

EXB-8500 and EXB-8500c 8mm
Tape Drive

Product Specification

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Revision History

Previous revisions of this manual include the following:

Revision	Date
P-000	October 1989
001	December 1990
002	August 1991
003	October 1991
004	March 1993 (Renamed manual)

Changes and Enhancements

This revision of the *EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystem Product Specification* includes the following changes and enhancements:

- Changed the manual name from *EXB-8500 8mm Cartridge Tape Subsystem Product Specification* to *EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems Product Specification*.
- **All chapters.** Added information about the EXB-8500c 8mm Cartridge Tape Subsystem.
- **Chapter 1.** Added information about related products.
- **Chapter 3.** Added information about how the EXB-8500 and EXB-8500c operate in the SCSI environment and information about SCSI protocol and SCSI commands.
- **Chapter 4.** Added information about the physical and logical format of the recorded tape.
- **Chapter 5.** Added information about write and read operations, and data compression for the EXB-8500c.
- **Chapter 7.** Modified the bit error rate for permanent write and read errors.
- **Chapter 8.** Modified the maximum power dissipation values.

Product Warranty Caution

The EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems are warranted to be free from defects in materials, parts, and workmanship and will conform to the current product specification upon delivery. **For the specific details of your warranty, refer to your sales contract or contact the company from which the EXB-8500 or EXB-8500c was purchased.**

The warranty for the EXB-8500 and EXB-8500c shall not apply to failures caused by:

- Physical abuse or use not consistent with the operating instructions or product specifications provided by EXABYTE's personnel or agent for the applicable equipment.
- Modifications by other than EXABYTE's personnel or agent in any way other than those approved by EXABYTE, provided the warranty shall not be voided by the repair or replacement of parts or the attachment of items in the manner described in maintenance or installation instructions provided by EXABYTE.
- Repair by other than EXABYTE's personnel or agent in a manner contrary to the maintenance instructions provided by EXABYTE.
- Removal of the EXABYTE serial number tag.
- Physical abuse due to improper packaging of returns.

CAUTION

Returning the EXB-8500 or EXB-8500c in unauthorized packaging may damage the unit and void the warranty.

If you are returning the EXB-8500 or EXB-8500c for repair, package it in its original packaging (or in replacement packaging obtained from your vendor). Refer to the packing instructions in this manual.

If problems with the EXB-8500 or EXB-8500c occur, contact your maintenance organization; do not void the product warranty by allowing untrained or unauthorized personnel to attempt repairs.

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About This Specification

This product specification describes the functional, performance, and environmental specifications for the EXABYTE® EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c). It concentrates on the similarities between the two products, pointing out the differences in function and appearance when necessary.

Intended Audience

This specification is for engineering, purchasing, or marketing personnel who want to evaluate either the EXB-8500 or EXB-8500c to determine the feasibility of integrating them into a product line.

Overview of This Specification

This specification contains the following chapters:

- **Chapter 1** describes the features of the EXB-8500 and EXB-8500c, including their compatibility with other EXABYTE Cartridge Tape Subsystems, custom EEPROM options, the EXB-8500c's use of data compression, and related products.
- **Chapter 2** describes the physical features of the EXB-8500 and EXB-8500c, including their mechanical and electrical components.
- **Chapter 3** describes the Small Computer System Interface (SCSI) characteristics for the EXB-8500 and EXB-8500c. It also provides a description of how SCSI commands can be used to design and implement a driver for the EXB-8500 and EXB-8500c.
- **Chapter 4** describes the physical and logical recording formats used by the EXB-8500 and EXB-8500c, including its implementation of helical scan recording technology.
- **Chapter 5** describes the functional features of the EXB-8500 and EXB-8500c, including how they perform read and write operations and how they can operate as a streaming or start/stop tape device.
- **Chapter 6** lists the performance specifications for the EXB-8500 and EXB-8500c, including write and read access times, tape speed, reposition time, and data transfer rates.

- **Chapter 7** lists the reliability specifications for the EXB-8500 and EXB-8500c, including service life, mean time between failures (MTBF), data integrity, and write and read reliability.
- **Chapter 8** lists power specifications for the EXB-8500 and EXB-8500c, including information about voltages and power dissipation. This chapter also lists the pin assignments for the power connector.
- **Chapter 9** lists the environmental specifications for the EXB-8500 and EXB-8500c, including temperature and humidity conditions, air flow requirements, shock and vibration criteria, and acoustic noise limits.
- **Chapter 10** describes the EXB-8500's and EXB-8500c's compliance with regulatory and safety agency standards.
- **Chapter 11** provides general information about shipping and installing the EXB-8500 or EXB-8500c.
- **Chapter 12** gives a brief overview of the operating and maintenance procedures for the EXB-8500 and EXB-8500c.
- A glossary, index, and reader's comment form are included at the back of this manual.

Related Publications

The following publications list additional, related information.

EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems

For information about installing, operating, and maintaining the EXB-8500 or EXB-8500c, and for information about implementing SCSI commands, refer to the following publications:

- *EXB-8500 8mm Cartridge Tape Subsystem User's Manual*, 510201
- *EXB-8500c 8mm Cartridge Tape Subsystem User's Manual*, 510209
- *Monitor User's Guide for the 8mm Cartridge Tape Subsystem*, 510206

EXB-8200 and EXB-8200SX 8mm Cartridge Tape Subsystems

For information about the EXB-8200 and EXB-8200SX, refer to the following publications:

- *EXB-8200 8mm Cartridge Tape Subsystem Product Specification*, 510005
- *EXB-8200 8mm Cartridge Tape Subsystem User's Manual*, 510006
- *EXB-8200SX 8mm Cartridge Tape Subsystem Product Specification and User's Manual*, 510011

Standards

For information about the standards used for the EXB-8500 and EXB-8500c, refer to the following publications:

- *ANSI Small Computer System Interface (SCSI)*, X3.131 - 1989
- *ANSI Small Computer System Interface-2 (SCSI-2)*, X3.131 - 1991
- *ANSI Helical-Scan Digital Computer Tape Cartridge*, X3B5/89-136, Rev. 6
- *ANSI/ISO/IEC 11319-1992 and ECMA-145, 8mm Wide Magnetic Tape Cartridge for Information Interchange*, July 1992
- *Standard ECMA-169, 8mm Wide Magnetic Tape Cartridge Dual Azimuth Format for Information Interchange, Helical Scan Recording*, June 1992

Conventions Used in This Specification

This specification uses special conventions to highlight notes, important information, and cautions. These conventions are explained below.

Note: Read *Notes* for hints or suggestions about the topic or procedure being discussed.

Important

Read the information in *Important* boxes to learn crucial information about the topic or procedure being discussed.

CAUTION

Read the information in *Caution* boxes to learn ways to avoid damaging the equipment.

1

Product Features

This chapter provides the following information about the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c):

- General features of the EXB-8500 and EXB-8500c, including their read and write compatibility with other 8mm products, custom EEPROM options, and the EXB-8500c's implementation of data compression.
- Products related to the EXB-8500 and EXB-8500c, including EXATAPE™ 8mm data cartridges, EXABYTE 8mm cleaning cartridges, and the EXABYTE 8mm Tabletop Cartridge Tape Subsystem.

About the EXB-8500 and EXB-8500c

Both the EXB-8500 and EXB-8500c are enhanced 8mm digital helical-scan cartridge tape subsystems. Packaged in the industry standard 5.25-inch form factor and combined with an integral Small Computer System Interface (SCSI) controller (either single-ended or differential configurations), the EXB-8500 and EXB-8500c are the easily integrated solution to your journaling, archiving, data interchange, software distribution, imaging, data acquisition, and backup/restore needs.

Figure 1-1 shows the EXB-8500. Except for the letter “c” on the front panel unload button, the EXB-8500c is identical on the outside.

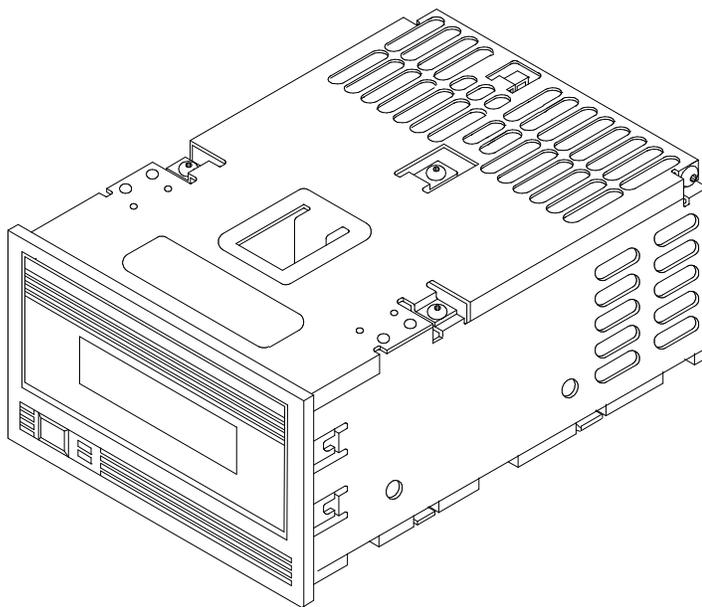


Figure 1-1 EXB-8500 Cartridge Tape Subsystem

Read/Write Compatibility with Other CTSs

The EXB-8500 can read and write data in the following logical formats:

- EXB-8500 uncompressed format
- EXB-8200 uncompressed format

The EXB-8500c can read and write data in the following logical formats:

- EXB-8500c compressed format
- EXB-8500 uncompressed format
- EXB-8200c compressed format
- EXB-8200 uncompressed format

Table 1-1 shows the compatibility of these four formats with other EXABYTE Cartridge Tape Subsystems (CTSs). For further information about the logical formats, refer to Chapter 4.

Table 1-1 Read/write compatibility of all EXABYTE 8mm Cartridge Tape Subsystems

A tape written in this format...	Can be read and written by an ...					
	EXB-8500	EXB-8500c	EXB-8200	EXB-8200SX	EXB-8205	EXB-8505
EXB-8200	✓	✓	✓	✓	✓	✓
EXB-8200c		✓			✓	✓
EXB-8500	✓	✓				✓
EXB-8500c		✓				✓

Custom EEPROM Options

For ease of integration and application development, both the EXB-8500 and EXB-8500c provide options that allow you to customize various aspects of operation. These options are programmed in the electronically erasable programmable read-only memory (EEPROM) and are called *EEPROM options*. They include such items as MODE SELECT power-on default values, command set options, hardware operation options, and SCSI configuration options.

When you order an EXB-8500 or EXB-8500c, you can contact an EXABYTE Account Manager or Technical Support representative to select which, if any, EEPROM settings you want to change from their standard settings. Using this information, EXABYTE can create a customized EEPROM image that meets your integration and application development requirements. Once your designated EEPROM structure is released, each EXB-8500 or EXB-8500c you purchase will be factory-configured to your specifications.

Note: As described in the *Monitor User's Guide for the 8mm Cartridge Tape Subsystem*, you can use the CTS Monitor program to change some of the EEPROM option settings.

Data Compression—EXB-8500c Only

When operating in either EXB-8500c format (default) or EXB-8200c format, the EXB-8500c implements a powerful algorithm that enables it to compress user data up to ratios of 5:1. Assuming an average compression efficiency of 2:1, the EXB-8500c can store up to 10 gigabytes of data on a single, standard 8mm data cartridge when writing data in EXB-8500c format or up to 5 gigabytes in EXB-8200c format.

Note: The actual compression ratio achieved depends on the type of data to be compressed. This manual assumes an average compression efficiency of 2:1.

When the EXB-8500c compresses data, it uses the established Improved Data Recording Capability (IDRC) algorithm. Licensed from IBM, this algorithm is the *de facto* standard in mainframe environments. It features the EXABYTE Compression Integrity Check™ feature to ensure that data is accurately compressed and decompressed into the original form sent by the initiator.

The compression algorithm is completely contained in an EXABYTE proprietary integrated circuit (IC). The EXB-8500c invokes the compression algorithm intelligently, constantly monitoring the compression ratio to determine whether compressing the data will actually decrease the size of the data set. The EXB-8500c sends compressed data to tape only when it benefits the user's storage capacity and throughput.

For detailed information about how the EXB-8500c implements data compression, see Chapter 5.

Related Products

This section describes other EXABYTE products that are used with the EXB-8500 and EXB-8500c, including the following:

- EXATAPE 8mm Data Cartridges
- EXABYTE 8mm Cleaning Cartridges
- EXABYTE 8mm Tabletop Cartridge Tape Subsystem (CTS)

EXATAPE Data Cartridges

The EXB-8500 and EXB-8500c use data-quality removable, rewriteable 8mm metal-particle data cartridges. These data cartridges require no formatting or other media conditioning before use.

Important

EXABYTE strongly recommends that you use EXATAPE™ data-grade metal-particle media with all EXABYTE products. Unlike media available from other manufacturers, EXATAPE media is specifically controlled for use in a data storage environment and offers extended durability, long-term archivability, and greater reliability. In addition, exclusive use of EXATAPE media with EXABYTE 8mm CTSs has been shown to prolong head and tape life. EXATAPE media meets specifications that are the most stringent in the industry.

Do not attempt to use “Hi-8” metal-particle or any type of metal-evaporative tape. These tapes will be ejected automatically by the EXB-8500 and EXB-8500c.

Figure 1-2 shows EXATAPE data cartridges.

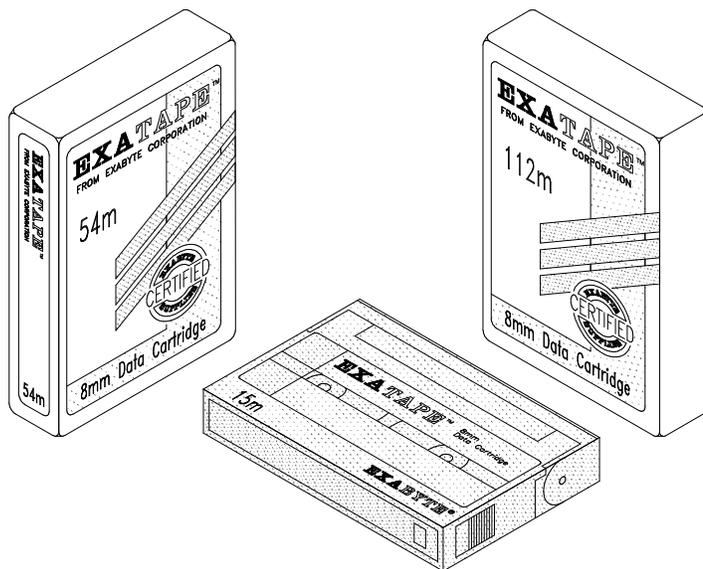


Figure 1-2 EXATAPE 8mm Data Cartridges

EXATAPE data cartridges are available from EXABYTE in the following three lengths:

- EXATAPE 15m
- EXATAPE 54m
- EXATAPE 112m

Table 1-2 lists the approximate capacities of these data cartridges in all four logical formats.

Table 1-2 Approximate capacities of EXATAPE data cartridges in all formats

Length of EXATAPE	Approximate Capacity to LEOT ^a in MBytes			
	EXB-8500c compressed format (2:1) ^b	EXB-8500 format	EXB-8200c compressed format (2:1) ^b	EXB-8200 format
15m	1,176	588	588	294
54m	4,697	2,348	2,348	1,174
112m	9,888	4,944	4,698	2,349

^a Logical end of tape.

^b These columns assume an average compression ratio of 2:1 (on average, each compressed 1,024-byte physical block represents 2,048 bytes of user data).

EXABYTE 8mm Cleaning Cartridges

Designed to clean the Cartridge Tape Subsystem (CTS), the EXABYTE 8mm Cleaning Cartridge contains a shed-free fabric tape that traps and removes debris from the CTS's heads and tape path. By using this cleaning cartridge on a regular basis, you will help the EXB-8500 and EXB-8500c maintain data integrity and improve reliability.

Using the cleaning cartridge is easy. You simply insert the cartridge into the CTS and the cleaning process is performed automatically.

Important

The EXABYTE 8mm Cleaning Cartridge (or EXABYTE-approved cleaning cartridge) is the only authorized method for cleaning the EXB-8500 and EXB-8500c. Other 8mm cleaning kits can leave minute fragments from the cleaning tapes in the CTS's tape path or on the heads. If you use any other type of cleaning material, your EXB-8500 or EXB-8500c warranty is void.

Figure 1-3 shows EXABYTE 8mm Cleaning Cartridges, which come in two types: either 3 cleaning passes per cartridge or 12 passes per cartridge.

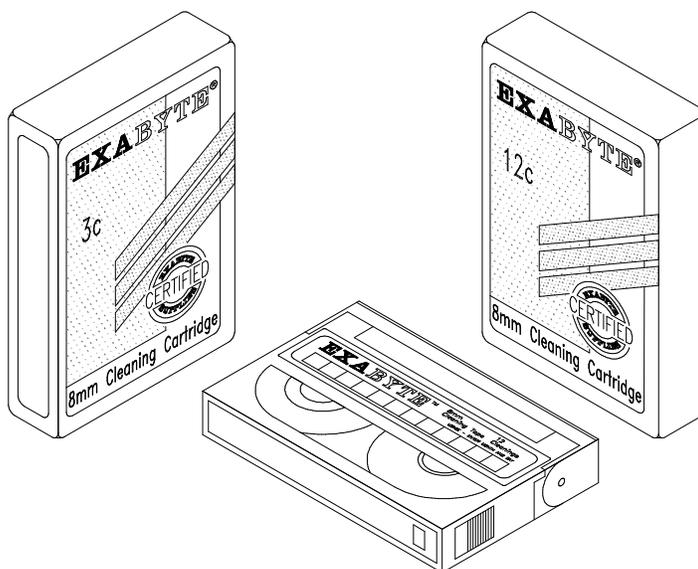


Figure 1-3 EXABYTE 8mm Cleaning Cartridges

Tabletop 8mm Cartridge Tape Subsystem

You can purchase the EXB-8500 or EXB-8500c already integrated with the EXABYTE Tabletop 8mm Cartridge Tape Subsystem (Tabletop CTS). Because the Tabletop CTS comes with its own power supply, SCSI connectors, and Monitor port, you do not need to spend additional development time designing an enclosure and obtaining agency approval. Figure 1-4 shows the Tabletop CTS with an EXB-8500 installed.

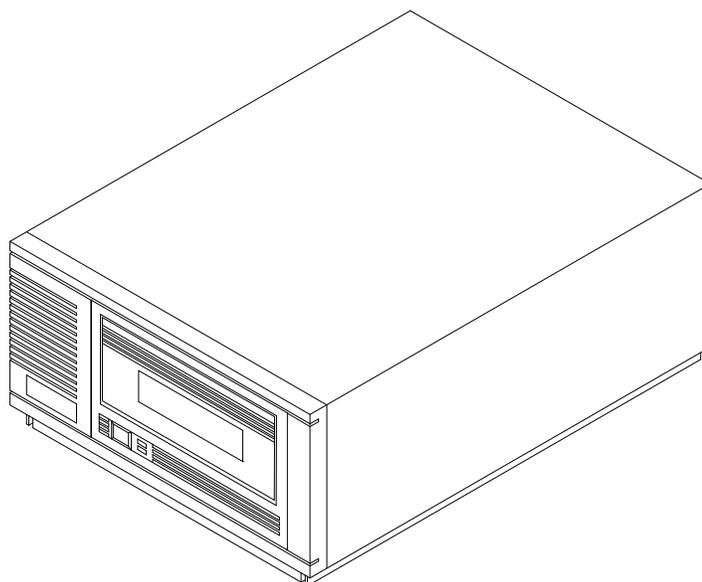


Figure 1-4 Tabletop CTS with an EXB-8500 installed

The Tabletop CTS offers these additional features:

- **Configuration flexibility.** Lightweight, completely enclosed, temperature controlled design.
- **Power protection.** Internal, self-switching universal power supply allows continuous operation during limited power interruptions or surges. AC line filter minimizes interference.
- **Superior reliability.** Maximum EMI/RFI shielding in a fully enclosed container meets the most stringent regulatory and safety agency standards.
- **Advanced interface.** Remote SCSI ID switch and two SCSI connectors provide multiple options in a daisy-chained environment.

- **Ease of use.** An external 9-pin Monitor port allows quick diagnostics and code updates for the enclosed CTS.

For more information about the Tabletop CTS, refer to the *Tabletop 8mm Cartridge Tape Subsystem Product Specification*.

2

Physical Description

This chapter describes the physical features of the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c), including the following:

- External features
- Size and weight
- Internal components

External Features

This section describes the external features of the EXB-8500 and EXB-8500c, including the controls and indicators on the front panel, the components on the back panel, and location of the labels.

Front Panel Controls and Indicators

Figure 2-1 shows the controls and indicators on the front panel of the EXB-8500c.

Note: Except for the letter “c” on the unload button, the front panel of the EXB-8500c is identical to the EXB-8500.

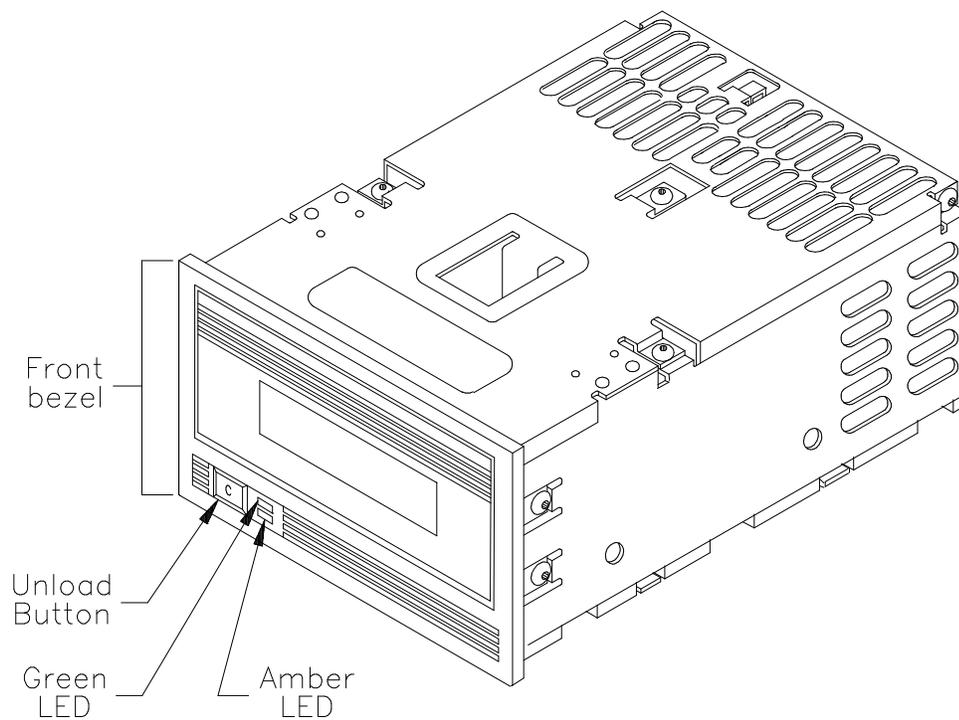


Figure 2-1 Front panel of the EXB-8500c

Front Bezel and Door

Standard colors for the front bezel and door include Black, Pearl White, Pebble Gray, Platinum, and Gray. EXABYTE can provide custom colors at additional cost. (Contact your Account Manager for more information.)

