electromagnetic emissions
- Conducted emissions
- Radiated emissions
- Magnetic radiated susceptibility
- Radiated susceptibility
- Conducted susceptibility

9.7.1 Electromagnetic Emissions

Electromagnetic emissions include:

CSA 108.8

EEC Directive 89/336

EN55022 and National standards are based on:

BS6527

UK

NEN55022

Netherlands

VDE 0871 Class

Germany

B

F-Mark

Cispr22 Class B

- FCC Rules
Part 15B
- Class B
Certified
- VCCI level
II

9.7.2 Conducted Emissions

Limits for Class B equipment are in the frequency range from 0.15 to 30 MHz. Note that the limit decreases linearly with the logarithm of the frequency in the range from 0.15 to 0.50 MHz.

Frequency Range (MHz)	Limits dB	
	Quasi-peak	Average
0.15 to 0.050	66 to 56*	56 to 46
0.50 to 5	56	46
5 to 30	60	50

*The limit decreases with the logarithm of the frequency.

Technical Specifications

9.7 Electromagnetic Interference Susceptibility

9.7.3 Radiated Emissions

Limits of radiated interference field strength, in the frequency range from 30 MHz to 30 GHz at a test distance of 3 and 10 meters, for Class B equipment are:

Frequency range (MHz)	Quasi-peak limit dB (μ V/m)	
	@ 10 m	@ 3 m
30 to 230	30	40
230 to 1000	37	46
Above 1000	NA	54

9.7.4 Magnetic Radiated Susceptibility

Refer to the following table for magnetic radiated susceptibility limits:

Table 9–13 Low Frequency, Magnetic Fields, 10 to 3000 kHz

100 dB (pt) @ 10 kHz declining to 80 dB (pt) @ 1 MHz	No errors, no screen distortion
--	---------------------------------

9.7.5 Radiated Susceptibility

Refer to the following table for radiated susceptibility limits:

Table 9–14 High Frequency, Electric Fields, 1 to 1000 MHz

3 V/m (rms) 80% modulated 1 kHz	No errors, no screen distortion
	SW recoverable errors
	No hardware failure

Technical Specifications

9.7 Electromagnetic Interference Susceptibility

9.7.6 Conducted Susceptibility

The transient voltage is the actual peak voltage that is above the normal ac voltage from the power source.

Refer to the following table for power and data cable voltage limits:

Table 9–15 Fast Transient (Bursts) for Power and Data Cables

2 kV	SW recoverable errors No hardware failures
------	---

Refer to the following table for power cable voltage limits:

Table 9–16 High Energy Transient Voltage for Power Cables

1.2 kV	No errors
2.5 kV	SW recoverable errors No hardware failure

Note

The maximum energy in a single pulse from the transient generator must be limited to 2.5 W.

Refer to the following table for low-level conducted interference voltage limits:

Table 9–17 Low-Level Conducted Interference

3 V(rms) 80% modulated 1 kHz	No errors SW recoverable errors No hardware failure
---------------------------------	---

9.7.7 ESD Failure Level Limits

The following table lists the ESD failure level limits for normal operator access areas:

Table 9–18 ESD Failure Level Limits

Failure Type	Equipment	Failure Level	Allowable Errors
Hard	Office	1 to 12 kV	No operator intervention (soft recoverable allowed)
Hardware	Office	Up to 15 kV	No component damage (soft /hard errors allowed)

9.7.8 Acoustic Noise Emissions

The acoustic noise emission levels are:

- 5.9 bels (idle mode)
- 6.0 bels (streaming mode)

9.8 Regulatory Requirements

Regulatory requirements include:

- Safety
- Electromagnetic emissions
- Shipping
 - Shock
 - Vibration
 - Physical drop test

9.8.1 Safety Requirements

Safety requirements include:

- UL1950 — Information Technology Including Electrical Business Equipment
- CSA C22.2 #220 — Information Technology Including Electrical Business Equipment
- TUV EN50950 — Information Technology Including Electrical Business Equipment

9.8.2 Electromagnetic Emission Requirements

Electromagnetic emission requirements include:

- FCC, Part 15 Subpart J, Class B
- VDE 0871 and 875, Class B

Technical Specifications

9.8 Regulatory Requirements

9.8.3 Shipping Requirements

Shipping requirements include:

Table 9–19 Shipping Requirements (Repetitive Synchronous Motion)

Impacts	14,200 total
Duration	35 min
Displacement	1/16 in
Application	Stimulate package in normal shipping position

Table 9–20 Vibration Requirements

Frequency range	5 to 300 Hz
Peak acceleration	1.19 Grms
Waveshape	Random vibration
Power spectral density	.003 g^2/Hz @ 5 Hz
Power spectral density	.02 g^2/Hz @ 10 Hz

Table 9–21 Physical Drop Test Requirements

Drop test distance	30 in
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9.9 Drive Reliability Factors

The following tables list reliability factors:

Table 9–22 Reliability Factors

Design life	Seven years	The design life statistics provide the point at which the statistical failure rate begins to rise.
Head life	6000 tape motion hours (average)	The head life may be less than listed if alternate sources for tape cartridges are used.
MTBF	60,000 hours	Digital Equipment Corporation does not warrant that the predicted MTBF is representative of any particular unit installed for customer use. The actual figures will vary from unit to unit.

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