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Digital SCSI Specification

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Abstract: This document defines Digital's version of the Small Computer System Interface (SCSI) protocol, used to connect peripheral devices to computer systems.

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0.1 Introduction

- 1 Digital has chosen to supply certain of its systems with computers and peripherals that use the Small Computer System Interconnect (SCSI) protocol as an interconnection method. Some of Digital's devices implement the SCSI protocol by hardware and software developed by Digital while some of the devices sold under Digital's name are designed or manufactured by other vendors.
- 2 This document specifies restrictions that apply to computers, peripheral devices, and driver software for the SCSI-1 interface that are sold under the Digital name. It is intended for use by Digital engineering groups that are involved in the design of SCSI devices.

0.2 Prerequisite

- 3 This document contains information that is supplementary to the ANSI SCSI specification. It is expected that any user of this document will have a copy of the ANSI specification; therefore no text has been included in this document to provide context for the reader.

0.3 Document Overview

- 4 This document is organized so that each chapter matches the relevant chapter in the ANSI SCSI-2 specification. The chapter titles are the same as the chapter titles in the ANSI specification. The appendices are different from the ANSI specification.
- 5 Industry practice for SCSI-1 disk drives is described in an unofficial document known as the "Common Command Set" (CCS). This specification includes the relevant text from the CCS document as it applies to Digital devices.
- 6 The protocol for power sequencing is contained in Appendix A.
- 7 Device specific exceptions to this specification will be contained in Appendix B.
- 8 Since some of the device specific information contained here does not have a counterpart in the ANSI specification, tables and figures have been gathered into Appendix C. For example, a table has been added there that includes device specific information about Digital disk and tape characteristics.

- 9 This document lists the modifications and extensions to the ANSI SCSI-1 specification that are required by Digital. The intent is to document those items that are
 1. required for integration of a new device with existing driver software with minimal changes to the software, and
 2. required for maximum compatibility between new devices and existing devices.
- 10 Two general kinds of information is contained in the spec.
 1. Information that defines the features that must be supported by any implementation, and
 2. Information marked "xxx IMPLEMENTATION NOTE", which describes how features are implemented in particular Digital devices.
- 11 Each section has a header that consists of a section number, a title, one or more references to where relevant information may be found, and a one line indication of why the requirement is needed. The text of the section describes the requirements using the terms "shall" for mandated features, "should" for recommended features, and "may" for allowed features. Paragraph numbers are used throughout the specification for reference purposes.
- 12 The intent is not to completely specify every Digital SCSI device. Therefore, detailed information that pertains to one specific device is not included. This information may be found in the device's SCSI interface specification.
- 13 Implementations covered in this version are:
 1. VMS requirements as defined in the SCSI Third Party Support documentation
 2. TZ30
 3. TZK50
 4. QIC tape based on preliminary information
 5. RZ22
 6. RZ23
 7. RZ55
 8. IEZ11 IEEE Interface
 9. VAXstations - NCR 5380 based
- 14 Implementations that will be covered in the SCSI-2 version of this document are:

1. RDAT - no SCSI implementation yet
 2. RRD40 - no information available
 3. RRD41 - no information available
 4. RZ56 - SCSI-1 implementation
 5. RZ57 - no information available
 6. RZ24 - SCSI-2 implementation
 7. scanner - no information available
 8. DECstation - MIPS machines - no information available
 9. VMS driver code - not incorporated yet
 10. Ultrix driver code - not incorporated yet
 11. SCSI-FDDI interface - no information available
 12. SCSI-Ethernet interface - no information available
- 15 The following devices will not be covered.
1. DECstations - Tandy machines will not be covered unless there is participation by the relevant group
 2. MicroVAX 2000.
- 16 The following comments from reviewers have been noted and will be incorporated into SCSI-2 version of this document.
1. Most of the sections in the ANSI spec marked "implementors note" contain recommendations for how SCSI implementations should work. I suggest that all such sections be specified as to whether they are required for Digital SCSI devices. There are lots of them and I don't know what to put for most of them.
 2. Default behavior needs to be clarified in a number of instances.
 3. Restriction on IDENTIFY message is needed: "The disconnect privilege is not enabled unless specifically granted for each command by the setting of bit six in the IDENTIFY message."
 4. Resolution of the RESET and power-on sequencing in general.
 5. Resolution of the code revision method in the INQUIRY command, which differs between RZ, RRD, and industry standard devices.
 6. Other message issues surrounding ABORT, STDR, etc.

7. Clarification of error behavior, such as command phase parity errors.
8. Resolve the question of returning a write complete status on devices that do buffering. Just a text change unless I hear objections.
9. I need to make another pass at the old notes in the SCSI and SCSI_REVIEW notesfiles to see whether any further issues should be added to this list.
10. "Any device may operate as an initiator for the purpose of selecting and sending a command to the processor in a single processor configuration." Check whether this is true for Fire-fox.
11. Additional comments are enclosed in brackets throughout the text.