The front door of the EXB-8500 and EXB-8500c includes a clear window that enables you to view the label of the inserted data cartridge.

Unload Button

The unload button is the only operator control on the EXB-8500 and EXB-8500c. Pushing this button starts the unload procedure. See Chapter 12 for more information about loading and unloading cartridges.

LEDs

The EXB-8500 and EXB-8500c contain two LEDs on the front panel. Various combinations of these LEDs (either on, off, or flashing) indicate the status of EXB-8500 and EXB-8500c operations. See Chapter 12 for more information about the LED functions.

Back Panel Components

Figure 2-2 shows the back panel of a single-ended EXB-8500 or EXB-8500c. The differential version looks similar, except it does not contain resistor terminators.

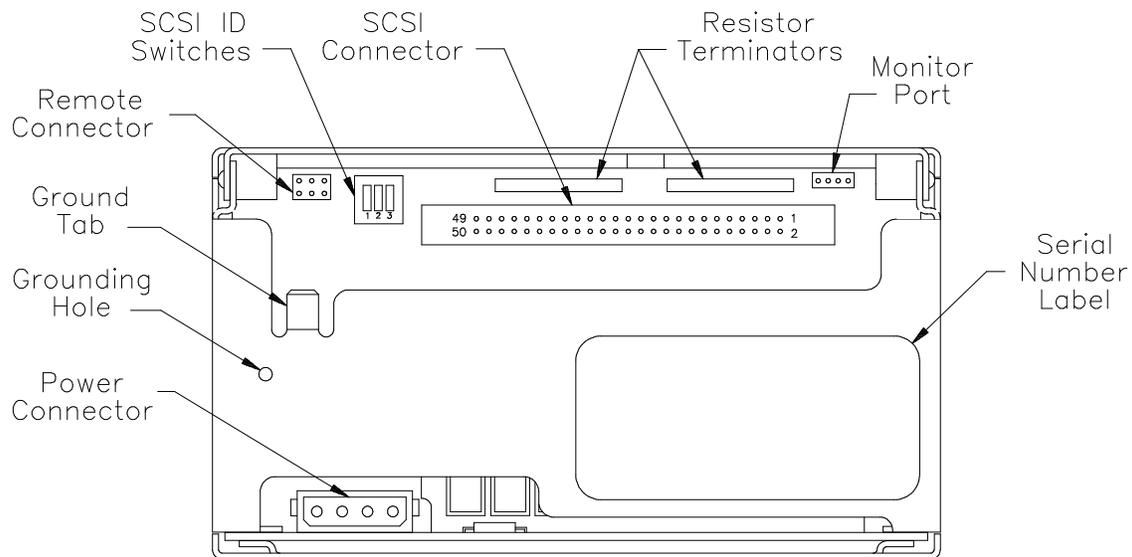


Figure 2-2 Back panel of the EXB-8500/EXB-8500c

Power Connector

The 4-pin power connector is compatible with the power connector used for standard 5.25-inch devices. See Chapter 8 for more information.

Ground Tab and Grounding Hole

The EXB-8500 and EXB-8500c include a ground tab and grounding hole to use if you want additional chassis grounding. See Chapter 8 for more information.

Remote Connector and SCSI ID Switches

The EXB-8500 and EXB-8500c include both a remote connector and DIP switches for setting the SCSI ID. See Chapter 11 for more information about setting the SCSI ID.

SCSI Connector

The 50-pin SCSI connector allows you to connect the EXB-8500 or EXB-8500c to the SCSI bus. See Chapter 11 for more information.

Resistor Terminators (single-ended configuration only)

The single-ended configuration of the EXB-8500 or EXB-8500c includes two single inline package (SIP) resistor terminators (R-packs) that you can use if the EXB-8500 or EXB-8500c is the terminating device for the SCSI bus. You can remove these terminators if the EXB-8500 or EXB-8500c does not terminate the bus or if you want to use external terminators.

Note: The differential configuration of the EXB-8500 or EXB-8500c does not include internal terminators and must be terminated externally. See Chapter 11 for more information.

Monitor Port

The Monitor port enables you to change some of the EEPROM options, download code updates, and perform diagnostic procedures.

To use the Monitor port, you need the EXABYTE CTS Monitor program, an IBM AT[®], XT[™], or compatible system with a serial port, a 4-pin to 25-pin connector cable (EXABYTE part number 727005), and, if the system has a serial port with a 9-pin connector, a 9-pin to 25-pin adapter cable.

For more information about the Monitor port and the Monitor program, refer to *Monitor User's Guide for the 8mm Cartridge Tape Subsystem*.

Label Locations

All EXABYTE products are required to include the standard Machine Level Code History (MLCH) and serial number labels. The serial number label is located on the back panel, as shown in Figure 2-2. The MLCH label (not shown) is located on the top panel.

Dimensions and Weight

Designed to meet industry-standard 5.25-inch factor mounting requirements, both the EXB-8500 and EXB-8500c are 3.25 inches high \times 5.75 inches wide \times 8.00 inches deep (82.5 \times 146.0 \times 203.2 mm). They each weigh 4.5 pounds (2.045 kilograms). Figure 2-3 shows the external dimensions of the EXB-8500 and EXB-8500c.

For information about mounting requirements, see Chapter 11.

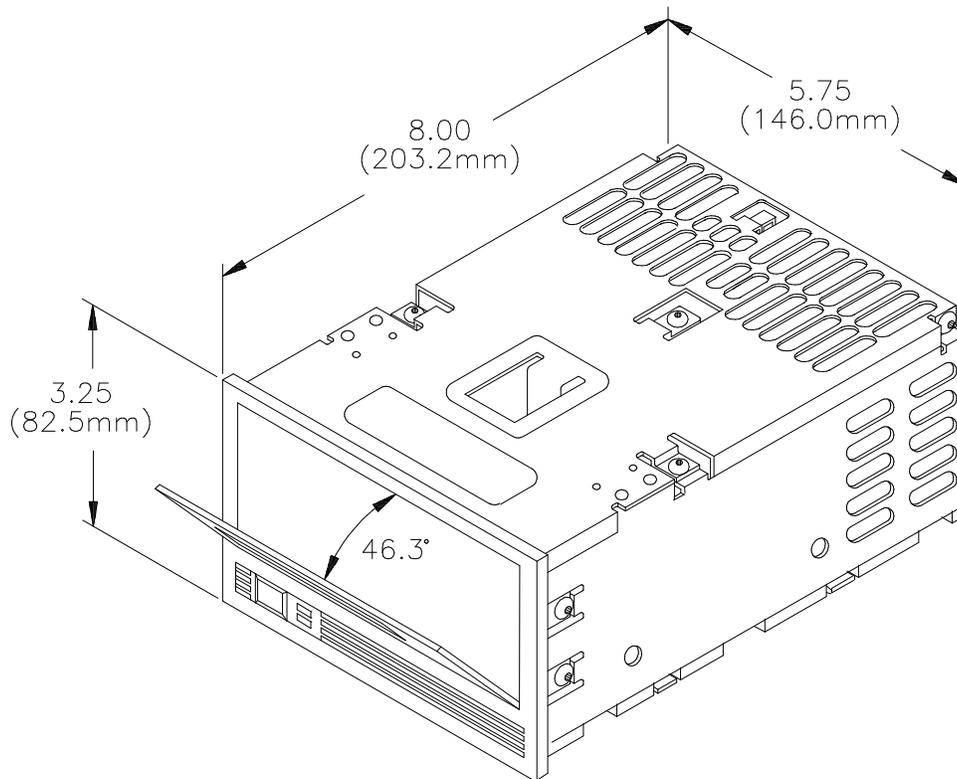


Figure 2-3 External dimensions in inches (and millimeters)

Internal Components

This section describes the internal components of the EXB-8500 and EXB-8500c, including the tape transport mechanism, the rotating drum assembly, and each of the main cards.

Figure 2-4 shows the internal components of the EXB-8500 and EXB-8500c.

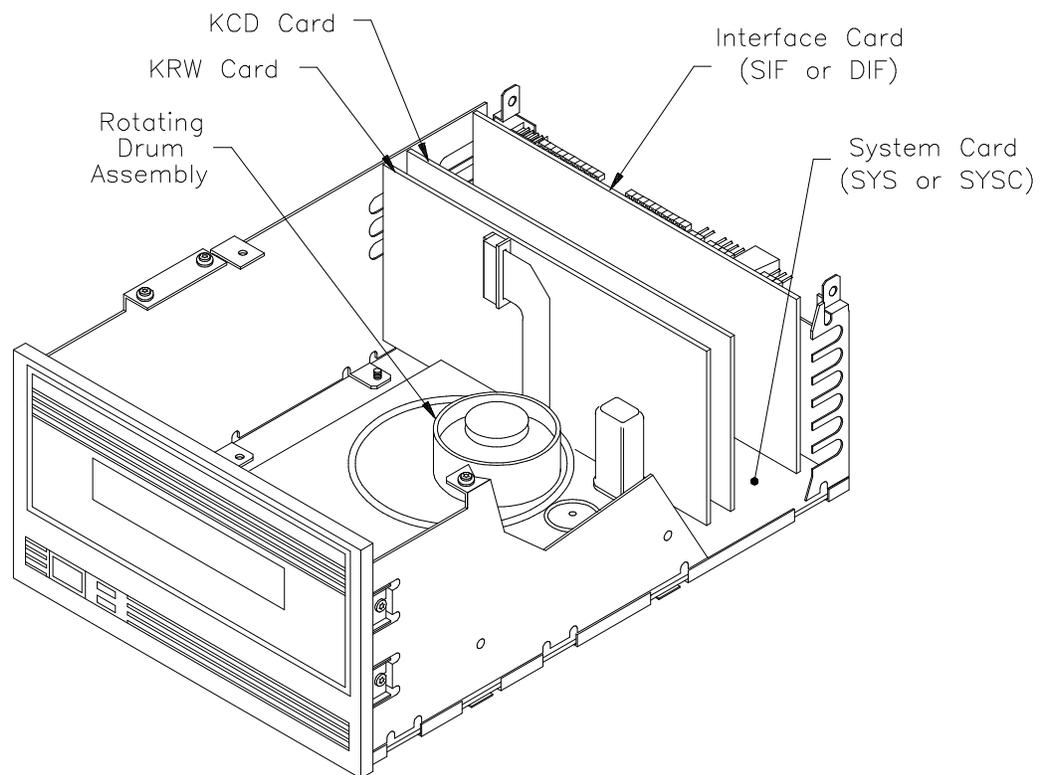


Figure 2-4 Internal components

Tape Transport Mechanism

The 8mm tape transport mechanism is manufactured by Sony to EXABYTE specifications. It is compatible with 8mm data cartridges that meet the ECMA-145 standard.

Rotating Drum Assembly

The rotating drum assembly has five heads: two write heads (W1, W2), two read heads (R1, R2), and one servo head. Figure 2-5 shows the location of the heads on the drum assembly.

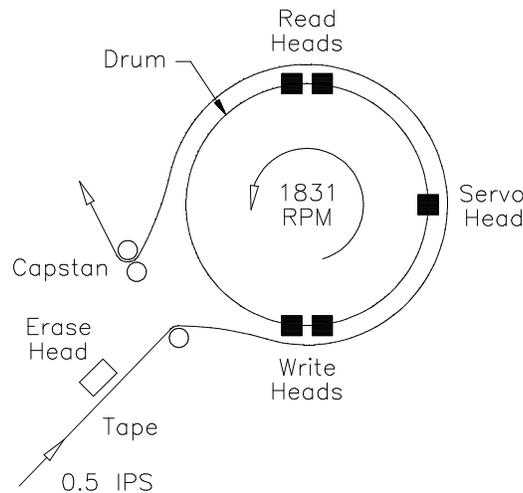


Figure 2-5 Write, read, and servo heads on the drum

The write and read heads can write and read two tracks of information simultaneously. (See Chapter 4 for more information about physical tracks on the tape.) The servo head is used for reading servo data, which enables the EXB-8500 and EXB-8500c to control linear tape velocity to ensure accurate positioning of the read heads over the tape.

The drum rotates constantly in the native format (either EXB-8500 format for the EXB-8500, or EXB-8500c for the EXB-8500c) at 1831 rpm, resulting in a nominal effective head-to-tape speed of approximately 150.5 inches per second (3.8 meters per second). Actual tape movement is 0.44 inches per second (11.1 millimeters per second). Forces acting on the tape and various component mechanisms are correspondingly low, resulting in long life for both the media and tape transport mechanism.

System Card (SYS or SYSC)

The System card (*SYS* for the EXB-8500; *SYSC* for the EXB-8500c) provides controller functions, servo functions, and certain data formatter functions of the EXB-8500 and EXB-8500c. For the EXB-8500c, the SYSC card also includes the IC that contains the Improved Data Recording Capability (IDRC) data compression algorithm.

Controller Functions

Controller functions are implemented using an 8051-compatible microprocessor with its own dedicated flash EPROM. These functions include the following activities:

- Scheduling of all operations
- Motion control management
- Data transfer and buffer management
- Logical to physical packing and unpacking
- Tape formatting: header and search field generation
- Read-after-write verification and rewrite management
- Statistics and sense data
- Error recovery procedures
- Monitor interface

Servo Functions

Servo functions are implemented using a 6303-compatible microprocessor with its own dedicated flash EPROM. Servo functions control all mechanical activities, including the following:

- Control of the tape transport mechanism
- Adjustment of tape velocity based on track-embedded servo information
- Control of the loading and unloading of the cartridge and the automatic threading and unthreading of the tape into the tape path.

The servo firmware controls the tape transport using the following circuits:

- Drum, reel, and capstan servos
- Circuits that drive the reel motor, the load motor, the drum and capstan motors, the mode change motor, and the control solenoid

- Sensor interface circuits for the drum, reel, and capstan tachometers
- Sensor interface circuits for the load and mode states
- Sensor interface circuits for detecting physical beginning of tape (PBOT), physical end of tape (PEOT), tape length and type, and write protect and door closed states

Data Formatter Functions

The System card includes the 1-MByte data buffer, the write encoder, and the read decoder, which are implemented in three digital LSI circuits that control certain data formatter functions. The System card also contains the erase electronics.

Data Buffer The data buffer includes 1 MByte of DRAM, which is organized as a 9-bit wide, dual-port, circular memory. Data transfers between the SCSI bus and the buffer occur asynchronously or synchronously. (See Chapter 5 for more information about the data buffer.)

Write Encoder The write encoder receives data blocks from the buffer. It then appends ECC information, inserts synchronization markers, and performs interleave sequencing of bytes through the modulation encoder and bit serializer. It also adds the search fields, clock sync areas, and servo data to create a complete track. (See Chapter 5 for more information about write functions. See Chapter 4 for more information about the format of the track.)

Read Decoder The read decoder receives a serial data bit stream and clock from the clocking and detection circuit. It detects synchronization markers, determines location of data, demodulates data bytes, and assembles data blocks (and corrects them if necessary). The read decoder also makes search field data available. (See Chapter 5 for more information about read functions.)

Erase Electronics The erase electronics consist of a frequency generator and an Automatic Gain Control current driver for the erase head.

KRW and KCD Cards

The KRW card contains read and write driver circuitry. The KCD card contains analog filters, equalization, and clock-detect circuitry. Together, these cards comprise the write and read electronics.

The write electronics consist of write control circuits for digital data and servo information, as well as the write head driver circuits.

The read electronics consist of preamplifiers and equalization circuits for the read channels, the servo channel, amplitude sensing, and data clocking and detection.

Interface Card (SIF or DIF)

The Interface card (*SIF* for single-ended SCSI; *DIF* for differential SCSI) contains an integrated SCSI controller, which provides the SCSI bus protocol that allows data to be transferred between the EXB-8500 or EXB-8500c and the initiator. This card is responsible for all SCSI bus management, SCSI command decoding, and SCSI status presentation.

The SCSI controller provides the following features:

- One of the following SCSI bus interface controllers:
 - 33C93A for single-ended SCSI configurations
 - 33C92A for differential SCSI configurations
- SCSI bus parity checking configurable through an EEPROM option or with the MODE SELECT command.
- Support for multiple initiator configurations.
- Support for the disconnect, reconnect, and arbitration feature. This feature releases the EXB-8500 or EXB-8500c from the bus so that it can operate under its own internal intelligence system and the SCSI bus can perform other I/O requests.

See Chapter 6 for information about data transfer rates.

Notes:

3

Interface Specifications

This chapter describes the Small Computer System Interface (SCSI) characteristics for the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c), including:

- Operation in the SCSI environment
- General SCSI features of the SCSI controller
- SCSI protocol for communication between devices
- SCSI commands supported by the EXB-8500 and EXB-8500c and a brief description of how you can use these commands to design and implement a SCSI driver program

The interface implemented for the EXB-8500 and EXB-8500c conforms to the following standard for a sequential access device: ANSI *Small Computer System Interface-2 (SCSI-2)*, X3.131-1991.

Operation in the SCSI Environment

The Small Computer System Interface (SCSI) is a standard specification that acts as a translation system between a host computer and targets, such as the EXB-8500 or EXB-8500c. The EXB-8500 and EXB-8500c use this translation system to receive commands for performing backup functions and to report their status.

The physical components of the SCSI system consist of the following:

- **Initiator or host.** A host bus adapter (HBA) card installed in a host computer allows the computer to act as the host of commands on the bus.
- **Targets.** The EXB-8500 and EXB-8500c are targets capable of receiving commands from the host.
- **SCSI bus.** The SCSI cable connected to the HBA card and to the EXB-8500 or EXB-8500c (as well as other devices on the bus) provides a pathway for passing the commands (or signals) from the host to the target and from the target to the host.

Note: You must provide your own host computer, host bus adapter card, and SCSI cable.

Figure 3-1 shows a simple, physical connection between a host computer and the Tabletop CTS with an EXB-8500 installed.

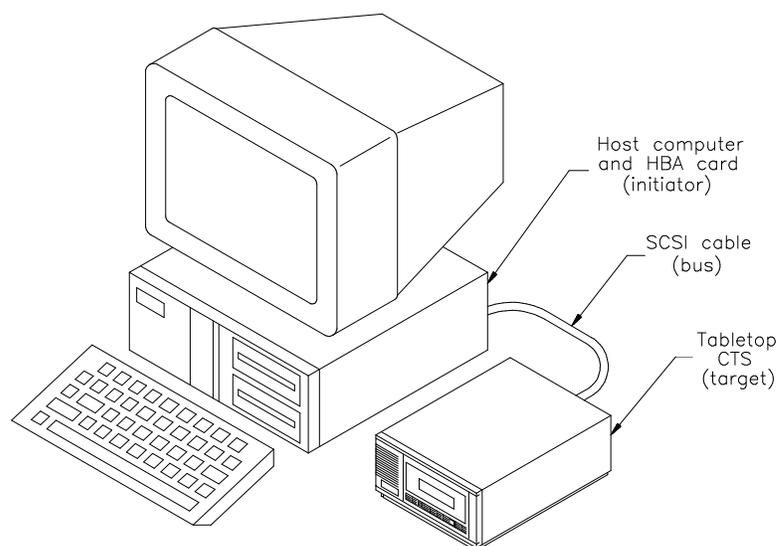


Figure 3-1 Physical connection in the SCSI environment (example)

In the example in Figure 3-1, the HBA card installed in the host acts as the initiator. The initiator sends commands along the bus (through the SCSI cable) to various targets. The target in this example is the EXB-8500 installed in the Tabletop CTS.

To increase your system's backup and restore capabilities, you can connect a combination of eight devices (initiators and/or targets) on the SCSI bus.

SCSI ID

The SCSI ID is a number that enables the initiator to access devices on the SCSI bus. Each device on the SCSI bus must have a unique ID, from 0 to 7. The default SCSI ID for the EXB-8500 or EXB-8500c is 0.

Single-Ended or Differential SCSI

The EXB-8500 and EXB-8500c support either single-ended or differential SCSI configurations. In a single-ended SCSI configuration, one line is used to transmit a bus signal between the initiator and the target. In a differential configuration, two lines are used to transmit a signal.

Important

When attached to the same SCSI bus, all devices—including the host system and the EXB-8500 or EXB-8500c—must have the same SCSI configuration (that is, either single-ended or differential).

SCSI Protocol

This section describes the SCSI protocol for communication between SCSI devices. This protocol includes the following:

- Bus phases
- Message system

Bus Phases

Bus phases control communication on the SCSI bus, such as the direction and type of information on the data lines. The possible bus phases include:

- Bus Free
- Arbitration
- Selection
- Reselection
- Transfer, which includes four subsets: Message (In or Out), Command Out, Data (In or Out), and Status In

Each of these phases is determined by a combination of bus signals.

Table 3-1 describes each of the phases.

Table 3-1 Bus phases and information transfer phases

Phase	Description
Bus Free	The Bus Free phase specifies that no device is using the bus.
Arbitration	The Arbitration phase allows devices to compete for access on the bus. Without this option, only a single initiator with no disconnect configuration could be used.
Selection	The Selection phase allows an initiator to select the target for communication.
Reselection	The Reselection phase allows the target to reconnect to the host after it disconnects.
Message In/ Message Out	The Message phases help manage the physical path between the initiators and targets. In the Message Out phase, the initiator sends a message to the target. In the Message In phase, the target sends a message to the initiator.
Command Out	In the Command Out phase, the initiator sends commands to the target. Commands contain information about what actions the target should perform.
Data In/Data Out	In the Data In phase, the target transfers data to the initiator. In the Data Out phase, the initiator transfers data to the target.
Status In	In the Status In phase, the target returns a status byte to the initiator after every command operation. The status byte indicates the results of the command's execution.

SCSI Message System

The message system allows communication between an initiator and the EXB-8500 or EXB-8500c for physical path management. These messages include management of error detection, data transfer retries, and the data path.

Table 3-2 lists the SCSI messages supported by the EXB-8500 and EXB-8500c Cartridge Tape Subsystems (CTSs).

Table 3-2 SCSI messages

Message	Hex Value	Description	Direction	
			In (CTS to Initiator)	Out (Initiator to CTS)
Command Complete	00h	The CTS informs the initiator that the execution of the command was completed and that it sent a valid status byte to the initiator.	✓	
Extended Message (Synchronous Data Transfer Request)	01h	The CTS and the initiator negotiate for synchronous data transfer.	✓	✓
Save Data Pointers	02h	The CTS informs the initiator that it received a block of data.	✓	
Restore Pointers	03h	The CTS informs the initiator that it did not properly receive a block of data and that the data needs to be transferred again from the last saved point.	✓	
Disconnect	04h	The CTS informs the initiator that it plans to disconnect from the SCSI bus and that a reconnect will occur later.	✓	
Initiator Detected Error	05h	The initiator informs the CTS that an error occurred. The CTS may retry the operation.		✓
Abort	06h	The initiator is clearing the present and any pending operations for that initiator. When the CTS accepts this message, it releases the bus into the Bus Free phase.		✓

Message	Hex Value	Description	Direction	
			In (CTS to Initiator)	Out (Initiator to CTS)
Message Reject	07h	Either the initiator or the CTS is indicating that the last message received was inappropriate or not implemented.	✓	✓
No Operation	08h	The initiator informs the CTS that it does not have a valid message to send in response to the CTS's request for a message.		✓
Message Parity Error	09h	The initiator informs the CTS that one or more bytes in the last message it received had a parity error.		✓
Bus Device Reset	0Ch	The initiator instructs the CTS to perform a hard reset. The CTS releases the SCSI bus into the Bus Free phase, with no operations pending for any initiator.		✓
Identify	80h or C0h	This message is used to establish a physical path connection between the initiator and the target for a particular LUN (logical unit number). When the CTS receives this message from the initiator, it can disconnect as required.	✓	✓

SCSI-2 Command Set

Table 3-3 lists the SCSI-2 command set supported by the EXB-8500 and EXB-8500c Cartridge Tape Subsystems (CTSs).

Table 3-3 SCSI-2 command set

Command	OP Code	Description
ERASE	19h	Erases the tape from its current position to the physical end of tape.
INQUIRY	12h	Causes the CTS to return information about its parameters to the initiator.
LOAD/UNLOAD	1Bh	Loads or unloads the data cartridge.
LOCATE	2Bh	Positions the tape at a specific logical block address. Used in conjunction with the READ POSITION command.
LOG SELECT	4Ch	EXB-8500c only. Allows you to manage the counters that the CTS maintains about its write and read error recovery operations.
LOG SENSE	4Dh	EXB-8500c only. Allows you to retrieve statistical information about the CTS's read and write error recovery operations.
MID-TAPE WAKE-UP	1Bh	EXABYTE unique—optional. Provides a quick way to power off the CTS and on during data logging operations. (When this command is used, the tape is not rewound or unloaded and the power-on self-test can be shortened.)
MODE SELECT	15h	Allows you to specify medium, logical unit, and device parameters.
MODE SENSE	1Ah	Enables the CTS to report medium, logical unit, or device parameters.
PREVENT/ALLOW MEDIUM REMOVAL	1Eh	Allows or disallows the removal of the data cartridge.
READ	08h	Transfers one or more bytes or blocks of data from the tape to the initiator.
READ BLOCK LIMITS	05h	Requests that the CTS return data identifying the maximum and minimum logical block lengths supported.
READ BUFFER	3Ch	Copies CTS microcode across the SCSI bus to the initiator. Used in conjunction with the WRITE BUFFER command.

Command	OP Code	Description
READ POSITION	34h	Reports the current logical tape position. Used in conjunction with the LOCATE command.
RECEIVE DIAGNOSTIC RESULTS	1Ch	Reports the results of the tests requested by a previous SEND DIAGNOSTIC command or provides a trace of SCSI and servo command activity.
RELEASE UNIT	17h	Releases the CTS from an initiator's exclusive use, or if third-party reservations are in effect, from another SCSI device's use. Used in conjunction with the RESERVE UNIT command.
REQUEST SENSE	03h	Requests that the CTS transfer sense data to the initiator.
RESERVE UNIT	16h	Reserves the CTS for an initiator's exclusive use, or if third-party reservations are in effect, for another SCSI device's use. Used in conjunction with the RELEASE UNIT command.
REWIND	01h	Rewinds the tape to the logical beginning of tape.
SEND DIAGNOSTIC	1Dh	Causes the CTS to perform certain self-diagnostic tests.
SPACE	11h	Causes the CTS to perform forward or backward searches at high speed.
TEST UNIT READY	00h	Allows you to determine if the CTS is ready to accept an appropriate medium access command.
VERIFY	13h	Enables the CTS to verify one or more logical blocks of data on the tape.
WRITE	0Ah	Transfers one or more bytes or blocks of data from the initiator to the CTS.
WRITE BUFFER	3Bh	Allows you to load new microcode from the SCSI bus into the CTS's control memories. Used in conjunction with the READ BUFFER command.
WRITE FILEMARKS	10h	Causes the CTS to write a specified number of filemarks to tape. (In EXB-8500c format, you can use this command to write setmarks as well as filemarks.)

Using SCSI Commands

The SCSI command set allows you to design and implement a driver for the EXB-8500 and EXB-8500c Cartridge Tape Subsystems (CTSs). As described in this section, some of the operations you can perform with SCSI commands include the following:

- Reserving the CTS
- Setting and reporting operating parameters
- Writing data to tape
- Reading data from tape
- Searching for data on tape at a high speed
- Erasing data
- Rewinding the tape and unloading the data cartridge
- Inquiring about the CTS status
- Performing diagnostic tests
- Copying microcode from one CTS to another
- Performing mid-tape wake-up operations

Reserving the EXB-8500 or EXB-8500c

Use the RESERVE UNIT (16h) command to reserve the CTS for the initiator's exclusive use or for another SCSI device's exclusive use (if third-party reservations are in effect). Use the RELEASE UNIT (17h) command to cancel the reservation.

Setting Operating Parameters

To set the operating parameters for the CTS, use the MODE SELECT (15h) command. To find out how these parameters are set, use the MODE SENSE (1Ah) command.

Writing Data

To transfer variable-length or fixed-length logical blocks of data from the initiator to the tape, use the WRITE (0Ah) command. As described in Chapter 4, you can write data in two logical tape formats with the EXB-8500; you can write data in four logical tape formats with the EXB-8500c. You specify the tape format you want with the MODE SELECT (15h) command.

To write filemarks or setmarks, use the WRITE FILEMARKS (10h) command.

Note: Setmarks are supported in EXB-8500c format only.

Reading Data

To transfer data from the tape to the initiator, use the READ (08h) command. The CTS automatically sets to the format used when the tape was written and can read tapes that have a combination of fixed-length and variable-length blocks.

Searching for Data

To perform forward or backward searches at high speed, use either the SPACE (11h) command or the READ POSITION (34h) and LOCATE (2Bh) commands. During space and locate operations, the CTS moves the tape at up to 75 times its nominal tape speed.

When you use the SPACE command, you specify the number of logical blocks or filemarks to space over (or you can space directly to the end of data). When you use the READ POSITION and LOCATE commands, you first find the logical block address with the READ POSITION command and then space to that address with the LOCATE command.

Erasing Data

Use the ERASE (19h) command to erase the tape from the current valid tape position to the physical end of tape (PEOT). When the CTS completes the erase operation, it automatically rewinds the tape to the logical beginning of tape (LBOT).

Rewinding and Unloading the Tape

You can use the REWIND (01h) command or the LOAD/UNLOAD (1Bh) command to rewind the tape. The REWIND command rewinds to the logical beginning of tape (LBOT) and stops; the LOAD/UNLOAD command rewinds to the physical beginning of tape (PBOT), unloads the tape from the tape path, and ejects the data cartridge.

Note: You can use the PREVENT/ALLOW MEDIUM REMOVAL (1Eh) command to prevent or allow the data cartridge from being ejected.

Inquiring About CTS Status

To inquire about CTS status, you can use the commands described below.

REQUEST SENSE (03h) Command

Use the REQUEST SENSE (03h) command to find out why the CTS returned Check Condition status when it was trying to complete another SCSI command. The REQUEST SENSE command returns the following type of information:

- Sense Key for the error that indicates the type of error (such as, Not Ready, Hardware Error, Illegal Request, Unit Attention, Aborted Command)
- Additional Sense Code (ASC) that indicates the type of error for the given sense key
- Additional Sense Code Qualifier (ASCQ) that indicates the specific error for the sense key and ASC
- Fault Symptom Code (FSC) that indicates the specific nature of hardware and software errors or other events (the FSC is an EXABYTE-unique byte)

INQUIRY (12h) Command

Use the INQUIRY (12h) command to obtain information about the firmware level of the CTS, the version of SCSI supported, and so on.

LOG SELECT (4Ch) and LOG SENSE (4Dh) Commands (EXB-8500c only)

Use the LOG SELECT (4Ch) command to manage the counters that the EXB-8500c maintains about its write and read error recovery operations. The LOG SELECT command allows you to reset these counters or to specify threshold or cumulative values for them. You can also specify if and when you want to be notified about changes to the counters. (For example, you might want to be notified when a counter reaches its threshold value.)

Use the LOG SENSE (4Dh) command to retrieve the default or current values for these counters.

Performing Diagnostic Tests

Use the SEND DIAGNOSTIC (1Dh) and RECEIVE DIAGNOSTIC RESULTS (1Ch) commands to obtain detailed information about CTS operations. The SEND DIAGNOSTIC command allows you to run special diagnostic self-tests, including a processor memory dump. The RECEIVE DIAGNOSTIC RESULTS command allows you to obtain either the results of these tests or a trace of SCSI and servo activity.

Copying Microcode

Use the READ BUFFER (3Ch) and the WRITE BUFFER (3Bh) commands to copy the microcode from one CTS to another. First, issue a READ BUFFER command to place the microcode into the correct format and to transfer the microcode image across the SCSI bus to the initiator. Then, issue a WRITE BUFFER command to transfer the microcode from the initiator to another CTS of the same type.

Performing Mid-Tape Wake-Up Operations

Use the MID-TAPE WAKE-UP (1Bh) to power the CTS off and on more quickly. The MID-TAPE WAKE-UP command is an EXABYTE-unique command that is designed for applications requiring battery operation, such as remote-site data logging. To reduce the drain on the batteries, the MID-TAPE WAKE-UP command allows you to do the following:

1. Power the CTS off without having to rewind the tape or unload the data cartridge.
2. Power the CTS back on and continue writing data where you left off.

Important

The MID-TAPE WAKE-UP command is an EXABYTE-unique command that is implemented using the vendor unique feature of the SCSI LOAD/UNLOAD command. It is an optional command that requires a special EEPROM image from EXABYTE.

If your CTS includes the special mid-tape wake-up EEPROM, other EEPROM options are not available; instead, the CTS is shipped in a standard configuration.

4

Recording Format

This chapter describes helical scan recording and the recording formats used by the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c). The recording format defines the arrangement of information recorded on the tape and has two forms:

- **Physical format**, which is determined by the internal operations of the EXB-8500 and EXB-8500c, including the data path, recording channel, and motion control system.
- **Logical format**, which is determined by the initiator's software and certain functions of the controller and data path of the EXB-8500 and EXB-8500c.

Helical-Scan Recording

The EXB-8500 and EXB-8500c implement advanced helical-scan recording technology to increase the amount of data that can be recorded on the tape. As shown in Figure 4-1, helical-scan recorders write very narrow tracks at an acute angle to the edge of the tape. This recording method creates a track length that is several times longer than the width of the tape. The geometry of the tape path allows the tracks to be accurately positioned to precise minimal tolerances, resulting in a very high number of tracks per inch.

The combination of the helical wrap of the tape around the drum, the rotation of the head/drum assembly, and the linear motion of the tape causes the heads to trace a track across the tape that is 2.5 inches (62.6 millimeters) long, at an acute angle of approximately 5 degrees to the bottom edge of the tape.

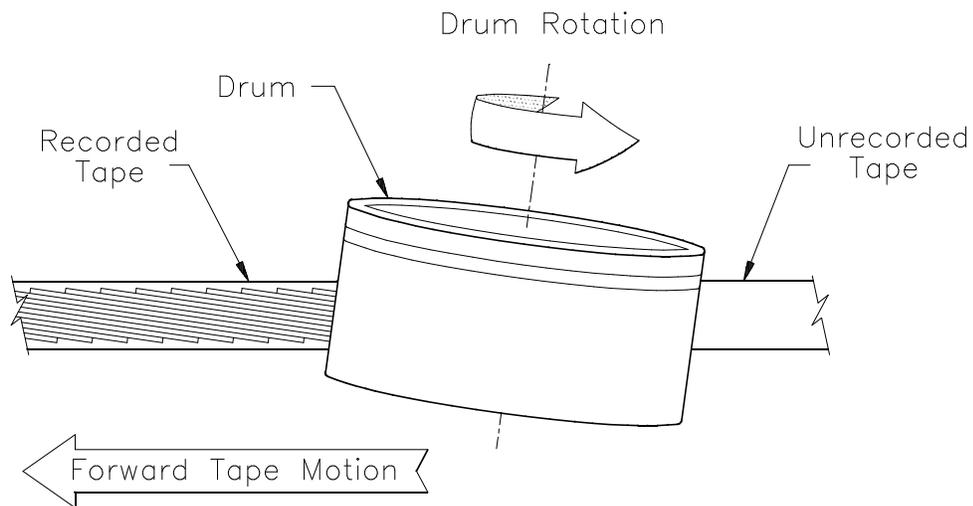


Figure 4-1 Helical scan recording

Physical Format

This section describes the physical track structure of the tape, including the types of physical track formats, physical blocks, search fields, and servo areas.

Supported Physical Track Structures

The EXB-8500 can write data to tape using either of two physical track structures:

- EXB-8500/EXB-8500c
- EXB-8200

The EXB-8500c can write physical tracks in one of three track structures:

- EXB-8500/EXB-8500c
- EXB-8200
- EXB-8200c

Table 4-1 provides additional information about the physical track structures.

Table 4-1 Physical track structures

Physical Track Structure	Description	Supported by . . .
EXB-8500/ EXB-8500c	Two overlapping tracks written to tape for each revolution of the drum. Each track contains data blocks, servo areas (track 2 only), clock sync areas, and search fields.	EXB-8500 and EXB-8500c
EXB-8200	Single track written to tape for each revolution of the drum. Each track contains data blocks and one servo area.	
EXB-8200c	Single track written to tape for each revolution of the drum. Each track contains data blocks, servo areas, clock sync areas, and search fields.	EXB-8500c

EXB-8500/EXB-8500c Physical Track Structure

In EXB-8500/EXB-8500c format, the EXB-8500 and EXB-8500c use the W1 and W2 heads to write two, partially overlapping physical tracks on the tape, for each revolution of its head/drum assembly. The width of each track is 15.5 μm . During a read operation, the EXB-8500 and EXB-8500c use the R1 and R2 heads to read the two tracks.

Figure 4-2 shows the physical track structure on a tape written in EXB-8500/EXB-8500c format.

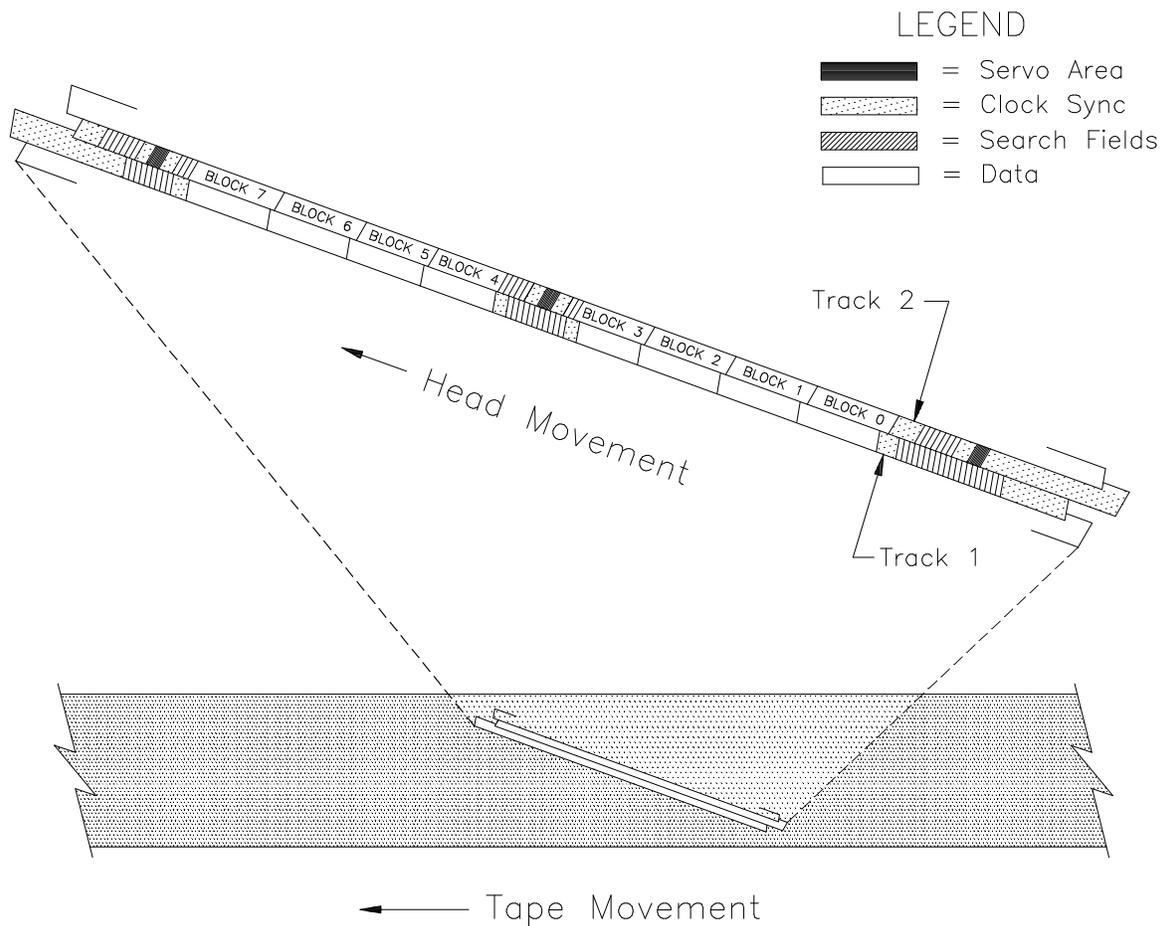


Figure 4-2 Physical track structure for EXB-8500/EXB-8500c format

Figure 4-3 shows the position of the write (W1, W2), read (R1, R2), and servo heads, relative to the tracks as the heads pass across the tape when the EXB-8500 and EXB-8500c are writing or reading EXB-8500/ EXB-8500c format tapes.

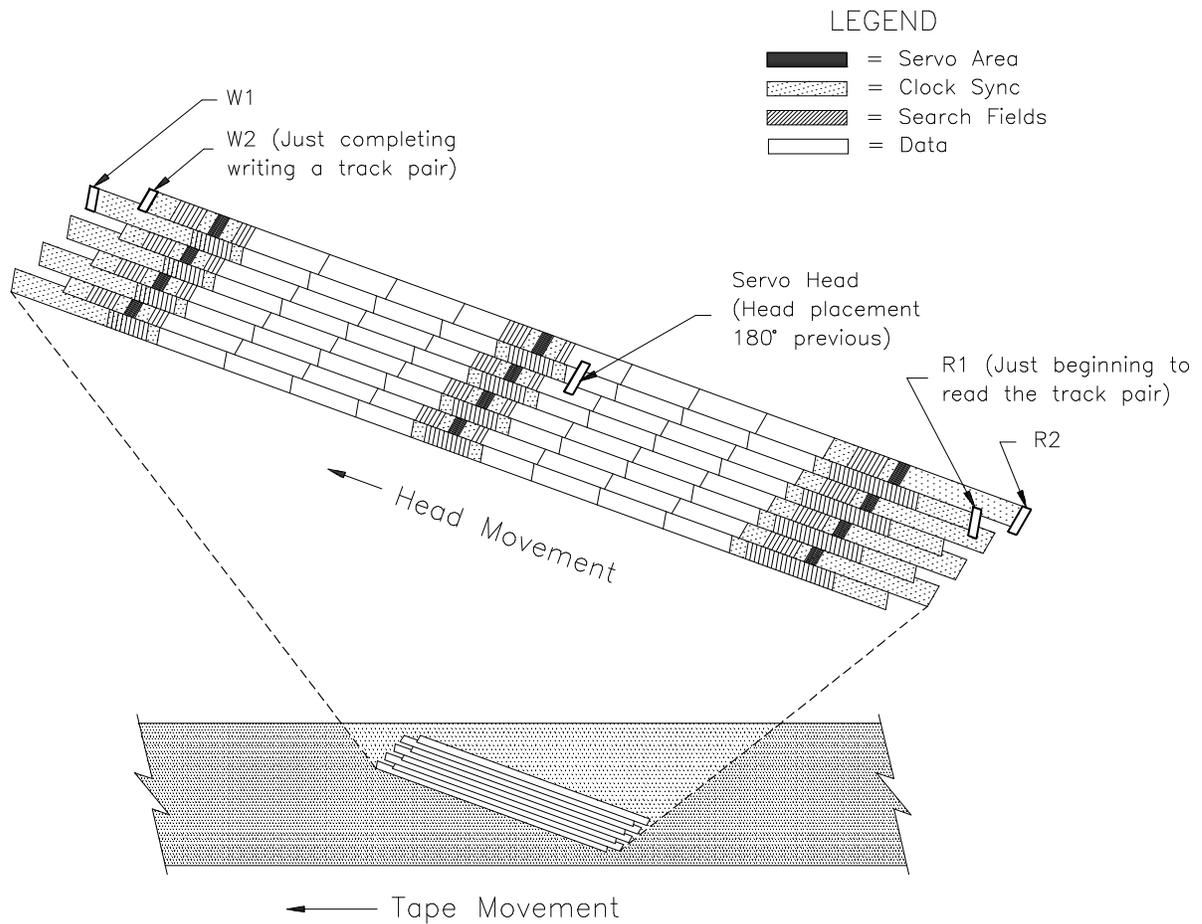


Figure 4-3 Position of the heads relative to the tracks (EXB-8500/EXB-8500c format)

EXB-8200c Physical Track Structure

In EXB-8200c format, the EXB-8500c uses the W2 head to write one physical track on the tape for each revolution of the head/drum assembly. The width of the track is 25 μm . During a read operation, the EXB-8500c uses the R2 head to read the single track.

Figure 4-4 shows the physical track structure on a tape written in EXB-8200c format.

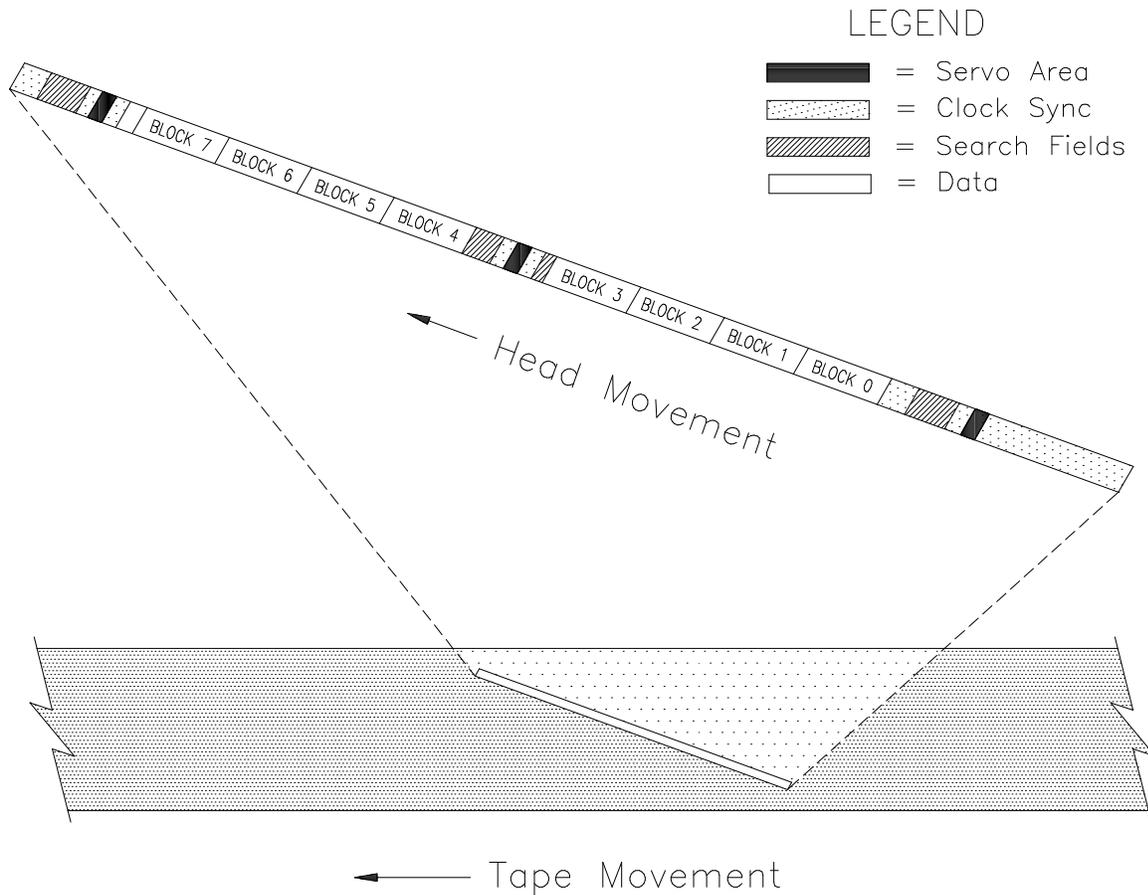


Figure 4-4 Physical track structure for EXB-8200c track format

Figure 4-5 shows the position of the EXB-8500c's write head (W2), read head (R2), and servo head, relative to the tracks as the heads pass across the tape when the EXB-8500c is reading and writing EXB-8200c format tapes.