0.4 Use of the Specification

- 17 The requirements defined by this specification are based on Digital's current implementations for SCSI-1 devices. A future version of this document will describe Digital's implementation of SCSI-2.
- 18 Designers should be aware that this Digital SCSI Specification describes the official Digital requirements, and that the existing specifications for some old devices may conflict with this specification. New SCSI devices shall comply with this Digital SCSI Specification.
- 19 In order to determine whether a device complies with this specification a designer should
 1. establish that his design meets the requirements of SCSI-1, and
 2. establish that his design meets the additional requirements of this specification.
- 20 In order to specify a device that is functionally equivalent to an existing Digital SCSI device, a designer should perform the above steps, then establish that his design is compatible with the device specification for the device with which his design is to be equivalent. Since existing devices have been grandfathered into compliance with this specification, it may not be possible to build a new device that is both fully compatible with the old device and fully compliant with the DEC SCSI Specification.

0.5 Digital Qualified Devices

- 21 Devices that are to be connected to a Digital system may be of two types, Digital Qualified and Non-Qualified.
- 22 Digital Qualified devices are reviewed for correct operation with Digital driver software and for compliant implementation of the ANSI SCSI-1 specification, CCS, and all additional Digital requirements. These devices are associated with a Device Specification, which lists values of certain device-specific parameters that are unique to that device. Several sections in this chapter indicate where additional information is to be contained in the Device Specification. All devices sold under the Digital name shall be Digital Qualified.
- 23 Non-Qualified devices are those that have not been reviewed by Digital, and no guarantee shall be made that such devices will operate correctly when connected to a Digital system.

0.6 Document Maintenance

- 24 The information in this document is owned by the Digital SCSI community. The Storage Systems Architecture Group (SSAG) has undertaken to provide a maintenance service for this specification.
- 25 SSAG provides the following services in support of the SCSI community.
 - 1. A directory is maintained at SSAG::SCSI\$DOCUMENTS that contains documents related to SCSI. This directory contains
 - a. this document,
 - b. the SCSI-1 specification,
 - c. the Command Command Set document (not currently available—if you know of an electronic copy, let me know),
 - d. the SCSI-2 specification in its latest form,
 - e. a pointer to documentation related to the SCSI Third Party Support program,
 - f. documents that describe Digital's position regarding the attachment of third party SCSI devices to its systems,
 - g. a pointer to documentation related to the VMS SCSI driver software,

- h. a document that describes SSAG's policy and procedure for proposing ECOs to the specifications it maintains,
 - i. a blank ECO proposal form,
 - j. pointers to some SCSI overview information available from outside sources, and
 - k. hints for working with DECwrite and postscript files.
2. An unrestricted notesfile for the discussion of general SCSI questions is maintained at SSAG::ASK_SSAG. This notesfile should be used for questions from marketing representatives and those with a casual interest in SCSI.
 3. A restricted membership notesfile is maintained for the discussion of technical SCSI issues. Membership in this conference is generally restricted to engineering personnel with a valid reason for access to technical information about SCSI.
 4. A restricted membership notesfile for the discussion of issues related to the maintenance of this document is maintained. Membership is restricted to the specification review committee defined below. Currently the membership lists of the two restricted conferences are the same.
 5. A document ("SSAG Process Document") that describes the method for proposing, drafting, and voting on changes to this specification is provided. Representatives of Digital groups interested in the Digital SCSI specification vote on proposed Engineering Change Orders (ECOs) to the specification using a prescribed voting procedure.

0.7 SCSI Architects

- 26 Digital has two members of the engineering staff who share responsibility for maintenance of Digital's implementation of SCSI.
- 27 The Digital SCSI Architect is Rudy Stalzer, at STLSEE::STALZER. Rudy is Digital's primary representative at the ANSI SCSI committee, and is the contact for questions about SCSI as it applies to workstations, servers, and devices other than storage devices.
- 28 The Storage SCSI Responsible Architect is Doug Hagerman, at STARCH::HAGERMAN. Doug is the contact for questions about SCSI as it applies to storage devices.
- 29 Please contact Rudy or Doug with any questions or comments about this document or any other issue related to SCSI.

Chapter 1

Scope

- 1 The goal of this specification is to maximize device interoperability for Digital SCSI-1 devices.
- 2 In addition to the requirements of the ANSI SCSI specification, Digital has chosen to define certain additional restrictions and limitations on devices to be sold as Digital SCSI devices. While the goal is that all Digital SCSI devices be interoperable, since system level integration is not guaranteed by the SCSI protocol, full compliance with this specification shall not be considered a replacement for system level verification.