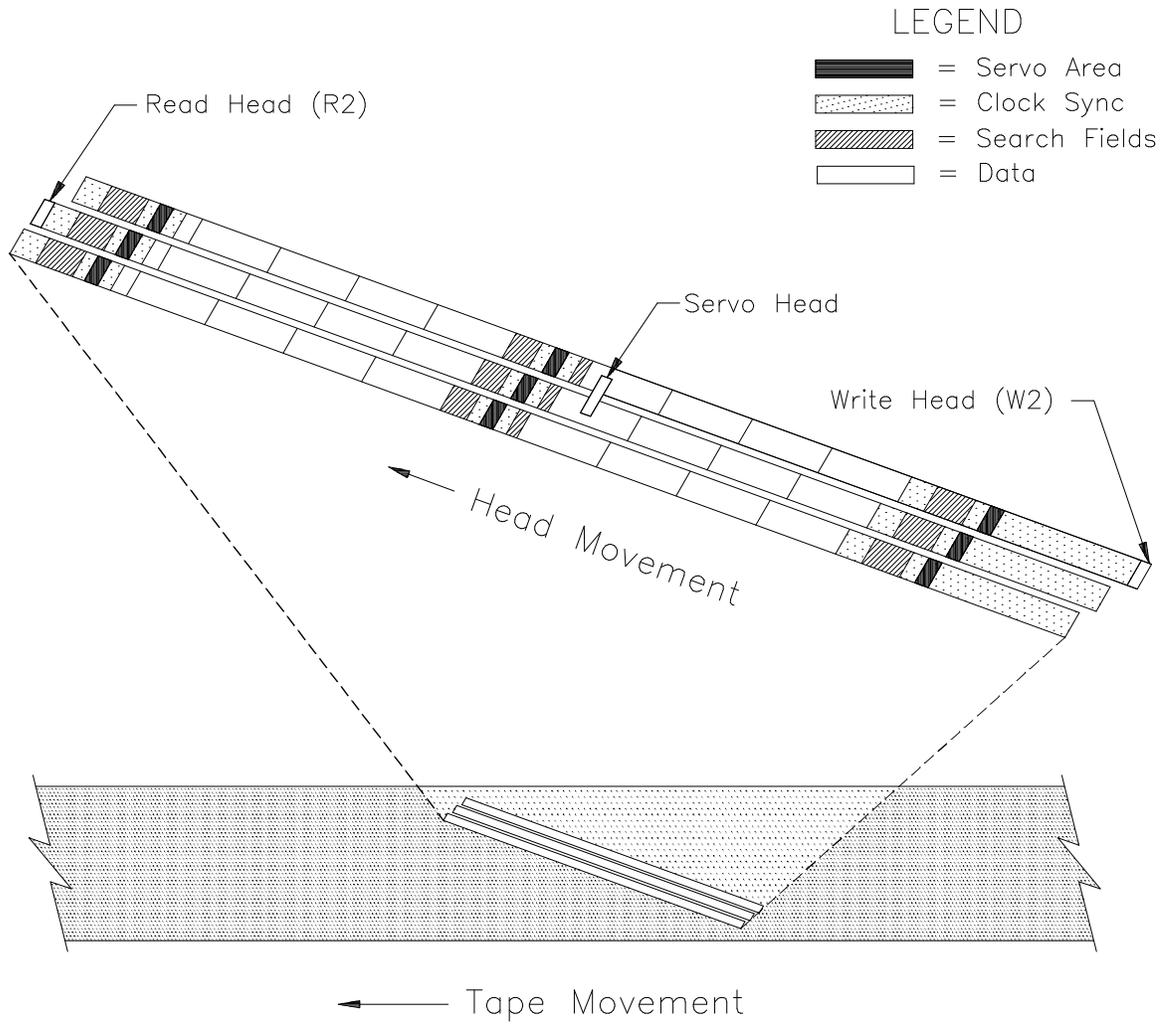


Figure 4-5 Position of the heads relative to the tracks (EXB-8200c format)

EXB-8200 Physical Track Structure

In EXB-8200 format, the EXB-8500 and EXB-8500c use the W2 head to write one physical track on the tape for each revolution of the head/drum assembly. The width of the track is 25 μm . During a read operation, the EXB-8500 and EXB-8500c use the R2 head to read the single track.

For more information about the EXB-8200 track structure, refer to the *EXB-8200 8mm Cartridge Tape Subsystem Product Specification*.

Physical Blocks

Each physical track contains eight physical blocks. A physical block can contain user data or other information. As shown in Figure 4-6, a physical block containing user data includes the following information:

- 14 bytes of header information
- 1,024 bytes of uncompressed user data or 2,048 of compressed user data (assuming a 2:1 compression efficiency)
- 400 bytes of error correction code (ECC) data
- 2 bytes of cyclic redundancy check (CRC) data

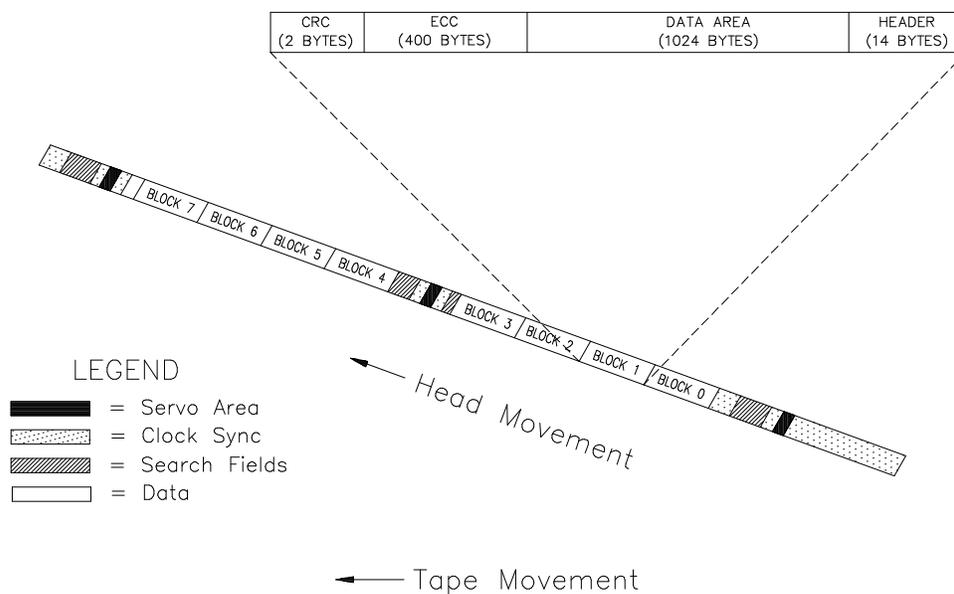


Figure 4-6 Physical block format (conceptual representation)

Note: The physical block header, ECC data, and physical block CRC data do not affect the data capacity of the tape.

Search Fields

For EXB-8500/EXB-8500c and EXB-8200c track structures, each track contains *search fields* used for high-speed search. (Figure 4-6 shows where search fields are located in a track.) The search fields are the only areas of the tape that are read during a high-speed search. The search field data contains information for locating files and blocks and detecting the end-of-data (EOD) mark during high-speed searches.

Note: Tapes written in EXB-8200 format are SCSI-1 compatible and do not contain search fields. For this reason, EXB-8200 format tapes do not support high-speed search. In addition, the EXB-8500 and EXB-8500c do not support the EXB-8200SX high-speed search feature.

Servo Areas

Each track contains *servo areas* that the EXB-8500 and EXB-8500c use to read tapes written by other Cartridge Tape Subsystems. (Figure 4-6 shows where servo areas are located in a track.) Each servo area contains a signal that the servo head detects and uses to control linear tape velocity. This track-following servo process results in accurate positioning of the track under the read head.

The servo scheme is based on the geometry of the track positions. Each servo area consists of one servo data signal burst surrounded by an erase (margin) signal. In EXB-8200c and EXB-8500/EXB-8500c formats, the EXB-8500 and EXB-8500c place a servo area at the beginning, middle, and end of the track to provide tracking information throughout the track. In EXB-8200 format, the EXB-8500 and EXB-8500c place the servo area at the beginning of each track.

Note: Refer to the *EXB-8200 8mm Cartridge Tape Subsystem Product Specification* for information about track-following servo for EXB-8200 format.

Recording Parameters

Table 4-2 shows the recording parameters for the EXB-8500 and EXB-8500c, including the parameters for writing and reading data in all physical formats.

Table 4-2 Recording parameters

Parameter	Reading and writing in this physical format:		
	EXB-8500/ EXB-8500c	EXB-8200c	EXB-8200
Tape width	8.00 mm (0.315 in)	8.00 mm (0.315 in)	8.00 mm (0.315 in)
Track length (data + servo) ^a	62.651 mm (2.47 in.)	62.651 mm (2.47 in)	71.628 mm (2.82 in)
Tracks per revolution ^b	2	1	1
Track pitch	15.5 μm (0.000610 in)	31.0 μm (0.001221 in)	31.0 μm (0.001221 in)
Track width	15.5 μm (0.000610 in)	25.0 μm (0.000984 in)	25.0 μm . (0.000984 in)
Track density	64.506 trk/mm (1638.455 trk/in)	32.253 trk/mm (819.226 trk/in)	32.254 trk/mm (819.253 trk/in)
Areal recording density	144.23 Kfc/mm ² (93.052 Mfc/in ²)	72.115 Kfc/mm ² (46.526 Mfc/in ²)	68.68 Kfc/mm ² (44.312 Mfc/in ²)
Drum speed	1831.055 rpm	1831.055 rpm	1922.607 rpm
Tape speed	11.079 mm/sec (0.436 ips)	11.079 mm/sec (0.436 ips)	11.633 mm/sec (0.458 ips)
Track angle	4.9 degrees	4.9 degrees	4.9 degrees
Wrap angle	221 degrees	221 degrees	221 degrees

^a In EXB-8200c and EXB-8500/EXB-8500c formats, servo information is embedded in three places along the length of the track. In EXB-8200 format, servo information is embedded at the beginning of the track.

^b Tracks per revolution is the number of tracks written or read for each revolution of the rotating drum assembly.

Logical Format

The following sections describe the logical characteristics of the information recorded on the tape. The logical tape format consists of the logical beginning of tape (LBOT) mark, followed by any number of tracks up to the limit for the data cartridge. These tracks can include logical blocks of data, gap blocks and gap bytes, filemarks, setmarks, partitions, and end-of-data information.

Supported Logical Formats

The EXB-8500 can write user data in one of two logical tape formats:

- EXB-8500 uncompressed format
- EXB-8200 uncompressed format

The EXB-8500c can write user data in one of four logical tape formats:

- EXB-8500 uncompressed format
- EXB-8200 uncompressed format
- EXB-8500c compressed format
- EXB-8200c compressed format

Table 4-3 provides additional information about the logical tape formats.

Table 4-3 Logical formats

Logical tape format	Corresponding physical track format	Are logical blocks compressed?	Amount of user data in each physical block	Capacity of 112m EXATAPE™ to LEOT ^a
EXB-8500c	EXB-8500/EXB-8500c (two overlapping tracks)	Optional ^b	2,048 bytes ^c	9,888 MBytes ^c
EXB-8500		No	1,024 bytes	4,944 MBytes
EXB-8200c	EXB-8200c (single track)	Yes	2,048 bytes ^c	4,698 MBytes ^c
EXB-8200	EXB-8200 (single track)	No	1,024 bytes	2,349 MBytes

^a Logical end of tape.

^b In EXB-8500c format, you can use the MODE SELECT (15h) command to turn compression on or off.

^c Assumes an average 2:1 compression ratio.

Logical Blocks

A *logical block* contains user data that is transferred from the host to the EXB-8500 or EXB-8500c. Logical blocks can have fixed or variable lengths, which can be intermixed on the tape. The EXB-8500 and EXB-8500c support uncompressed logical block sizes from 1 to 240 KBytes.

For information about setting the logical block size, refer to the appropriate user's manual.

Logical Block Compression (EXB-8500c only)

When writing data in EXB-8500c and EXB-8200c formats, the EXB-8500c compresses logical blocks of user data before placing them in the physical blocks. Thus, each physical block contains a compressed representation of the original user data. Assuming that the compression algorithm allows user data to be compressed an average of two times, each physical block written by the EXB-8500c in compressed format can contain, on average, the compressed equivalent of 2,048 bytes of user data.

Note: The actual compression ratio achieved by the EXB-8500c in EXB-8500c and EXB-8200c formats depends on the type of data to be compressed. This manual assumes an average compression efficiency of 2:1.

For more information about compression, refer to Chapter 5.

Logical Block Packing

To optimize tape capacity when writing tapes in EXB-8200c, EXB-8500, or EXB-8500c formats, the EXB-8500 and EXB-8500c pack logical blocks of user data into physical blocks. Each 1,024-byte physical block on tape can contain multiple logical blocks (for example, two 512-byte uncompressed logical blocks can be written in one physical block). To prevent losing data capacity when small logical block sizes are used, the EXB-8500 and EXB-8500c can begin writing a logical block in one physical block and end in a subsequent physical block.

Note: In EXB-8200 format, logical blocks are not packed. Only one or part of one logical block can be written in each physical block.

Figure 4-7 shows how logical blocks can be packed into one 1,024-byte physical block. In EXB-8200c, EXB-8500, and EXB-8500c formats, each physical block includes a 14-byte header that can define only two logical blocks. If the physical block contains more than two logical blocks, the EXB-8500 and EXB-8500c add an additional two-byte header in the data field for each logical block after the second one. In EXB-8200 format, each physical block contains one header and one logical block.

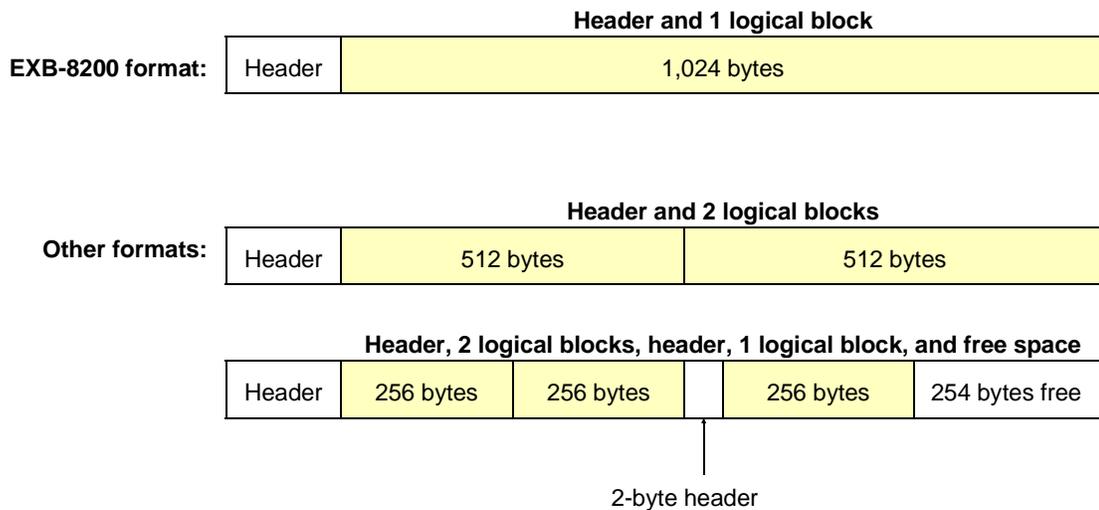


Figure 4-7 Logical block packing (one physical block)

Gap Bytes

A *gap byte* is a byte containing undefined data that the EXB-8500 and EXB-8500c use to fill empty space in a physical block. The EXB-8500 and EXB-8500c may automatically write gap bytes in the following cases:

- At the end of a write operation.
- Before writing a filemark or setmark.
- When it is physically impossible to start the next logical block in the physical block because less than three bytes are available. (This is because the two-byte header and at least one data byte must be present in the first physical block before the logical block can spill over to a second physical block.)

Figure 4-8 shows how gap bytes can be used to fill empty space at the end of a physical block.

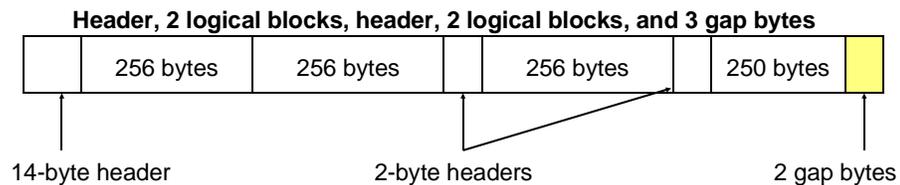


Figure 4-8 Gap bytes (one physical block)

Gap bytes cannot be accessed by any SCSI command.

Gap Blocks and Gap Tracks

A *gap block* is a physical block containing 1,024 gap bytes. A *gap track* is a physical track containing eight gap blocks. When the EXB-8500 and EXB-8500c stop at the end of a write operation, they write at least one gap track following the last track containing data blocks. In EXB-8200 or EXB-8200c formats, they write one gap track. In EXB-8500 or EXB-8500c formats, they can write two gap tracks.

The gap track provides the track orientation required to append data. When a subsequent write operation begins, the controller repositions the tape and records the data on a track adjacent to the gap track.

Figure 4-9 shows two tracks, one with seven data blocks and one gap block, and one with a gap track.

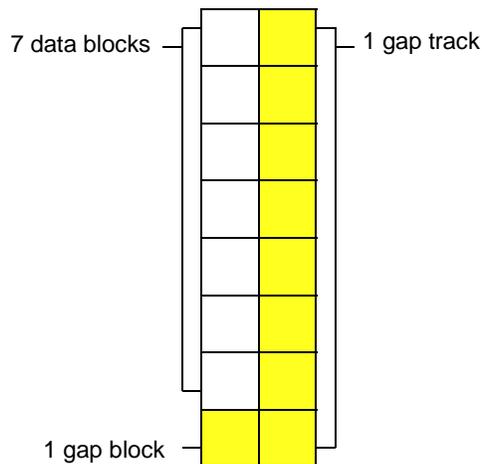


Figure 4-9 One gap block and one gap track in two physical tracks

Gap blocks cannot be accessed by any SCSI command.

Filemarks

Filemarks enable the initiator to locate particular blocks of data on the tape quickly during a high-speed search. By using a SPACE filemark (11h) command, the initiator can position the tape to the data marked by filemarks at up to 75 times the normal tape speed (or up to 10 times the normal tape speed when reading an EXB-8200 format tape).

Depending on the format, the EXB-8500 and EXB-8500c can write either a long or short filemark. Table 4-4 shows the type and size of filemarks for each format type.

Table 4-4 Type and size of filemarks for each format

Logical format	Type and size of filemarks	
	Long filemark (KBytes)	Short filemark (KBytes)
EXB-8500 or EXB-8500c	48	1
EXB-8200	2,160	184
EXB-8200c	2,160	1

Long Filemarks

A long filemark in either EXB-8500 or EXB-8500c format consists of six tracks of information:

- Two gap tracks at the beginning
- Two tracks of filemark physical blocks
- Two gap tracks at the end

Figure 4-10 shows the structure of a long filemark in EXB-8500 or EXB-8500c formats.

Figure 4-10 Long filemark tracks in EXB-8500 and EXB-8500c formats

A long filemark in EXB-8200c or EXB-8200 format consists of the following:

- An erase gap equivalent in length to 249 tracks
- 21 tracks (168 blocks) of long filemark physical blocks

The information in the filemark physical blocks identifies the filemark's number and location on the tape and cannot be accessed or changed by the user. The gap tracks at the beginning and end allow file append and file splice operations. The EXB-8500 and EXB-8500c may write additional gap tracks and gap blocks before the filemark to ensure that all data has been written to tape correctly or to complete tracks that are not completely filled with data blocks.

Short Filemarks

In EXB-8500, EXB-8500c, and EXB-8200c formats, a short filemark consists of a single, 1-KByte physical block. This block contains information identifying the filemark's number and location on the tape.

In EXB-8200 format, a short filemark consists of 21 tracks of information.

Setmarks (EXB-8500c only)

When the EXB-8500c is writing in EXB-8500c format, you can issue a WRITE FILEMARKS (10h) command to write one or more *setmarks* to tape. Setmarks provide an additional way to indicate data boundaries on the tape; in a sense, they can be thought of as “hierarchically superior” filemarks.

You can issue a SPACE (11h) command to space to setmarks; however, you can also use a MODE SELECT (15h) command to suppress setmark detection during read, verify, space block, and space filemark operations.

Each setmark occupies 249 tracks of erase gap and 21 tracks of setmark physical blocks.

End of Data (EOD)

When writing tapes in EXB-8500, EXB-8500c, or EXB-8200c format, the EXB-8500 and EXB-8500c write an end-of-data (EOD) mark after the last data written to tape. The EOD mark consists of one or more gap tracks, erase gaps, and 600 tracks of end-of-data blocks. These tracks are used when the initiator issues a SPACE (11h) command to locate the last data written to tape. The EXB-8500 and EXB-8500c overwrite the EOD mark when they write additional data to tape.

In EXB-8200 format, there is no EOD mark, but you can space to the end of data.

Partitions (EXB-8500c only)

In EXB-8500c format, the EXB-8500c can write and read tapes containing either one or two *partitions*, which are self-contained writable and readable areas on a tape. Partitioned tapes provide a highly efficient way to maintain a directory at the beginning of a tape. For more information about partitions, refer to the *EXB-8500c 8mm Cartridge Tape Subsystem User's Manual*.

Track and Block Counts

The number of tracks and physical blocks on the tape depend on the following markers:

- **Physical beginning of tape (PBOT).** PBOT is located at the point on the tape where the translucent leader material is attached to the media. This position is detected by an optical sensor in the tape transport mechanism.
- **Logical beginning of tape (LBOT).** When you issue a write operation at the beginning of tape, the EXB-8500 and EXB-8500c automatically record LBOT at approximately 29 inches (74 cm) from PBOT. The LBOT area includes tracks of LBOT information, which are used to indicate the LBOT's location, to calibrate the servo system and to indicate whether the tape was written in uncompressed or compressed format. The data contained in the LBOT blocks cannot be altered or accessed by the user.
- **Logical end of tape (LEOT).** LEOT is determined by the number of recorded tracks that occur after LBOT. For this purpose, lengths of erased segments are converted into an equivalent number of tracks.
- **Physical end of tape (PEOT).** PEOT is located at the point on the tape where the translucent trailer material is attached to the media. This position is detected by an optical sensor in the tape transport mechanism.

The number of tracks between LBOT and LEOT depends on the type and length of tape. Table 4-5 and Table 4-6 list the following information for tapes written in all formats:

- The number of tracks and 1,024-byte physical blocks between LBOT and LEOT
- The approximate number of tracks and 1,024-byte physical blocks that occur between LEOT and PEOT

Table 4-5 Track and physical block counts for EXB-8200 and EXB-8200c formats

EXATAPE Size	LBOT to LEOT				LEOT to PEOT*			
	Number of tracks		Number of blocks		Number of tracks		Number of blocks	
	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal
15m	8C44h	35,908	46220h	287,264	11A9h	4,521	8D48h	36,168
54m	22FF2h	143,346	117F90h	1,146,768	114Eh	4,430	8A70h	35,440
112m	46000h	286,720	230000h	2,293,760	45B0h	17,840	22D8h	142,720

*Track and block counts from LEOT to PEOT are approximate.

Table 4-6 Track and physical block counts for EXB-8500 and EXB-8500c formats

EXATAPE Size	LBOT to LEOT				LEOT to PEOT*			
	Number of tracks		Number of blocks		Number of tracks		Number of blocks	
	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal
15m	11888h	71,816	8C440h	574,528	954h	2,388	4AA0h	19,104
54m	45FE4h	286,692	22FF20h	2,293,536	229Eh	8,862	114F0h	70,896
112m	93568h	603,496	49AB40h	4,827,968	22A2h	8,866	11510h	70,928

*Track and block counts from LEOT to PEOT are approximate.

5

Functional Description

This chapter describes the functional features of the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c), including information about how they perform write and read operations.

Write Operations

Figure 5-1 provides an overview of data flow during write operations.

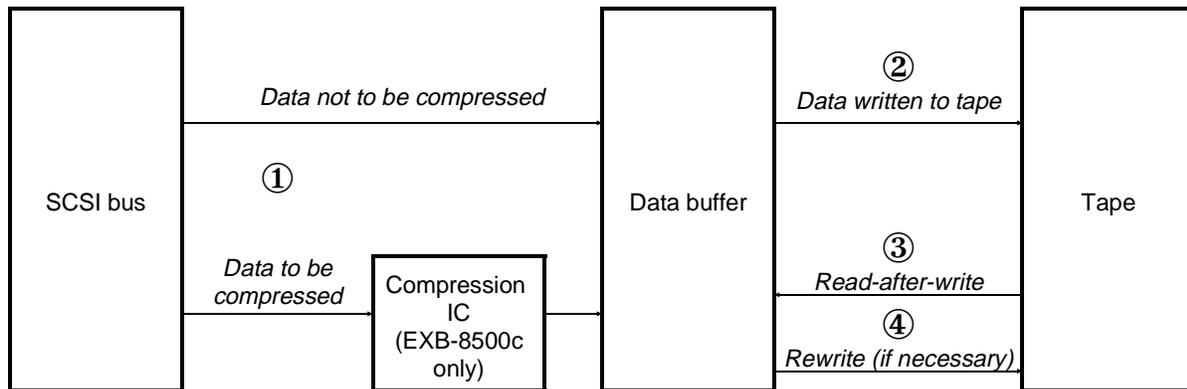


Figure 5-1 Data flow during a write operation

The steps below correspond to the circled numbers in Figure 5-1.

- ① If you are using an uncompressed tape format, the data goes directly from the SCSI bus to the 1-MByte data buffer. (Data transfers between the SCSI bus and the buffer occur asynchronously or synchronously.)

or

If you select a compressed tape format for the EXB-8500c, the data goes from the SCSI bus to the compression integrated circuit (IC) where it is compressed. Then, the data goes to the data buffer. (Refer to the section titled “Data Compression” on the next page for information about what occurs in the compression IC.)

- ② Once the motion threshold is exceeded in the data buffer, tape motion begins, ECC and physical-block CRC bytes are integrated with each physical block, and data is written to tape.
- ③ The EXB-8500 or EXB-8500c performs a read-after-write check on the written data to ensure that the data on tape was written accurately.
- ④ If necessary, the EXB-8500 or EXB-8500c rewrites the data.

Data Compression—EXB-8500c Only

If you are using an EXB-8500c and you selected a compressed tape format at LBOT, the data is sent to the compression integrated circuit (IC). Figure 5-2 illustrates what happens inside the compression IC during a write operation.

Figure 5-2 Data compression data flow (EXB-8500c only)

The steps below correspond to the circled numbers in the flow chart.

- ① After receiving user data to be compressed, the EXB-8500c looks at the currently active MODE SELECT parameters to see if data compression has been turned off.

If data compression is turned off, the EXB-8500c skips to step 3.

Note: If you select EXB-8200c format, data compression is always on; you cannot turn it off.

- ② If data compression is turned on, the data is compressed and then decompressed. The EXB-8500c performs a Compression Integrity Check™ by comparing the decompressed data to the original data.

If the decompressed data does not match the original data, the EXB-8500c indicates that a compression error has occurred and does not write the data to tape.

- ③ If the decompressed data matches the original data or if data compression was turned off, the EXB-8500c appends two bytes of CRC data to each logical block. Then, it transfers the data to its data buffer.

Note: EXB-8500c compresses data written to tape at an average ratio of 2:1. However, the actual compression ratio achieved depends on the type of data to be compressed.

Logical Block CRC—EXB-8500c Only

As shown in Figure 5-2, the EXB-8500c adds two bytes of cyclic redundancy check (CRC) data to every logical block written in compressed format. These bytes add an extra check to ensure that the user data is compressed and decompressed accurately.

Note: These logical block CRC bytes are in addition to the two bytes of physical block CRC data that the EXB-8500c adds to every physical block on tape.

Adding logical block CRC bytes to each logical block reduces the data capacity of the tape by two bytes for every logical block. For example, if you are writing 1,024-byte logical blocks, the data capacity of the tape will be reduced by 0.2% (that is, $2 \div 1,024 \times 100\%$).

Data Compression Monitoring—EXB-8500c Only

The EXB-8500c constantly monitors the compression ratio to determine whether compressing the data will actually decrease the size of the data set. When a logical block expands (as it might, for example, when it has already been compressed by the initiator), the EXB-8500c automatically switches to uncompressed format, beginning with the next logical block. It remains in this format until it encounters a compressible logical block. Then, it switches back to the compressed format, beginning with the next logical block. The EXB-8500c accomplishes this monitoring and switching without compromising performance.

Data Buffer Operations

When the EXB-8500 or EXB-8500c transfers data to the 1-MByte data buffer, the data buffer's formatter performs the following tasks:

- Formats logical user data blocks into physical blocks
- Appends tag, address, and index information to each data block

The sections below describe other data buffer operations.

Streaming and Start/Stop Modes

The data buffer enables the EXB-8500 or EXB-8500c to operate as either a streaming tape device or as a start/stop tape device. The mode of operation depends on the rate that data can be transferred between the initiator and the EXB-8500 or EXB-8500c, as follows:

- **The EXB-8500 or EXB-8500c operates in streaming mode** if the initiator can sustain a minimum of:
 - 1 MByte per second for EXB-8500c format (assuming a 2:1 compression ratio)
 - 500 KBytes per second for EXB-8500 format
 - 500 KBytes per second for EXB-8200c format (assuming a 2:1 compression ratio)
 - 262.5 KBytes per second for EXB-8200 format
- **The EXB-8500 or EXB-8500c operates in start/stop mode** if the initiator cannot sustain these minimum transfer rates; starting and stopping occur automatically.

Thresholds During a Write Operation

In start/stop mode, you can use the motion threshold to fine-tune the starting and stopping of tape motion. In streaming mode, you can use the reconnect threshold to fine-tune the rate of disconnects and reconnects between the EXB-8500 or EXB-8500c and the initiator. The values of both of these thresholds can be changed with a MODE SELECT (15h) command.

Motion Threshold

In a start/stop write operation, the initiator-to-buffer transfer speed is slower than the buffer-to-tape transfer speed. In this mode of operation, the motion threshold value represents the minimum amount of data (in 4-KByte increments) that must be in the 1-MByte buffer before tape motion will start.

Reconnect Threshold

In a streaming write operation, the initiator-to-buffer transfer rate is equal to or greater than the buffer-to-tape transfer rate. In this mode of operation, the EXB-8500 or EXB-8500c disconnects from the initiator when the buffer becomes full, but continues to write data to tape. The reconnect threshold value represents the minimum amount of free space (in 4-KByte increments) that must be in the 1-MByte buffer before the EXB-8500 or EXB-8500c will reconnect to the initiator to accept additional data.

When the reconnect threshold value is exceeded, the EXB-8500 or EXB-8500c reconnects to the initiator and data transfer resumes. The data transfer from the initiator continues until the buffer is full. Then, the EXB-8500 or EXB-8500c disconnects from the initiator, but continues to transfer data from the buffer to the tape until the threshold is exceeded. The EXB-8500 or EXB-8500c then reconnects again.

Figure 5-3 shows how the motion and reconnect thresholds work during a write operation.

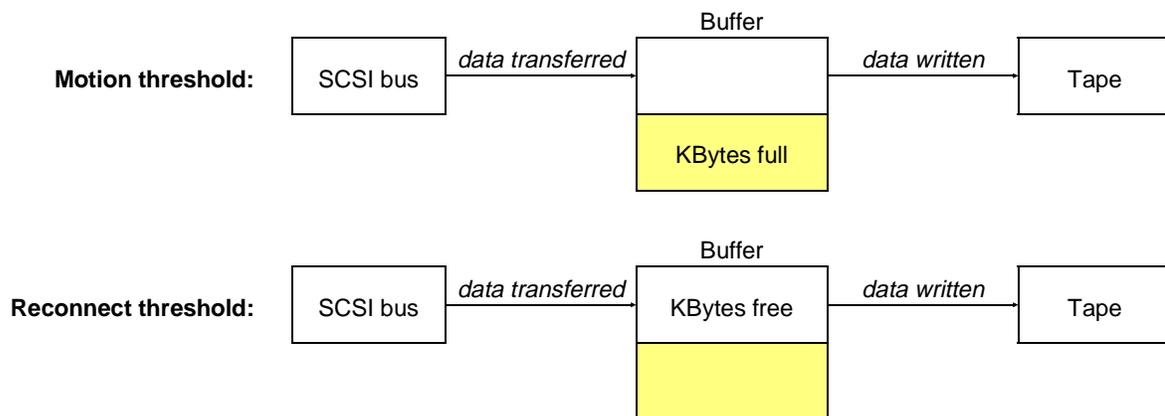


Figure 5-3 Motion and reconnect thresholds during a write operation

Error Detection, Correction, and Recovery Procedures

As the EXB-8500 and EXB-8500c write data to tape, they include error correction code (ECC) and physical-block cyclic redundancy check (CRC) bytes within each physical block. Then after they write data, they use the ECC and CRC to perform a read-after-write check to ensure data reliability. By using read-after-write error checking and sophisticated error correction procedures, the EXB-8500 and EXB-8500c offer a non-recoverable error rate of less than one bit in 10^{17} bits read.

Error Correction Code (ECC) and Cyclic Redundancy Check (CRC)

The Reed/Solomon ECC algorithms can correct a burst as long as 264 consecutive bytes in error and as many as 80 additional random errors in each physical data block. The ECC is capable of multiple burst and random error corrections. It has been designed to be extremely effective against the types of error patterns that may occur in cartridge tape subsystems that use helical-scan technology.

The EXB-8500 and EXB-8500c also add two bytes of cyclic redundancy check (CRC) data to every physical block on tape. The CRC data is used in the read-after-write check.

Read-After-Write Checking

The EXB-8500 and EXB-8500c perform a read-after-write check of the recorded user data to ensure full data reliability. If they detect an error during this check, the EXB-8500 and EXB-8500c rewrite the data without requiring host intervention or repositioning of the tape.

For more information about how the EXB-8500 and EXB-8500c correct data during the read-after-write check, refer to page 7-6.

Read Operations

Figure 5-4 provides a high-level overview of data flow during a read operation.

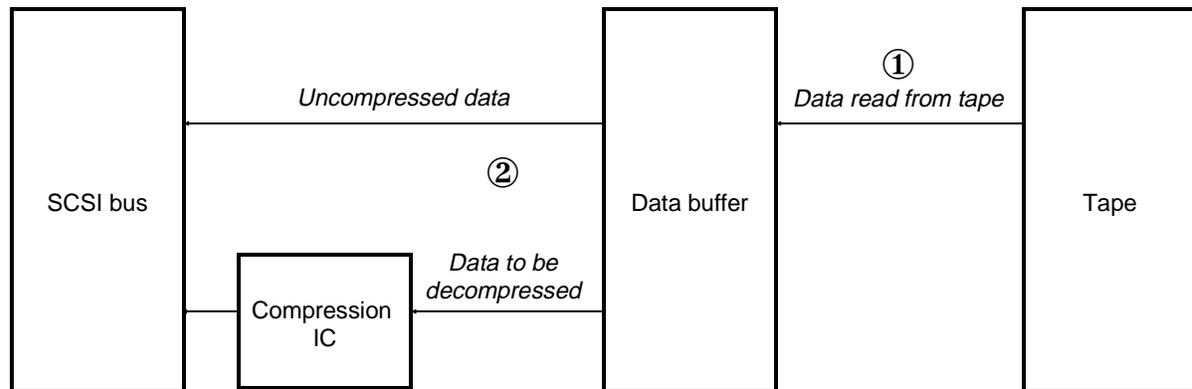


Figure 5-4 Data flow during a read operation

The steps below correspond to the circled numbers in Figure 5-4.

- ① The EXB-8500 and EXB-8500c read data from tape, use ECC to correct errors as necessary for each physical block, and transfer data to the data buffer. The read operation continues until the buffer is full and tape motion stops. (See page 5-10 for more information about thresholds during a read operation.)
- ② If you are using an uncompressed tape format, the data goes directly from the data buffer to the SCSI bus.

or

If you select a compressed tape format for the EXB-8500c, the data goes from the data buffer to the compression IC to be decompressed. Then, the decompressed data is sent to the SCSI bus.

Thresholds During a Read Operation

As explained on page 5-6, you can use the motion threshold to fine-tune the starting and stopping of tape motion or you can use the reconnect threshold to fine-tune the rate of disconnects and reconnects between the EXB-8500 or EXB-8500c and the initiator.

Motion Threshold

In a start/stop read operation, the motion threshold value represents the minimum amount of free space (in 4-KByte increments) that must be in the 1-MByte buffer before tape motion will start and data will be read from the tape to the buffer. When the motion threshold value is exceeded, tape motion starts. The read-from-tape operation continues until the buffer is full and tape motion stops. Tape motion does not restart until the amount of free space in the buffer once again exceeds the motion threshold value.

Reconnect Threshold

In a streaming read operation, the EXB-8500 or EXB-8500c disconnects from the initiator when the buffer becomes empty, but continues to read data to tape. The reconnect threshold value represents the minimum amount of data (in 4-KByte increments) that must be in the 1-MByte buffer before the EXB-8500 or EXB-8500c will reconnect to the initiator to transfer data from the buffer.

When the reconnect threshold value is exceeded, the EXB-8500 and EXB-8500c reconnect to the initiator and data transfer resumes. The data transfer to the initiator continues until the buffer is empty. Then, the EXB-8500 or EXB-8500c disconnects from the initiator but continues to transfer data from the tape to the buffer.

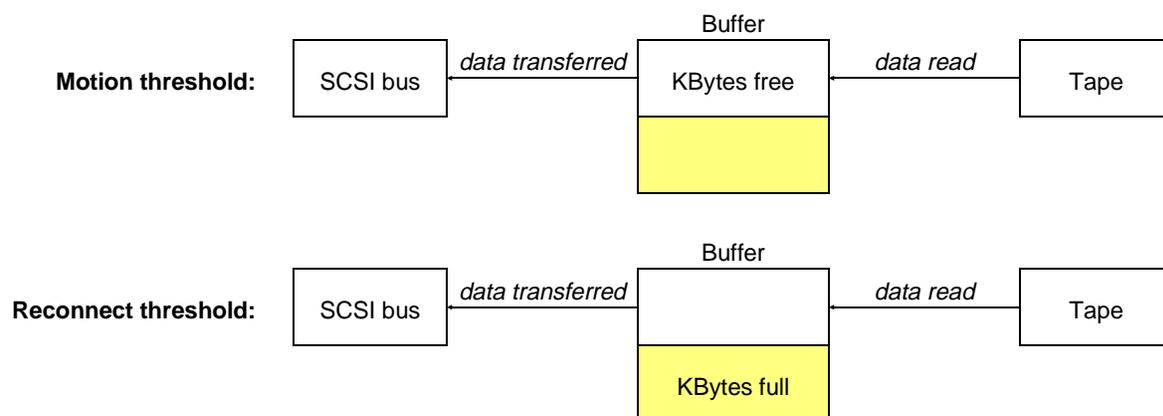


Figure 5-5 Motion and reconnect thresholds during a read operation

6

Performance Specifications

This chapter describes the performance specifications for the following EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystem (EXB-8500 and EXB-8500c) functions:

- Write access time
- Read access time
- Tape speed
- Reposition time
- Drum rotation period
- Tape tension release and drum motion suspension
- Data transfer rate

Write Access Time

Write access time starts when the EXB-8500 or EXB-8500c receives the last byte of the WRITE command (that is, when the initiator de-asserts ACK) and ends when the EXB-8500 or EXB-8500c asserts REQ to request that the initiator transfer the first data byte across the SCSI bus.

Table 6-1 lists typical write access times for the EXB-8500 and EXB-8500c. As shown in the table, write access time depends on whether the EXB-8500 or EXB-8500c is operating in start/stop mode or streaming mode.

Table 6-1 Typical write access times

Mode	Typical write access time
Start/stop	1.7 msec
Streaming	3.1 msec

Note: The measurement of write access time does not include the initial WRITE command received after the mode is changed from read to write.

Read Access Time

Read access time starts when the EXB-8500 or EXB-8500c receives the last byte of the READ command (that is, when the initiator de-asserts ACK) and ends when the EXB-8500 or EXB-8500c asserts REQ to indicate that it is ready to transfer the first data byte across the SCSI bus to the initiator.

Table 6-2 lists typical read access times for the EXB-8500 and EXB-8500c. As shown in the table, read access time depends on whether the EXB-8500 or EXB-8500c is operating in start/stop mode or streaming mode.

Table 6-2 Typical read access times

Mode	Typical read access time
Start/stop	1.8 msec
Streaming	3.2 msec

Tape Speed

Table 6-3 lists the nominal tape speed at which data can be written and read by the EXB-8500 and EXB-8500c.

Table 6-3 Nominal tape speed

CTS type	Format	Nominal tape speed
EXB-8500 or EXB-8500c	EXB-8200	11.633 mm/sec (0.458 inch/sec)
	EXB-8500	11.079 mm/sec (0.436 inch/sec)
EXB-8500c	EXB-8200c	
	EXB-8500c	

File-Search Tape Speed

Table 6-4 lists forward and backward file-search tape speeds for the EXB-8500 and EXB-8500c. These high-speed search times occur when the initiator issues either of the following:

- LOCATE command (for tapes written in EXB-8200c, EXB-8500, or EXB-8500c formats)
- SPACE command (for all formats)

Table 6-4 File-search tape speed

CTS type	Format	Forward speed	Backward speed
EXB-8500 or EXB-8500c	EXB-8200	116 mm/sec (4.58 inch/sec)	87.25 mm/sec (3.45 inch/sec)
	EXB-8500	831 mm/sec max (32.7 inch/sec)	831 mm/sec max (32.7 inch/sec)
EXB-8500c	EXB-8500c		
	EXB-8200c		

EXB-8500, EXB-8500c, and EXB-8200c Formats

If the tape is written in EXB-8500, EXB-8500c, or EXB-8200c formats, the EXB-8500 and EXB-8500c can perform forward and backward file-search operations at up to 75 times the nominal tape speed.

EXB-8200 Format

If the tape is written in EXB-8200 format, the EXB-8500 and EXB-8500c can perform forward file-search operations at 10 times the nominal tape speed and backward file-search operations at 7.5 times the nominal tape speed.

Rewind Tape Speed

Table 6-5 lists maximum rewind times for the EXB-8500 and EXB-8500c for the three sizes of EXATAPE 8mm data cartridges. Rewind time starts when the initiator issues a REWIND (01h) command and ends when the EXB-8500 or EXB-8500c returns a Command Complete message (for a non-immediate rewind). All times listed in the table assume the following:

- The tape is positioned at LEOT when you issue a REWIND command.
- The drum has not stopped rotating.
- Tape tension has not been released.

Table 6-5 Rewind times for EXATAPE 8mm data cartridges

Size of EXATAPE*	Length m (ft)	Maximum rewind time (seconds)
15m	15 (49)	60
54m	54 (177)	120
112m	112 (367)	180

* EXATAPE data cartridges are recommended for use with all EXABYTE products and are available for purchase from EXABYTE Corporation.

Drum Rotation Period

Table 6-6 shows the drum rotation period for the EXB-8500 and EXB-8500c reading and writing tapes in all formats.

Table 6-6 Drum rotation period

CTS type	Format	Drum rotation period	Nominal effective head-to-tape speed
EXB-8500 or EXB-8500c	EXB-8200	31.21 msec (1922.607 rpm)	4.015 m/sec (158.075 inch/sec)
	EXB-8500	32.77 msec (1831.055 rpm)	3.824 m/sec (150.548 inch/sec)
EXB-8500c	EXB-8200c		
	EXB-8500c		

Tape Tension Release and Drum Motion Suspension

The EXB-8500 and EXB-8500c release tape tension under either of the following conditions:

- The tape is at LBOT and the EXB-8500 or EXB-8500c has not received a command to move the tape in the last 5 seconds.
- The tape is not at LBOT and the EXB-8500 or EXB-8500c has not received a command to move the tape in the last 15 seconds.

After releasing tape tension, the EXB-8500 or EXB-8500c will stop drum rotation if it does not receive a tape motion command within the next 60 seconds.

If tape tension has been released, approximately 1.5 seconds will elapse before the EXB-8500 or EXB-8500c can perform a tape motion command. If the drum rotation has been stopped, approximately 7 seconds will elapse before the EXB-8500 or EXB-8500c can perform a tape motion command.

Data Transfer Rates

This section provides the maximum data transfer rates for the EXB-8500 and EXB-8500c.

Sustained Transfer Rates

The sustained transfer rates depend on the tape format, as follows:

- **In EXB-8200 format:** up to 262.5 KBytes/second
- **In EXB-8500 format:** up to 500 KBytes/second
- **In EXB-8200c format:** up to 500 KBytes/second, assuming an average compression ratio of 2:1 (EXB-8500c only)
- **In EXB-8500c format:** up to 1 MByte/second, assuming an average compression ratio of 2:1 (EXB-8500c only)

Burst Transfer Rates

The burst transfer rates are limited by the performance of the SCSI host bus adapter, the SCSI bus interface controller, and the EXB-8500's or EXB-8500c's buffer control hardware.