1.1 ANSI SCSI is Underlying Requirement

- 3 This document defines the official Digital implementation of the SCSI-1 architecture. The requirements stated herein are in addition to the ANSI SCSI-1 requirements which shall be followed by any device that to be shipped as a Digital SCSI device.
- 4 All disk drive products shall also comply with the CCS addendum to the SCSI-1 specification. This specification includes all relevant text from the CCS document.
- 5 All Digital SCSI-1 units shipped (not FRS!) from ??-???-1990 shall be compatible with ANSI SCSI-1 as amended by this document.
- 6 Digital SCSI units shipped before ??-???-1990 are hereby grandfathered into compliance with this specification. This approach is taken because of the practical impossibility of refitting the devices already in the field.

1.2 Types of devices that must meet these requirements

- 7 This specification is applicable to the following types of devices sold under the Digital name:
 1. Host processors that have peripheral ports that are advertised as SCSI compatible must meet this specification.
 2. Hosts that have embedded SCSI peripherals that are not advertised as SCSI compatible must meet this specification.

3. Hosts and peripherals that have ports that are based on SCSI but that are not intended to be compatible with SCSI devices (such as DSSI ports) are not required to meet this specification.
- 8 In coordination with the DSSI interface specification and the other appropriate DSA interface specifications, it is intended that all Digital storage devices be covered by some SSAG specification.
- 9 No restriction is placed on the implementation of optional features as long as they are implemented according to the ANSI SCSI-1 standard, do not conflict with what we expect to be contained in the SCSI-2 standard, and do not conflict with requirements of this document. Optional features must be documented in the applicable device specification. In addition, the responsible engineering group should consider whether an ECO to this document should be prepared to make such features mandatory for similar follow-on devices.

Chapter 2

Referenced Standards and Organizations

- 10 The device shall comply with the ANSI SCSI-1 specification, X3.131-1986.

Chapter 3

Glossary and Conventions

- 11 **ANSI.** The American National Standards Institute, an organization that develops procedures which when followed result in American National Standards. X3, IEEE, EIA, and CBEMA are accredited standards organizations. CBEMA is the organization which sponsors, among others, X3T9.2, the SCSI committee.
- 12 **CCS.** Common Command Set. An addendum to SCSI-1 that describes additional requirements for direct-access devices.
- 13 **DEC SCSI Compliant.** This name is associated with any device sold under the Digital name that is advertized as a SCSI device. While there is no "architecture police", it is expected that everyone in Digital will understand the advantages of a common approach to the problems associated with the SCSI specification. Specific advantages include proper operation with Digital operating systems, support by Digital diagnostics and field service, and reduced system integration difficulty.
- 14 **Device.** SCSI allows both storage and non-storage devices to be interconnected. In this document, "device" means any device that can be connected to the SCSI bus.
- 15 **Device Specification.** Every SCSI device marketed by Digital is described by a device specification that states the technical description of the device, including its SCSI interface implementation.
- 16 **Digital Qualified Device.** Digital Qualified devices are reviewed for correct operation with Digital driver software and for compliant implementation of the ANSI SCSI-1 specification, CCS, and all additional Digital requirements.
- 17 **Direct Access Device.** Disk.
- 18 **DSA.** Digital Storage Architecture, the overall approach to computer information storage used by Digital in its memory and mass storage systems.
- 19 **SCSI-1.** The ANSI Small Computer System Interface (X3.131-1986).
- 20 **SCSI-2.** The ANSI Small Computer System Interface (X3.131-19xx). This specification is still in preparation.
- 21 **Sequential Access Device.** Tape.
- 22 **SSAG.** The Storage Systems Architecture Group, the organization within Storage that is responsible for the development, maintenance, and documentation of the Digital Storage Architecture.

- 23 Storage. Used in this document as a synonym for Digital's Storage and Information Management Group (SIMG), which is responsible for the design and manufacturing of Digital's mass storage products.
- 24 Storage device. In this document, "storage device" means any mass storage device that can be connected to the SCSI bus.

Chapter 4

Physical Characteristics

4.1 Physical Description

- 25 ANSI SCSI-1 specification, Section 4.1.
Required for compatibility with all Digital implementations.
- 26 Single-ended drivers and receivers shall be used.

4.2 Connector Requirements

- 27 ANSI SCSI-1 specification, Section 4.3.
Required for compatibility with all Digital implementations.
- 28 All cable connectors shall be low density.
- 29 Non-shielded cable connectors may be used inside system boxes and other enclosures that are required to meet FCC regulations as a unit.
- 30 Shielded cable connectors shall be used with cables that are to be used between enclosures.
- 31 The connectors shall be keyed to prevent cabling errors.