For the EXB-8500, the burst transfer rates are as follows:

- Asynchronous: up to 1.5 MBytes/second
- Synchronous: up to 4.0 MBytes/second

For the EXB-8500c, the burst transfer rates are as follows:

- Asynchronous: up to 2.5 MBytes/second
- Synchronous: up to 5.0 MBytes/second

Notes:

7

Reliability Specifications

This chapter lists the reliability specifications for the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c), including the following:

- Service life
- Machine reliability (MTBF)
- Data integrity
- Data reliability

Service Life

The EXB-8500 and EXB-8500c have been designed to exceed a useful service life of five years, during which time all performance and reliability specifications are applicable.

Machine Reliability: Mean Time Between Failures (MTBF)

The mean time between failures (MTBF) value for the EXB-8500 and EXB-8500c is defined as follows:

$$\text{MTBF} = \frac{\text{Total Power-on Hours}}{\text{Number of Relevant Equipment Failures}}$$

where:

- **Total Power-on Hours** is the total time the EXB-8500 or EXB-8500c is drawing current from the input power supply system.
- **Relevant Equipment Failures** are those failures that cannot be corrected by the operating personnel and require the intervention of maintenance personnel.

The MTBF value for the EXB-8500 and EXB-8500c is 40,000 power-on hours.

Test Conditions

The MTBF value for the EXB-8500 and EXB-8500c is determined under the following conditions:

- A minimum of 32 EXB-8500s and EXB-8500c's are tested, with each unit installed for 8,000 hours.
- MTBF is specified for a maximum duty cycle of 10%, where duty cycle is defined as:

$$\text{Duty Cycle} = \frac{\text{Total Hours of Mechanical Operation}}{\text{Total Power-on Hours}} \times 100\%$$

- The EXB-8500s and EXB-8500c's are tested at the following ambient temperature and relative humidity:
 - 23° C ± 2° C
 - 50% relative humidity ± 10% (non-condensing)
- The EXB-8500s and EXB-8500c's are operated in accordance with operating specifications.

Conditions for the MTBF Value

Conditions under which the specifications for MTBF apply are as follows:

- The EXATAPE data cartridges used must comply with Standard ECMA-145.
- Environmental conditions for the EXB-8500 or EXB-8500c and the 8mm data cartridges must be maintained as specified in Chapter 9.
- The EXB-8500 or EXB-8500c must be cleaned with an EXABYTE or an EXABYTE-approved cleaning cartridge using the recommended cleaning procedure. Refer to the appropriate user's manual for instructions.

Restrictions for the MTBF Value

The following types of failures are excluded from the calculation of MTBF:

- Failures arising from incorrect operating procedures
- Cable failures, power supply failures, or other failures not caused by equipment
- Failures caused by incorrect grounding procedures or by interference from external sources
- Media failures, or any failures or degraded performance caused by use of faulty or damaged media
- New failures that arise from continued use of a failed, misaligned, or damaged EXB-8500 or EXB-8500c
- Failures caused by incorrect maintenance procedures, and all failures that occur within the first 40 power-on hours of any maintenance activity that includes the modification, adjustment, or replacement of any assembly
- Failures of new EXB-8500s and EXB-8500c's that occur within the first 40 power-on hours

Data Integrity

Conditions under which data integrity is maintained are as follows:

- No recorded data will be lost as a result of power loss while the EXB-8500 or EXB-8500c is reading data.
- The EXB-8500 or EXB-8500c will not record incorrect data to tape without posting an error condition.
- The EXB-8500 or EXB-8500c will not return incorrect data to the system without posting an error condition.

Data Reliability

Data reliability is specified as a bit error rate (BER) in units of one error per total number of bits transferred to the host.

Conditions for Data Reliability

The conditions under which the specifications for data reliability apply are as follows:

- The EXATAPE data cartridges used must comply with Standard ECMA-145.
- Data cartridges must be written and read on an EXB-8500 or EXB-8500c that is in good operating condition and properly grounded.
- Environmental conditions for the EXB-8500 or EXB-8500c and the 8mm data cartridges must be maintained as specified in Chapter 9.
- The EXB-8500 or EXB-8500c must be cleaned with an EXABYTE or EXABYTE-approved 8mm cleaning cartridge using the recommended cleaning procedure. Refer to the appropriate user's manual for instructions.

Restrictions for Data Reliability

The following types of errors are not included in the determination of data reliability:

- Errors caused by a failure of the EXB-8500 or EXB-8500c
- Errors caused by faulty or damaged cartridges or media
- Errors caused by failure to comply with input power and grounding requirements, interference from external sources, or incorrect system operation or failure
- Errors corrected by the EXB-8500's or EXB-8500c's ECC
- Errors occurring in blocks other than blocks containing user data

Write Reliability

Write reliability is determined by the rate of permanent write errors. During a write operation, the EXB-8500 and EXB-8500c use read-after-write checking to determine whether physical data blocks are correctly written to tape. When the read-after-write check criteria are not met for a data block, the EXB-8500 or EXB-8500c rewrites the block. The EXB-8500 and EXB-8500c keep track of the number of times blocks are rewritten and store this number internally. The number is available through the REQUEST SENSE (03h) command and the LOG SENSE (4Dh) command.

If the EXB-8500 or EXB-8500c can rewrite the data block correctly, the error is a temporary write error, which does not affect write reliability. If, however, the EXB-8500 or EXB-8500c cannot rewrite the data block correctly after a maximum of 11 rewrite attempts (12 write attempts total), the error is a permanent write error. When a permanent write error occurs, the EXB-8500 or EXB-8500c returns Check Condition status. The rate for permanent write errors is as follows:

$$\text{Bit error rate: } 1.0 \times 10^{-17}$$

Read Reliability

Read reliability is determined by the rate of permanent read errors. If, during a read operation, the EXB-8500 or EXB-8500c cannot read a block that has been correctly written, it attempts to reread the block. The EXB-8500 or EXB-8500c keeps track of the number of times it attempts to reread a block and stores this number internally. This number is available through the REQUEST SENSE (03h) command and the LOG SENSE (4Dh) command.

If the EXB-8500 or EXB-8500c can reread the data block correctly, the error is a temporary read error, which does not affect read reliability. If, however, the EXB-8500 or EXB-8500c cannot reread the data block correctly after one reread attempt at normal speed and one reread attempt at slow speed, the error is a permanent read error. When a permanent read error occurs, the EXB-8500 or EXB-8500c returns Check Condition status. The rate for permanent read errors is as follows:

$$\text{Bit error rate: } 1.0 \times 10^{-17}$$

8

Power Specifications

This chapter lists the power specifications for the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c), including information about voltages, power dissipation, safety agency considerations, the power connector, and chassis grounding.

Voltages

Both the EXB-8500 and EXB-8500c operate from standard +5 VDC and +12 VDC supply voltages, as specified in Table 8-1. All specified voltages are DC; no external AC power is used.

Table 8-1 Power specifications at +5 and +12 volts DC

Specification	+5 Volts DC	+12 Volts DC
Voltage Tolerance	± 5%	± 5%
Ripple and Noise (60 Hz to 20 MHz)*	125 mVpp max	125 mVpp max
Operating Current:		
Minimum	0.69 A	0.39 A
Maximum	2.09 A	0.75 A
Power Consumption:		
Minimum	3.5 watts	4.7 watts
Maximum	10.45 watts	9.1 watts
Total minimum power consumption: 8.3 watts		
Total maximum power consumption: 19.55 watts		

* The ripple voltage is included in the total voltage tolerance.

The EXB-8500 and EXB-8500c do not provide any overvoltage or overcurrent protection.

Power Dissipation

Table 8-2 lists maximum power dissipation values for common EXB-8500 and EXB-8500c functions at +5 and +12 volts DC. As indicated by the table, the amount of power dissipated by the EXB-8500 or EXB-8500c depends on the function being performed. In addition, power dissipation depends on whether the EXB-8500 or EXB-8500c uses a single-ended SCSI configuration or a differential SCSI configuration.

Note: The numbers listed in Table 8-2 are for a single-ended EXB-8500 or EXB-8500c. If you are using a differential version, you should expect a 27% increase in power dissipation at +5 volts.

Table 8-2 Maximum power dissipation at +5 and +12 volts (single-ended SCSI configuration)

Function	+5 Volts DC		+12 Volts DC	
	Amps	Watts	Amps	Watts
Power up	2.03	10.15	0.65	7.80
Load tape	2.09	10.45	0.62	7.44
Unload tape	1.94	9.70	0.61	7.32
Write tape	2.02	10.10	0.75	9.0
Read tape	1.99	9.95	0.60	7.20
Rewind	1.75	8.75	0.59	7.08
Search (10×)	1.76	8.80	0.58	6.96
Search (75×)	1.75	8.75	0.59	7.08
Stopped	1.51	7.55	0.60	7.20

Table 8-3 lists minimum power dissipation values at +5 and +12 volts DC.

Table 8-3 Minimum power dissipation at +5 and +12 volts (single-ended SCSI)

+5 Volts DC		+12 Volts DC	
Amps	Watts	Amps	Watts
0.72	3.6	0.39	4.7

Safety Agency Considerations

Safety agency certification requires that the supplied voltages be from one of the following:

- A Safety Extra-Low Voltage source (per IEC 950)
- A Class 2 transformer rated at 30 volts RMS sinusoidal or less
- An isolating transformer, or a power supply that includes an isolating transformer, with open-circuit potential or no-load output of not more than 42.4 volts peak or 60 VDC. The energy available is limited so the current under any condition or load, including short circuit, is not more than 8 amps after one minute of operation.

Power Connector

The power connector used in the EXB-8500 and EXB-8500c is compatible with the power connector used for standard 5.25-inch devices. Figure 8-1 shows the location of the power connector, labeled P1, on the rear of an EXB-8500 or EXB-8500c. Table 8-4 lists the pin assignments for the power connector (AMP 641737-1):

Table 8-4 Pin assignments for the P1 power connector

Pin No.	Assignment
1	+12 VDC
2	Ground, 12 VDC return
3	Ground, 5 VDC return
4	+5 VDC

Chassis Ground

The rear panel of the EXB-8500 and EXB-8500c includes a grounding hole and a ground tab, as shown in Figure 8-1. These can be used to provide additional chassis grounding if desired. The grounding hole uses an M3-0.5 × 6 mm self-tapping screw, while the ground tab uses a ¼-inch female spade connector.

Note: The power supply returns are connected to the chassis, so you cannot isolate logic common ground from chassis ground.

8 Power Specifications

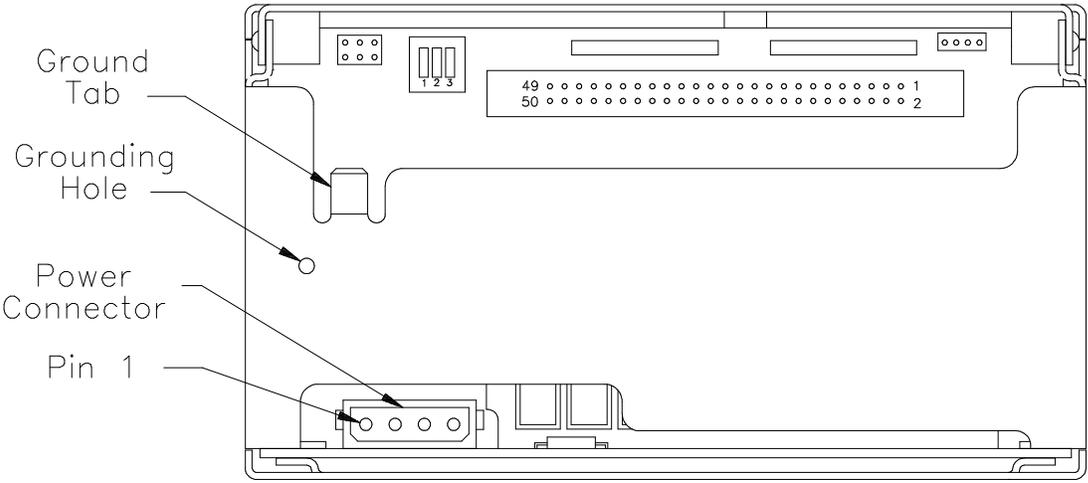


Figure 8-1 Power connector and ground (single-ended configuration)

9

Environmental Specifications

This chapter describes the following environmental specifications for the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c):

- Operating environment
- Air flow requirements
- Particulate contamination limits
- Shock and vibration specifications
- Acoustic noise limits

Table 9-1 shows the overall environmental specifications for the EXB-8500 and EXB-8500c.

9 Environmental Specifications

Table 9-1 Environmental specifications

Specification	Operation ^b	Storage ^c or Not operating ^d	Transportation ^c
Temperature Range ^a	+5° C to + 40° C (+41° F to +104° F)	−40° C to +60° C (−40° F to +140° F)	−40° C to +60° C (−40° F to +140° F)
Temperature Variation ^e	1° C per minute; max 10° C per hour (2° F per minute; max 18° F per hour)	1° C per minute; max 20° C per hour (2° F per minute; max 36° F per hour)	1° C per minute; max 20° C per hour (2° F per minute; max 36° F per hour)
Relative Humidity ^e	20% to 80% Non-condensing	10% to 90% Non-condensing	10% to 90% Non-condensing
Wet Bulb	26°C (79°F) max		
Altitude	−304.8 m to +3,048 m (−1,000 ft to +10,000 ft)	−304.8 m to +3,048 m (−1,000 ft to +10,000 ft)	−304.8 m to +12,192 m (−1,000 ft to +40,000 ft)

^a The temperature specifications for the EXB-8500 and EXB-8500c assume that temperature measurements are made at the tape path.

^b All operating measurements include an EXATAPE data cartridge.

^c The EXB-8500 or EXB-8500c has not been unpacked. Data cartridges are not packed with the EXB-8500 or EXB-8500c. The packaging is designed to protect the EXB-8500 and EXB-8500c from the condensation caused by extreme temperature variations. **When the EXB-8500 or EXB-8500c is moved from a cold storage environment to a warm operating environment, it must acclimate in its packaging for at least 12 hours before opening to prevent serious condensation damage from occurring.**

^d The EXB-8500 or EXB-8500c has been unpacked but is not operating. The data cartridge is not included.

^e The data cartridge's temperature and humidity must be allowed to stabilize in the specified ambient environment for 24 hours.

Operating Environment

The psychrometric chart, Figure 9-1, shows the operating temperature and humidity ranges for the EXB-8500 and EXB-8500c. The dotted line represents the operating environment.

Table 9-2 defines the temperature and humidity points shown in Figure 9-1.

Table 9-2 Temperature and humidity points for psychrometric chart

Point	Temperature	Humidity
A	05° C	80%
B	29° C	80%
C	40° C	34%
D	40° C	20%
E	05° C	20%

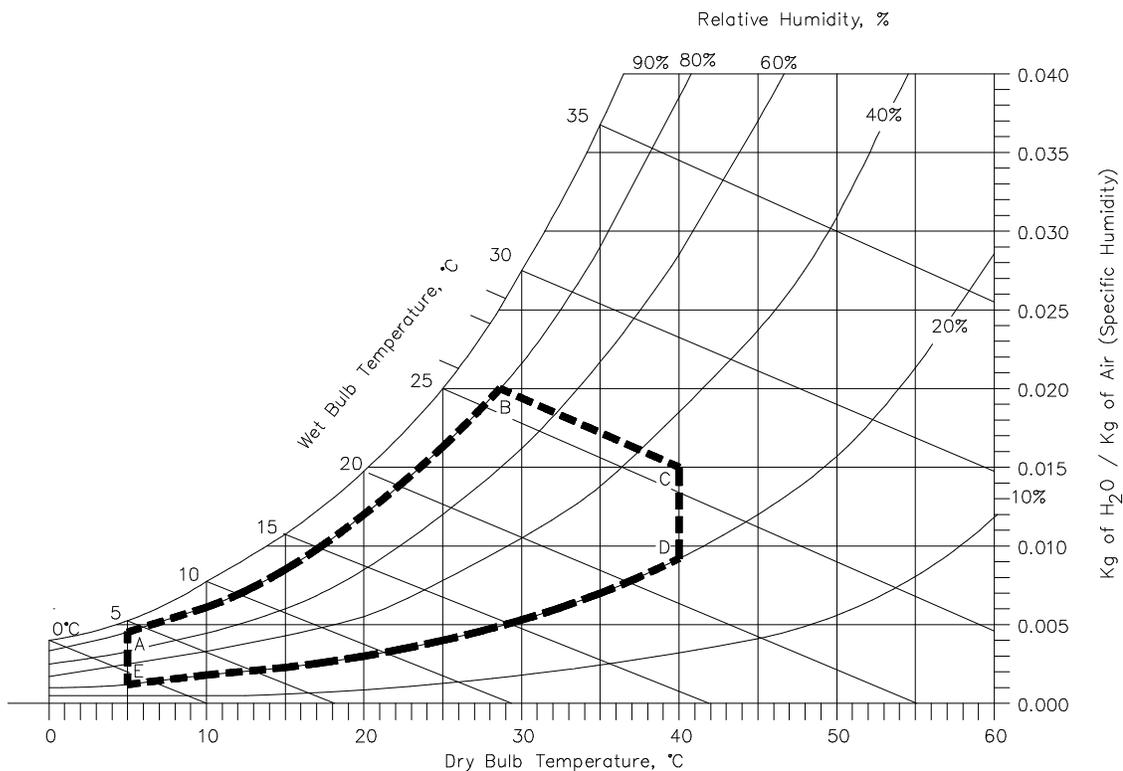


Figure 9-1 Temperature and humidity ranges for EXB-8500 and EXB-8500c operation

Air Flow Requirements

Adequate air flow must be provided in the enclosure for the EXB-8500 or EXB-8500c to dissipate heat resulting from approximately 15 watts of power consumption. The air flow around the entire drive must be sufficient to prevent the tape path temperature from exceeding 40° C (104° F). However, air flow within the enclosure must be minimal at the tape path. Otherwise, particulate contamination of the media can result.

Particulate Contamination Limits

The ambient operating environment should not exceed the particulate counts shown in Table 9-3.

Table 9-3 Maximum particulate counts for operation

Particle Size (microns)	Number of Particles ≥ Particle Size per Cubic Meter	Number of Particles ≥ Particle Size per Cubic Foot
0.1	8.8×10^7	2.5×10^6
0.5	3.5×10^7	1.0×10^6
5.0	2.5×10^5	7.0×10^3

Figure 9-2 shows the particulate contamination profile of a typical office compared to the specifications for the EXB-8500 and EXB-8500c. Contamination profiles of individual office areas vary.

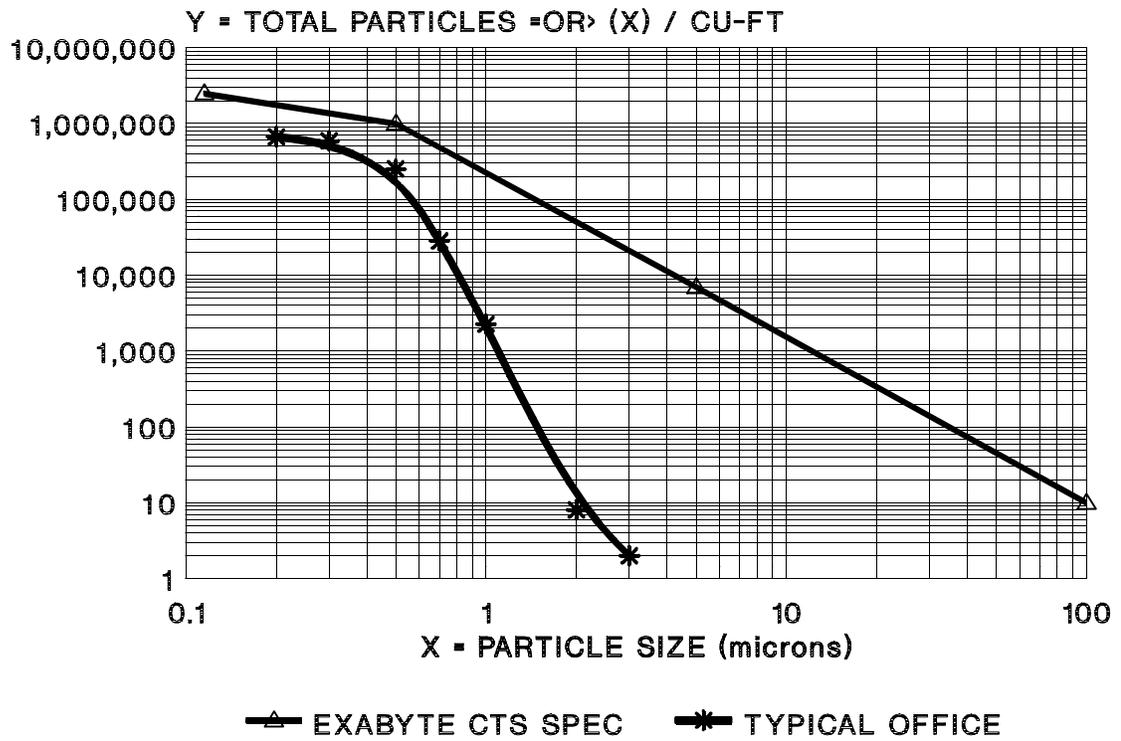


Figure 9-2 Particulate contamination specification vs. typical office

Shock Specifications

Table 9-4 lists the shock specifications for the EXB-8500 and EXB-8500c. The operating shock levels indicate how much shock the EXB-8500 or EXB-8500c can withstand while it is reading and writing data. The non-operating and storage shock levels indicate how much shock it can withstand when it is not operating. After withstanding this amount of shock, the EXB-8500 or EXB-8500c will operate normally.

Table 9-4 Shock specifications

Operating	Storage ^a or Not Operating ^b	Transportation ^a
3 g for 5 ms ^c	45 g at a velocity change of 192 inch/sec ^d	NSTA Project 1A
2 g for 11 ms ^c		

^a The EXB-8500 or EXB-8500c has not been unpacked.

^b The EXB-8500 or EXB-8500c has been unpacked, but no power has been applied.

^c A minimum of 20 shock pulses were applied to each of the three orthogonal axes. The shock pulses were half-sine waves and were applied at a rate not exceeding one shock per second.

^d A minimum of three trapezoidal shock pulses of 45 g were applied to each of the EXB-8500 or EXB-8500c's six sides at a velocity change of 192 inches per second (equivalent height equals 48 inches).

Vibration Specifications

Table 9-5 lists the vibration specifications for the EXB-8500 and EXB-8500c during operation, non-operation, storage, and transportation. The operating specifications listed in this table indicate the amount of vibration that the EXB-8500 and EXB-8500c can withstand while reading and writing data.

Table 9-5 Vibration specifications

Random vibration^a applied during operation	
1 Hz	PSD = 0.000003 g ² /Hz
5 Hz	PSD = 0.00002 g ² /Hz
10 to 150 Hz	PSD = 0.0003 g ² /Hz
200 to 400 Hz	PSD = 0.00008 g ² /Hz
Random vibration^b applied during non-operation^c and storage^d	
1 Hz	PSD = 0.0003 g ² /Hz
3 Hz	PSD = 0.00055 g ² /Hz
12 to 100 Hz	PSD = 0.01 g ² /Hz
400 Hz	PSD = 0.000003 g ² /Hz
Transportation^d	
NSTA Project 1A	

^aA 0.30 g RMS random vibration spectrum is applied to each of three orthogonal axes for a minimum of 20 minutes per axis.

^bA 1.06 g RMS random vibration spectrum is applied to each of three orthogonal axes for a minimum of 20 minutes per axis.

^cThe EXB-8500 or EXB-8500c has been unpacked, but no power has been applied.

^dThe EXB-8500 or EXB-8500c has not been unpacked.

Acoustic Noise

The overall, averaged A-weighted sound power levels (decibels) for the EXB-8500 and EXB-8500c do not exceed the upper limits specified in Table 9-6. The EXB-8500 and EXB-8500c have an NC rating of 50 or better.

Table 9-6 Acoustic noise limits

Operating mode	LWA*
The EXB-8500 or EXB-8500c is powered on and idle.	40 dBA
The EXB-8500 or EXB-8500c is fully operational and operating in streaming mode for a read or write operation.	45 dBA

*LWA is the average A-weighted sound power level over the following frequency range: 5 Hz to 12.5 KHz.

10

Safety and Regulatory Agency Compliance

This chapter describes the EXB-8500's and EXB-8500c's compliance with the following:

- Safety agency standards
- Electrostatic discharge (ESD) standards
- Electromagnetic compatibility (EMC)
- Radiated susceptibility

Safety Agency Standards

When purchased from EXABYTE Corporation, the EXB-8500 and EXB-8500c are certified as components by the following domestic and international product safety standards.

- UL Standard 1950, 1st Edition, Information Technology Equipment
- CAN/CSA Standard C22.2 No. 950-M89, Safety of Information Technology Equipment
- IEC 950/EN60950, Safety of Information Technology Equipment including Electrical Business Equipment (TUV)

Certification of the final product is the responsibility of the system integrator.

Electrostatic Discharge (ESD)

When properly installed with a shielded cabinet, shielded cables, and adequate grounding of the SCSI bus and the input power, the EXB-8500 and EXB-8500c can withstand discharges of the following:

- Up to 10,000 volts applied to those points that are accessible during normal use without affecting the permanent read error rate or requiring operator intervention.
- Up to 15,000 volts applied to those points that are accessible during normal use without sustaining permanent damage. However, at this level of discharge, operator intervention may be required to reset the EXB-8500 or EXB-8500c.

Note: No errors will occur or damage be caused to the EXB-8500 or EXB-8500c when a cartridge charged to a maximum of 20,000 volts is inserted.

Electromagnetic Compatibility (EMC)

When properly installed with a shielded cabinet, shielded cable and adequate grounding of the SCSI bus and the input power, the EXB-8500 and EXB-8500c meet the requirements for radiated and conducted emissions as defined by the following standards:

- FCC Rules, Part 15, Class B Computing Devices
- Canadian Department of Communications, Radio Interference Regulation for Digital Apparatus, Class B
- VDE Vfg 1046/1984, Class B
- CISPR Publication 22, 1985, Class A

Radiated Susceptibility

When properly installed with a shielded cabinet, shielded cables, and adequate grounding of the SCSI bus and the input power, the EXB-8500 and EXB-8500c will continue to operate without error when subjected to electromagnetic energy of severity level 2 (3 volts/meter) as defined by IEC Publication 801-3.

Notes:

11

Shipping and Installation

This chapter describes packing and shipping specifications and lists the requirements for installing the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c).

Shipping Requirements

This section includes information about the shipping cartons and lists the environmental conditions needed for transportation.

Shipping Cartons

The EXB-8500 and EXB-8500c are sealed in static protection bags and are shipped with either one drive per carton (single-pack) or four drives per carton (four-pack). Table 11-1 shows the dimensions and weights of these cartons.

Table 11-1 Dimensions and weights of shipping cartons

Size	Dimensions	Weight
Single-pack	15 inches long 12 ⁵ / ₈ inches wide 10 ¹ / ₄ inches high (38.1 × 32.1 × 26.0 cm)	With one CTS: 8.0 lbs (3.6 kg)
Four-pack	23 ¹ / ₂ inches long 13 ¹ / ₂ inches wide 10 ⁷ / ₈ inches high (59.7 × 34.3 × 27.6 cm)	With four CTSs: 23.0 lbs (10.4 kg)

Both the single-pack and the four-pack shipping cartons and internal packing materials are designed so that an enclosed EXB-8500 or EXB-8500c does not receive a shock greater than 45 g when the carton is dropped on any surface, corner, or edge from the following heights:

- 48 inches (121.9 cm) at a velocity change of 192 inches per second (488 cm/sec) for the single-pack carton
- 36 inches (91.4 cm) at a velocity change of 167 inches per second (424 cm/sec) for the four-pack carton

Both sizes of shipping carton pass the tests described in the National Safe Transit Association (NSTA) Project 1A for packaged products weighing less than 100 pounds.

The packing materials are unbleached, reusable, recyclable, and environmentally safe. The materials contain no chlorofluorocarbons (CFCs) or heavy metals.

Environmental Specifications for Transportation

The environmental specifications listed in Table 11-2 must be met whenever the EXB-8500 or EXB-8500c is transported.

Table 11-2 Environmental specifications for transportation

Specification	Range
Temperature Range	-40° C to +60° C (-40° F to +140° F)
Temperature Variation	1° C per minute up to a maximum of 20° C per hour (2° F per minute up to a maximum of 36° F per hour)
Relative Humidity	10% to 90% non-condensing
Wet Bulb	26° C max (79° F max)
Altitude	-304.8 m to +12,192 m (-1,000 ft to +40,000 ft)

Unpacking and Packing Instructions

Unpacking and packing instructions for the EXB-8500 and EXB-8500c are included in the appropriate user's manual.

CAUTION

The packaging is designed to protect the EXB-8500 and EXB-8500c from the condensation caused by extreme temperature variations. **When you move an EXB-8500 or EXB-8500c from a cold storage environment to a warm operating environment, you must allow it to acclimate in its packaging for at least 12 hours before opening the box.** Otherwise, serious condensation damage may occur.

To avoid damaging the EXB-8500 or EXB-8500c, use the original shipping carton and packing materials (or replacement packaging obtained from the vendor) when repacking and shipping it. The shipping carton and packing materials are not intended to be used for shipping items other than a full-high EXABYTE Cartridge Tape Subsystems (CTSs). Also, do not use a four-pack shipping carton when shipping fewer than four CTSs.

Installation Requirements

This section describes the requirements for installing the EXB-8500 and EXB-8500c. For step-by-step instructions for completing the following installation tasks, refer to the appropriate user's manual.

- Setting the SCSI ID
- Attaching the EXB-8500 or EXB-8500c to a frame (if desired)
- Connecting the EXB-8500 or EXB-8500c to the SCSI bus
- Connecting the EXB-8500 or EXB-8500c to a power supply
- Performing the initial power on

Requirements for Setting the SCSI ID

The *SCSI ID* is the address asserted by the EXB-8500 or EXB-8500c during arbitration. The SCSI ID is factory-set to 0; however, you can change it to any address between 0 and 7.

To change the SCSI ID, you can do one of the following:

- Set the DIP switches on the back of the EXB-8500 or EXB-8500c (see Figure 11-1).
- Connect a remote switch to the remote connector on the back of the EXB-8500 or EXB-8500c (see Figure 11-1). A remote switch is not provided with the EXB-8500 or EXB-8500c; you can use a female Molex® 22-55-2061 or equivalent cable connector to control the address remotely.
- Attach jumpers to the six pins on the remote connector. Jumpers are not provided with the EXB-8500 or EXB-8500c; you can use an AMP 881545-1 jumper or equivalent (0.2-inch low-profile jumper with handle).

Changes in the SCSI ID setting do not take effect until the EXB-8500 or EXB-8500c is reset by a normal power-on, SCSI bus reset, or Bus Device Reset message. For detailed instructions for setting the SCSI ID, including the pin assignments for the remote connector, refer to the appropriate user's manual.

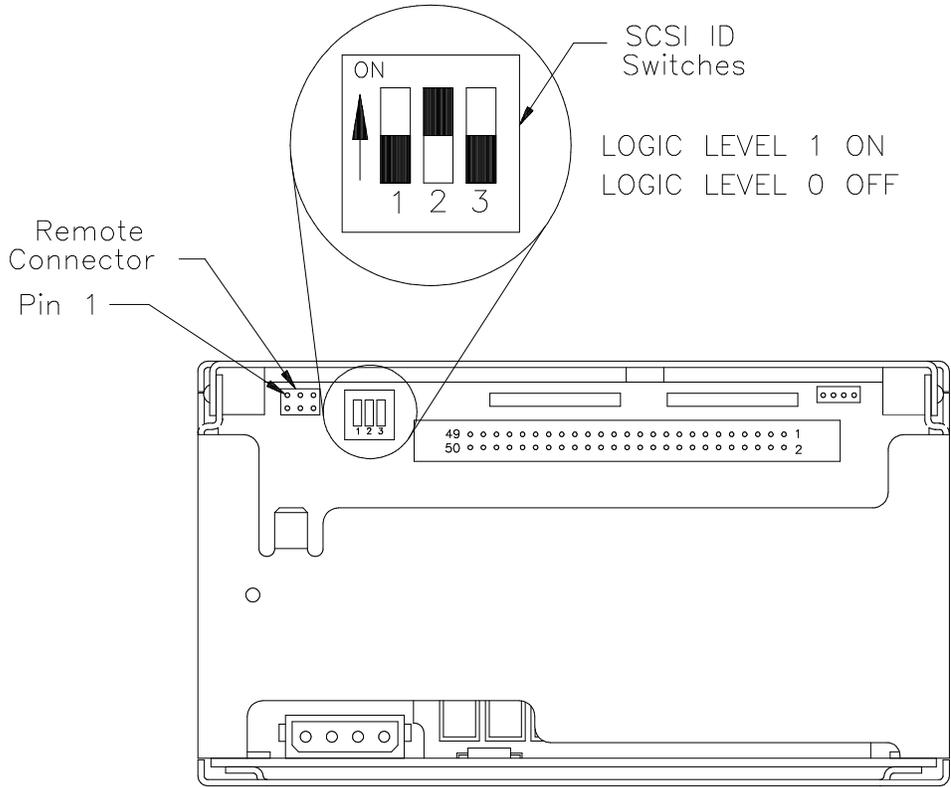


Figure 11-1 SCSI ID DIP switches and remote connector (single-ended configuration)

Requirements for Mounting the EXB-8500 or EXB-8500c

The EXB-8500 or EXB-8500c can be mounted either horizontally or vertically and in a stationary or sliding position. When the EXB-8500 or EXB-8500c is mounted horizontally, the door opens down from the top. When the EXB-8500 or EXB-8500c is mounted vertically, the door can open to the left or right. (See Figure 2-3 for the angle of the door.)

As shown Figure 11-2 and Figure 11-3, the main housing includes two sets of mounting holes (one set on the sides and one set on the bottom) to allow for a number of mounting positions. These mounting holes accommodate #6-32 screws and are designed for standard 5.25-inch form factor mounting requirements. The holes are 0.31 inches (7.9 mm) deep.

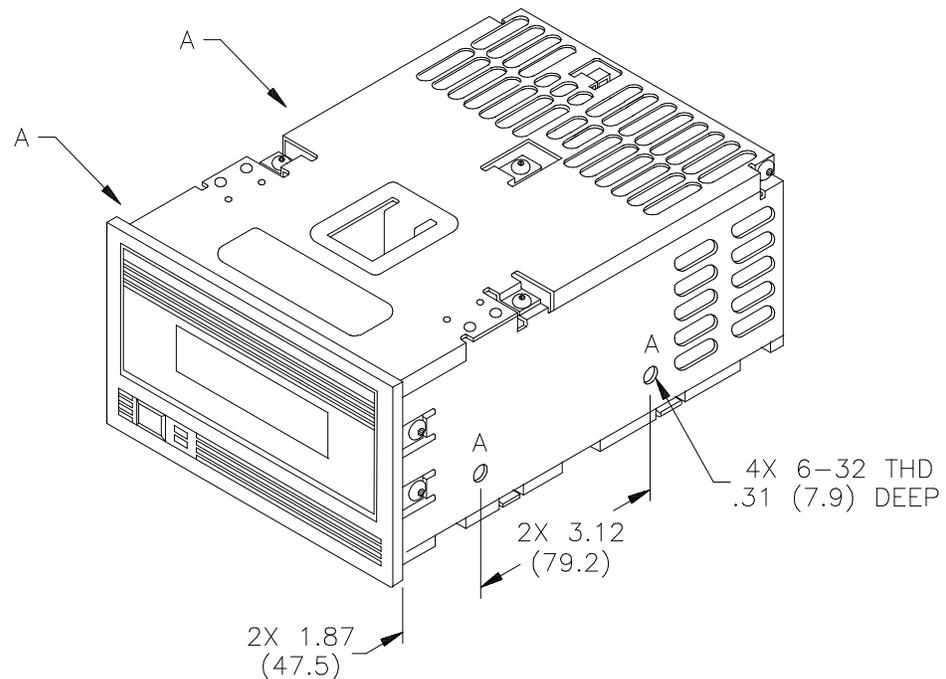


Figure 11-2 Mounting holes on the sides

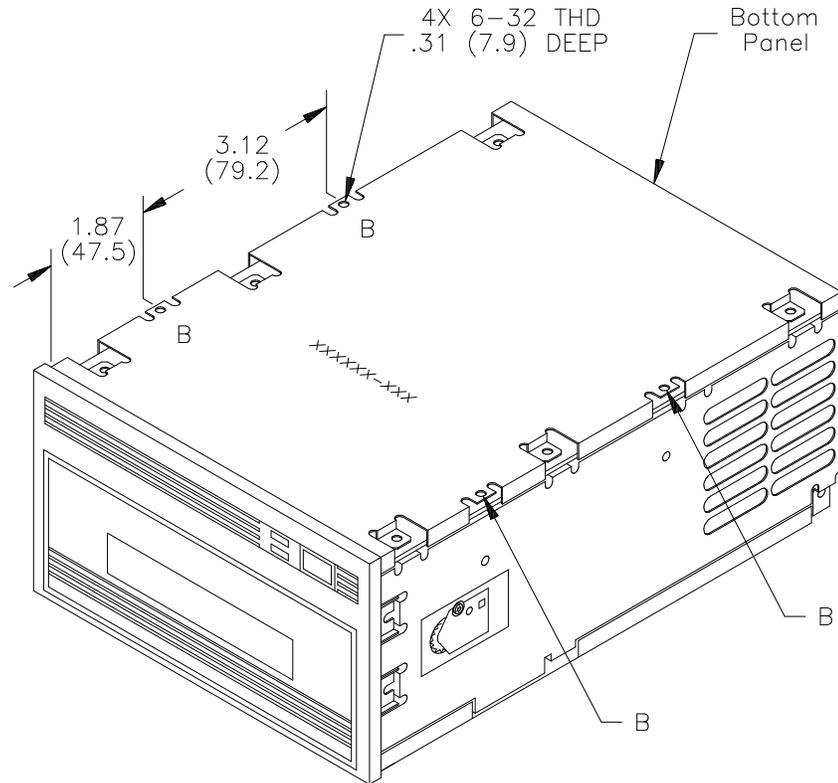


Figure 11-3 Mounting holes on the bottom

When mounting the EXB-8500 or EXB-8500c, follow these guidelines:

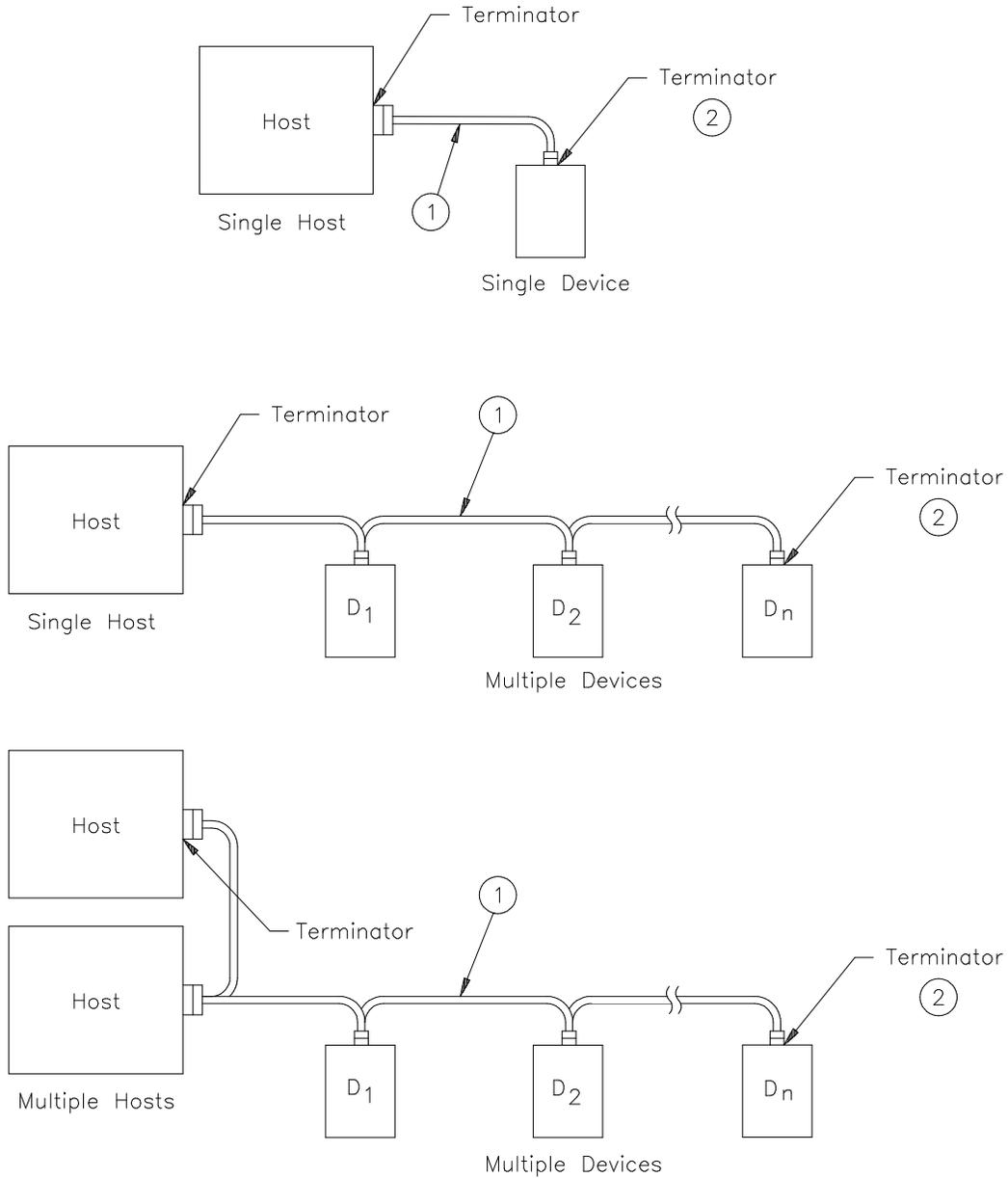
- Use the four mounting holes on the sides (“A” in Figure 11-2) or the four mounting holes on the bottom (“B” in Figure 11-3).
- To ensure that the EXB-8500 or EXB-8500c is securely mounted, use all four holes in whichever set you choose.
- To ensure that the chassis is not subject to distortion, do not use combinations of mounting holes from different sets.
- To ensure that the EXB-8500 or EXB-8500c can be adequately cooled, do not obstruct the ventilation slots on the sides and top of the device.

Do not allow objects such as screw heads, cables, or adjacent devices to touch the EXB-8500 or EXB-8500c frame.

Requirements for SCSI Bus Termination

If the EXB-8500 or EXB-8500c is the last device on the SCSI bus, it must be terminated. As described in this section, the termination requirements depend on whether you are using a single-ended or differential SCSI configuration.

Figure 11-4 shows typical SCSI bus configurations for the EXB-8500 and EXB-8500c.



NOTES:

- ① Total length of cable not to exceed: Single-ended – 6 Meters
Differential – 25 Meters
- ② Termination to be on the last device in the string even if the cable itself extends past the last device.
3. Only one set (each end) of terminators is to be used. Each end must be terminated.

Figure 11-4 Typical SCSI bus configuration

Terminators for Single-Ended Configuration

As shown in Figure 11-5, the single-ended SCSI configuration of the EXB-8500 or EXB-8500c includes two 10-pin, 9-resistor single in-line package (SIP) terminators (R-packs), which are rated at 110 ohms. Replacement R-packs are available from EXABYTE (part number 002228).

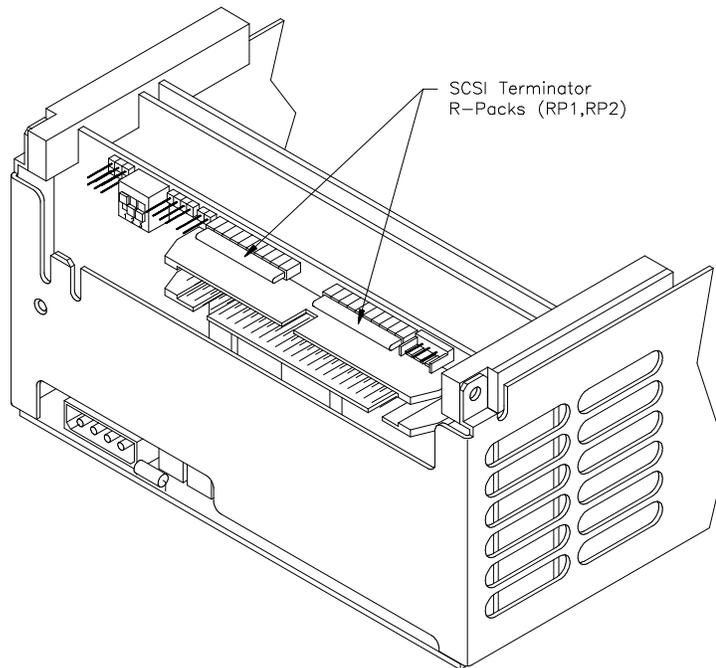


Figure 11-5 Resistor terminators on the single-ended EXB-8500 or EXB-8500c

Leave the R-packs in place if the EXB-8500 or EXB-8500c terminates the SCSI bus (that is, if it is physically located at the end of the SCSI cable). Remove them if the EXB-8500 or EXB-8500c does not terminate the SCSI bus or if you are using external SCSI bus termination.

Note: If you need to terminate a single-ended EXB-8500 or EXB-8500c externally, remove the R-packs and install an external terminator. To ensure that the EXB-8500 or EXB-8500c performs to specification, EXABYTE recommends a Methode Electronics, Inc. dataMate® DM103-02-0 single-ended external terminator.

Terminators for Differential Configuration

If you are installing the differential SCSI configuration and the EXB-8500 or EXB-8500c will terminate the SCSI bus, you must provide external terminators. To ensure that the EXB-8500 or EXB-8500c performs to specification, EXABYTE recommends a Methode Electronics, Inc. dataMate DM103-01-0 differential external terminator.

Requirements for Connecting a SCSI Cable

EXABYTE does not provide a cable for connecting an EXB-8500 or EXB-8500c to the SCSI bus. You must provide a cable that complies with the appropriate safety and regulatory agency requirements. To comply with FCC, Canadian DOC, and VDE limits, the EXB-8500 and EXB-8500c require shielded cables when the cables are external to the mounting enclosure.

Impedance

Ideally, to match the cable terminators, the cable should have a characteristic impedance of 122 ohms (differential) or 132 ohms (single-ended). However, since cables with this high of a characteristic impedance are not generally available, somewhat lower impedances are acceptable. A characteristic impedance of 100 ohms \pm 10% is recommended for unshielded flat or twisted-pair ribbon cable. A characteristic impedance greater than 90 ohms is recommended for shielded cables.

Important

To minimize discontinuities and signal reflections, EXABYTE recommends that cables used on the same bus have the same impedances.

Cable Length

The maximum length of the SCSI cable depends on whether you are using a single-ended or differential SCSI configuration, as follows:

- For single-ended SCSI configurations, the maximum allowable bus length is 6 meters (19.7 feet).
- For differential SCSI configurations, the maximum allowable bus length is 25 meters (82 feet).

A stub length of no more than 0.2 meters (8 inches) is allowed off the mainline interconnection within any connected equipment.

Primary Conductor

A minimum primary conductor size of 28 AWG is recommended to minimize noise effects and ensure proper distribution of terminator power.

SCSI Cable Connector Requirements

The SCSI connector is located on the back of the EXB-8500 and EXB-8500c, as shown in Figure 11-6. The connector is a 50-pin male ribbon cable connector, consisting of two rows of 25 pins with adjacent pins 2.54 mm (0.1 inch) apart. The stub length within the EXB-8500 and EXB-8500c is less than 50 mm.

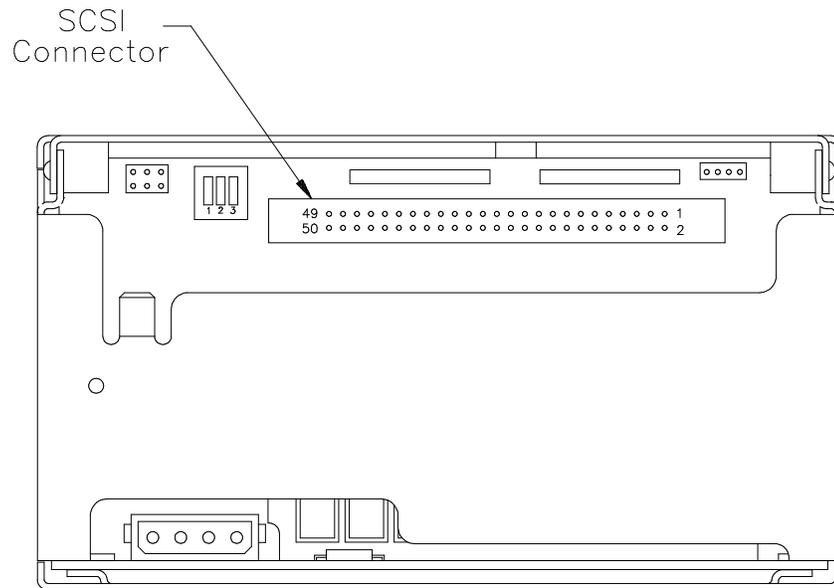


Figure 11-6 SCSI connector location

To connect an EXB-8500 or EXB-8500c to the SCSI bus, use a 50-pin female ribbon cable connector (AMP No. 1-746285-0 or equivalent). Table 11-3 shows the connector pin assignments for a differential EXB-8500 or EXB-8500c; Table 11-4 shows the connector pin assignments for a single-ended EXB-8500 or EXB-8500c.

Table 11-3 Connector pin assignments for differential configurations

Signal	Pin Number		Signal
SHIELD GROUND	1	2	GROUND
+DB(0)	3	4	-DB(0)
+DB(1)	5	6	-DB(1)
+DB(2)	7	8	-DB(2)
+DB(3)	9	10	-DB(3)
+DB(4)	11	12	-DB(4)
+DB(5)	13	14	-DB(5)
+DB(6)	15	16	-DB(6)
+DB(7)	17	18	-DB(7)
+DB(P)	19	20	-DB(P)
DIFFSENS	21	22	GROUND
GROUND	23	24	GROUND
TERMPWR	25	26	TERMPWR
GROUND	27	28	GROUND
+ATN	29	30	-ATN
GROUND	31	32	GROUND
+BSY	33	34	-BSY
+ACK	35	36	-ACK
+RST	37	38	-RST
+MSG	39	40	-MSG
+SEL	41	42	-SEL
+C/D	43	44	-C/D
+REQ	45	46	-REQ
+I/O	47	48	-I/O
GROUND	49	50	GROUND

Table 11-4 Connector pin assignments for single-ended configurations

Signal	Pin Number*
+DB(0)	2
+DB(1)	4
+DB(2)	6
+DB(3)	8
+DB(4)	10
+DB(5)	12
+DB(6)	14
+DB(7)	16
+DB(P)	18
GROUND	20
GROUND	22
GROUND	24
TERMPWR	26
GROUND	28
GROUND	30
-ATN	32
GROUND	34
-BSY	36
-ACK	38
-RST	40
-MSG	42
-SEL	44
-C/D	46
-REQ	48
-I/O	50

* All odd pins except pin 25 are connected to ground. Pin 25 is left open.

12

Operation and Maintenance

This chapter describes operation and maintenance of the EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems (EXB-8500 and EXB-8500c), including the following:

- Using the LEDs, loading data cartridges, unloading data cartridges, and resetting the EXB-8500 or EXB-8500c
- Cleaning the EXB-8500 or EXB-8500c
- Loading new microcode

Refer to the appropriate user's manual for complete information about operation and maintenance.

Operating the EXB-8500 and EXB-8500c

This section provides general information about operating the EXB-8500 and EXB-8500c.

Power-On Mode

In its normal power-on mode, the EXB-8500 or EXB-8500c completes a power-on self-test, loads the tape (if inserted), and positions the tape at LBOT. The total time for this operation is about 60 seconds for a rewound cartridge.

Operator Controls

The unload button is the only operator control on the EXB-8500 and EXB-8500c. You can use it to unload the tape from the tape path and to eject the data cartridge. You can also use this button to reset the EXB-8500 or EXB-8500c if a servo error occurs. Refer to page 12-4 for more information about loading data cartridges.

LED States

Figure 12-1 shows the location of the green and amber LEDs on the front panel of the EXB-8500 and EXB-8500c. The two LEDs are status indicators.

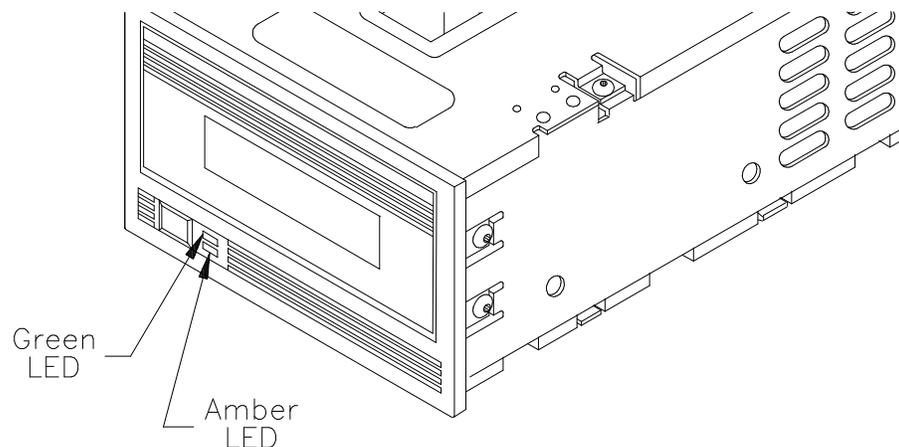


Figure 12-1 LEDs on the front of the EXB-8500

Table 12-1 describes how the LEDs are used to indicate operating states.

- The LED is on.
- The LED is off.
- * The LED is flashing, as follows:
 - a slow flash is about one flash per second (0.94 Hz)
 - a fast flash is about four flashes per second (3.76 Hz)

Table 12-1 EXB-8500 and EXB-8500c states indicated by the LEDs

When the Amber LED is . . .	When the Green LED is . . .	The state of the EXB-8500 or EXB-8500c is . . .
●	●	Power-on initialization ^a
○	○	Passed power-on self-test ^b
	●	Ready and tape loaded
● or ○ ^c	Slow *	Normal tape motion
	Fast *	High speed search/rewind
●, ○, or *	Four *s, then ○	Servo error
Slow *	● or ○	CRC fail ^d
		Unrecoverable fault
Fast *	○	Failed power-on self-test
	● or ○	Unload button fail

^a The EXB-8500 or EXB-8500c is performing power-on self-test diagnostics. This takes less than 60 seconds.

^b The green LED may go off before the amber LED if no tape is loaded.

^c The amber LED is on when data transfer is occurring on the SCSI bus. The amber LED is off when no data transfer is occurring. The combination of on and off may appear as an irregular flash.

^d CRC failures occur only within the first two seconds after a power-on reset. An unrecoverable fault can occur anytime during operation.

Loading Data Cartridges

To load a tape into the EXB-8500 or EXB-8500c, first set the write protect switch on the EXATAPE data cartridge as required (either write protected or write enabled), open the door, insert the data cartridge, and close the door.

When you insert a cartridge, the EXB-8500 or EXB-8500c automatically loads the tape, unless you have issued a MODE SELECT (15h) command to disable the autoload function. Once the data cartridge is loaded, the EXB-8500 or EXB-8500c presents ready status (green LED on) and commands requiring loaded media will execute normally.

Notes:

- If you disabled the autoload function, the EXB-8500 or EXB-8500c does not present ready status until you issue a LOAD (1Bh) command.
- If you attempt to load a cartridge while the servo is testing during the power-on self-test (approximately 10 seconds), the EXB-8500 or EXB-8500c ejects the cartridge.

Refer to the appropriate user's manual for instructions for setting the write protect switch, performing the load procedure, and using the MODE SELECT and LOAD commands.

Load Time

The time required to load the data cartridge and position the tape to LBOT after the data cartridge is inserted is approximately 40 seconds. When loading a tape, the EXB-8500 or EXB-8500c spaces forward from PBOT and determines the following:

- **The tape format.** The format will be either blank, EXB-8200, EXB-8200c, EXB-8500, EXB-8500c, or unknown.
- **The adaptive servo parameters.** This process enables the EXB-8500 or EXB-8500c to read tapes produced by different manufacturers, tapes that are aged and worn, and tapes written by any other 8mm Cartridge Tape Subsystem.
- **The length of the tape in use** (that is, the EXB-8500 or EXB-8500c autosizes the data cartridge). For more information about data cartridge autosizing, refer to the appropriate user's manual.

Unloading Data Cartridges

You can unload a data cartridge either by pressing the unload button or by issuing an UNLOAD (1Bh) command. This section describes what happens when the unload button is pressed; for information about using the LOAD/UNLOAD (1Bh) command, see the appropriate user's manual.

If a data cartridge is loaded and the EXB-8500 or EXB-8500c is error free, the EXB-8500 or EXB-8500c performs the following actions when you press the unload button:

- Completes any command that is currently in progress
- Writes any buffered information to tape
- Writes EOD (except in EXB-8200 format)
- Rewinds the tape to physical beginning of tape (PBOT)
- Unloads the tape from the tape path, opens the door, and ejects the cartridge

Note: If you press the unload button when there is no data cartridge in the EXB-8500 or EXB-8500c, the door opens.

In addition, the EXB-8500 and EXB-8500c have unload button options for "normal," "fast," and "super fast" unload operations.

Unload Time

Table 12-2 summarizes the EXB-8500 and EXB-8500c actions for each of the unload button options. The time required for each of the actions in the table is as follows:

- The time required to complete the current operation depends on the type of operation.
- A maximum of 12 seconds is required to empty the buffer to tape and write an EOD mark (EXB-8500c, EXB-8500, and EXB-8200c format tapes only).
- A maximum of 180 seconds (for a 112m tape) is required to rewind a tape.
- A maximum of 30 seconds is required to unload and eject a data cartridge.

Table 12-2 Action for each unload button option

Unload button option	EXB-8500 or EXB-8500c action			
	Complete current operation	Write contents of buffer to tape and write EOD	Rewind to PBOT	Unload and eject tape
Normal	✓	✓	✓	✓
Fast		✓*	✓	✓
Super Fast		✓*		✓

* If the EXB-8500 or EXB-8500c is performing a write operation when you press the “fast” or “super fast” version of the unload button, it aborts the command *after* writing to tape the last logical block that was completely transmitted from the initiator. However, any partially transmitted logical blocks will be lost.

Effect of PREVENT/ALLOW MEDIUM REMOVAL Command

If you have issued a PREVENT MEDIUM REMOVAL (1Eh) command to prevent the removal of the data cartridge, the door of the EXB-8500 or EXB-8500c does not open and the data cartridge does not eject until you send an ALLOW MEDIUM REMOVAL (1Eh) command.

For more information about using the PREVENT/ALLOW MEDIUM REMOVAL command, see the appropriate user’s manual.

Error During Unload Procedure

If an error exists before or during the unload procedure, the EXB-8500 or EXB-8500c suspends the preceding sequence of events and the amber LED will flash. If you press the unload button again, the EXB-8500 or EXB-8500c reattempts the unload sequence; however, it does not write buffered information to tape. The EXB-8500 or EXB-8500c clears the buffer and errors.

Resetting the EXB-8500 or EXB-8500c

You can reset an EXB-8500 or EXB-8500c using any of the following methods:

- Powering the EXB-8500 or EXB-8500c off and back on again (power-on reset).
- Sending an RST pulse on the SCSI bus for a minimum of 25 μ sec (SCSI bus or “hard” reset). A SCSI bus reset immediately clears all devices from the bus and resets their associated equipment.
- Issuing a Bus Device Reset (0Ch) message to the EXB-8500 or EXB-8500c (device or message reset). A device reset clears it from the bus and resets it.
- Pressing the unload button to clear a hardware error.

Note: If a SCSI bus or device reset occurs during a power-on reset, the EXB-8500 or EXB-8500c performs a full power-on reset.

If a data cartridge is loaded when a reset condition occurs, the EXB-8500 or EXB-8500c rewinds the tape and positions it at LBOT when the reset operation is complete. The total time required for the reset may be as long as three minutes if the tape is positioned near the end of tape.

Reselection Phase Timeout

If the initiator fails to respond to a device reselection sequence, the EXB-8500 or EXB-8500c times out after 250 msec. The EXB-8500 or EXB-8500c continues to repeat the reselection process until it is reset or the initiator finally responds.

Preventive Maintenance

Except for cleaning, the EXB-8500 and EXB-8500c have no user serviceable adjustments or maintenance procedures. All service or repairs must be performed by EXABYTE Corporation or authorized service personnel.

Cleaning the EXB-8500 and EXB-8500c

You should clean the heads and tape path of the EXB-8500 and EXB-8500c after **every 30 tape motion hours**. This cleaning frequency does not depend on the format in which you write and read data. However, if you are using the EXB-8500 or EXB-8500c in a particularly dirty environment or if you operate it infrequently, you may want to clean the EXB-8500 or EXB-8500c more often than every 30 tape motion hours. Cleaning the EXB-8500 or EXB-8500c helps to ensure that it will perform according to its specifications.

The only cleaning material authorized for use with the EXB-8500 and EXB-8500c is an EXABYTE or EXABYTE-approved 8mm Cleaning Cartridge. For more information about the cleaning cartridge, refer to Chapter 1.

Important

Using cloth swabs, cleaning agents, or cleaning cartridges not approved by EXABYTE will void the warranty on the EXB-8500 or EXB-8500c.

For instructions for using the cleaning cartridge, refer to the appropriate user's manual.

Determining When the EXB-8500 or EXB-8500c Needs Cleaning

The EXB-8500 and EXB-8500c keep track of tape motion hours internally. You can access this information by issuing a REQUEST SENSE (03h) command and looking at the setting of the CLN and CLND bits (byte 21, bits 4 and 3). If the CLN bit is set to 1, the EXB-8500 or EXB-8500c needs to be cleaned. This bit is reset to 0 when a successful cleaning cycle has been performed. The CLND bit is set to 1 when the EXB-8500 or EXB-8500c has been cleaned and is reset to 0 when the next REQUEST SENSE command is received.

Loading New Microcode

When a new firmware release becomes available, you can download the microcode to the EXB-8500 and EXB-8500c in one of three ways:

- Using an EXABYTE microcode update tape
- Using the WRITE BUFFER and READ BUFFER SCSI commands
- Using the EXABYTE CTS Monitor program

For instructions for downloading code using a microcode update tape or the WRITE BUFFER command, refer to the appropriate user's manual. For instructions for downloading code using the CTS Monitor program, refer to the *Monitor User's Guide for the 8mm Cartridge Tape Subsystem*.

Notes:

Glossary

- ACK** Acknowledge signal. This SCSI bus signal is asserted by the initiator to indicate that it has received data from the EXB-8500 or EXB-8500c. See also *REQ*.
- address** See *SCSI ID*.
- ATN** Attention signal. The SCSI bus signal is asserted by the initiator to indicate that it has a message to transmit to the EXB-8500 or EXB-8500c.
- ANSI** American National Standards Institute.
- AWG** American Wire Gauge.
- ber** Bit error rate.
- BOT** Beginning of tape.
- bpi** Bits per inch.
- bus devices** Initiator or target devices connected to the SCSI bus.
- byte** Eight bits or one character.
- C** Celsius (Centigrade).
- Canadian DOC** Canadian Department of Communications.
- CISPR** International Special Committee on Radio Interference.
- cm** Centimeter (0.3937 inches).
- connect** The establishment of communications between the initiator and the selected target.
- CRC** Cyclic redundancy check.
- CSA** Canadian Standards Association.
- CTS** Cartridge Tape Subsystem. Either the EXB-8200, EXB-8200SX, EXB-8500, EXB-8500c, EXB-8205, or the EXB-8505.

disconnect	The termination of communications between the initiator and the target. During a disconnect, the target releases control of the SCSI bus, allowing the bus to become free.
ECC	Error correction code.
ECMA	European Computer Manufacturers Association.
EEPROM	Electrically erasable programmable read only memory.
EPROM	Erasable programmable read only memory.
EOD	End of data.
EOT	End of tape.
EXATAPE	A data-grade, metal particle, rewriteable 8mm data cartridge that is recommended for use in all EXABYTE 8mm Cartridge Tape Subsystems.
EXB-8200	The EXB-8200 8mm Cartridge Tape Subsystem. The EXB-8200 can store up to 2.5 gigabytes of data on a single EXATAPE 8mm data cartridge.
EXB-8200 format	One of the data formats written and read by the EXB-8500 or EXB-8500c.
EXB-8200c format	One of the compressed data formats written and read by the EXB-8500c.
EXB-8200SX	The EXB-8200SX 8mm Cartridge Tape Subsystem. The EXB-8200SX is very similar to the EXB-8200 but offers a high-speed search capability.
EXB-8500	The EXB-8500 8mm Cartridge Tape Subsystem. The EXB-8500 can store up to 5.0 gigabytes of data on a single EXATAPE 8mm data cartridge.
EXB-8500 format	One of the data formats written and read by the EXB-8500 or EXB-8500c.
EXB-8500c	The EXB-8500c 8mm Cartridge Tape Subsystem. The EXB-8500c is physically similar to the EXB-8500, but offers data compression as an option. Assuming an average ratio of 2:1, the EXB-8500c can store up to 10.0 gigabytes of data on a single EXATAPE 8mm data cartridge.
EXB-8500c format	One of the compressed data formats written and read by the EXB-8500c.

F	Fahrenheit.
FCC	Federal Communications Commission.
FEPROM	Flash erasable programmable read only memory.
g	Gravity.
GByte	Gigabyte; 1,024 MBytes.
h	Hexadecimal (base 16) numbering system.
host	The computer system that acts as the initiator of an operation.
Hz	Hertz.
IC	Integrated circuit.
ID	Identification.
IDRC	Improved Data Recording Capability. The compression algorithm used by the EXB-8500 or EXB-8500c (licensed from IBM).
IEC	International Electrotechnical Commission.
initiator	A host computer system that requests an operation to be performed by the target.
I/O	Input/output.
ips	Inches per second.
ISO	International Standards Organization.
KByte	Kilobyte; 1,024 bytes.
Kfc	Kiloflux changes.
KHz	Kilohertz.
LBOT	Logical beginning of tape.
LEOT	Logical end of tape.
logical format	The tape format that is relative to the initiator's software and certain functions of the CTS's controller and data path
LUN	Logical unit number.
ma	Milliamp.
MByte	Megabyte; 1,024 KBytes.

Glossary

MHz	Megahertz.
MLCH	Machine level control history.
mm	Millimeter (0.03937 inches).
motion threshold	<p>During a start/stop write operation, the minimum amount of data that must be in the CTS's 1-MByte buffer before data in the buffer will be written to tape.</p> <p>During a start/stop read operation, the minimum amount of free space that must be in the CTS's buffer before data will be transferred from the tape to the buffer.</p> <p>The motion threshold is measured in 4-KByte increments. See also <i>reconnect threshold</i>.</p>
ms or msec	Millisecond.
mVpp	Millivolts peak-to-peak.
MTBF	Mean time between failures.
ns	Nanosecond.
NSTA	National Safe Transit Association.
PBOT	Physical beginning of tape.
PEOT	Physical end of tape.
physical format	The tape format that is relative to the functions of the CTS's data path, recording channel, and motion control systems.
POH	Power-on hours.
POST	Power-on self-test, which is the process that occurs when the EXB-8500 or EXB-8500c performs its initial power-on diagnostics.
PSD	Power spectral density.
ready	The state of the EXB-8500 or EXB-8500c when it is ready to process commands.
reconnect	The function that occurs when the target arbitrates and reconnects to an initiator after a disconnect.

reconnect threshold When a disconnect occurs during a streaming write operation, the minimum amount of free space that must be in the CTS's 1-MByte buffer before the CTS reconnects to the initiator and data transfer from the initiator to the buffer continues.

When a disconnect occurs during a streaming read operation, the minimum amount of data that must be in the CTS's buffer before the CTS reconnects to the initiator and data transfer from the buffer to the initiator continues.

The reconnect threshold is measured in 4-KByte increments. See also *motion threshold*.

SCSI Small Computer System Interface.

SCSI address An octal representation of the unique address (0-7) assigned to a SCSI device.

SCSI ID A unique identifier assigned to each device or subsystem on the SCSI bus. Also referred to as the *address*.

signal assertion Driving a signal to the true state.

signal de-assertion Driving a signal to the false state or biasing the signal by the cable terminators to the false state.

signal release When a signal is not driven by a bus but is biased by the cable terminators to the false state.

status Information sent from the target to the initiator upon completion of a command.

target A bus device (usually a controller) that performs an operation requested by an initiator. The EXB-8500 is a target.

trk track.

TUV Technischer Uberwachungs-Verein.

UL Underwriters Laboratories.

μm Micrometer (0.00003937 inches).

μs or μsec Microsecond.

VAC Volts AC.

Glossary

VDC Volts DC.

VDE Verband Deutscher Elektrotechniker. (German Association of Electrotechnical Engineers.)

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Notes:

Reader's Comment Form

EXB-8500 and EXB-8500c 8mm Cartridge Tape Subsystems Product Specification Part Number 510200-004

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