4.3 Shielded Connector Requirements

- 32 ANSI SCSI-1 specification, Section 4.3.2.
Required for compatibility with all Digital implementations.
- 33 In order to support daisy-chained connections, devices that use shielded connectors shall provide two shielded device connectors on the device enclosure.
- 34 System enclosures may provide one shielded device connector.

4.4 Electrical Description

- 35 ANSI SCSI-1 specification, Section 4.4.
Required for compatibility with all Digital implementations.
- 36 Devices to be connected to an external SCSI bus shall not have internal termination. Near-end termination may be provided within the system enclosure only if the enclosure provides only one external connector. Far-end termination for any SCSI bus that is external to the enclosure shall be provided

by a terminating connector plugged into the last SCSI jack. There shall be no other terminators on an external bus.

37 | SCSI lines shall exhibit high impedance when the device is powered off.

38 | [Note to Best: SCSI requires that all grounds hook together, even in inter-cabinet cables.]

4.5 Terminator Power

39 | ANSI SCSI-1 specification, Section 4.4.3.
Required for compatibility with all Digital implementations.

40 | Each device, whether it is an initiator, target, or both, may provide terminator power to the TERMPWR pin. Each separately powered enclosure shall provide TERMPWR at at least one of its devices.

41 | A current limiter is required. The current limiter shall not curtail current below 1.0 Ampere, but shall prevent current greater than 1.5 Ampere. Current limiting at 1.5 Amperes is required since it allows for alternative 2 terminations.

42 | [Note to Best: System enclosures come with one terminator per externally accessible bus connector. Devices come with two connectors, and are daisy chained. Customer should not have to buy a terminator unless he loses it.]

4.6 SCSI Bus

43 | ANSI SCSI-1 specification, Section 4.5.
Required for compatibility with all Digital implementations.

44 | The SCSI ID is a value ranging from 0 to 7 that defines the logical position of the device controller on the SCSI bus. The device shall have user-selectable switches, jumpers, or software so that the SCSI ID may be changed easily in the field.

45 | SCSI ID assignments may vary from system to system. However, the following SCSI ID assignments should be used as initial defaults.

SCSI_ID	Device
-----	-----
7	processor on VAXstation 3520/3540
6	processor on VAXstation 3100/3150
6	processor on MicroVAX 3100/3150
6	processor on VAXserver 3100/3150
?	processor on DECstation 2100

- ? processor on DECstation 3100
 - ? processor on DECsystem 3100
 - | 5 tape drive or floppy disk drive
 - 2 to 4 disks drives
 - 0 and 1 unassigned
- 46 The device logical unit number distinguishes between multiple units attached to a single SCSI controller. Logical unit numbers from 0 to 7 may be used.
- 47 Sub-logical unit numbers (SCSI-1) shall not be used.

4.7 SCSI Bus Signals

- 48 ANSI SCSI-1 specification, Section 4.6.
Required for compatibility with all Digital implementations.
- 49 The device shall generate odd parity during all information transfer phases in which the device writes data to the SCSI bus, and it shall check odd parity during all information transfer phases in which it reads data from the bus.
- | Parity shall be generated and checked during the SELECTION phase and the RESELECTION phase.

4.8 Configuration Rules

- 50 This section defines restrictions on bus configurations that are required to maximize the chance of successful operation. These rules shall apply to systems built by Digital. These rules should apply to systems configured by customers, but marketing considerations may require looser limits. Marketing documents should make the appropriate restrictions clear to the customer.
- 51 Up to eight SCSI IDs may be used.
- 52 The total bus length shall not exceed a total of four meters, including both inside and outside the boxes. Cables and terminators shall be supplied by Digital.
- 53 At each bus connection, the maximum stub length shall be no more than 0.1 meters in length. Stubs shall be placed at least 0.3 meters apart.
- 54 The total number of boxes of any type connected to any single SCSI bus shall not exceed four. Since Digital does not support multiple-host SCSI buses, the configuration shall be one host adapter and up to three other boxes. There may be multiple devices (and therefore IDs) in a single box.

Chapter 5

Logical Characteristics

5.1 SCSI Bus Phases

- 55 | [House: We should disallow the SCSI-2 technique for targets to respond to a parity error during msg_out.]
- 56 | [House: If a target uses unexpected bus free as an error mechanism, it should act as though it got out a check condition status and prepare a request sense packet. Initiators should do the request_sense when they detect the unexpected us free condition.]
- 57 | ANSI SCSI-1 specification, Section 5.1.
Required for compatibility with all Digital implementations.
- 58 | Digital imposes certain timing restrictions on bus phases to ensure that bus phases proceed in a timely manner. Specific restrictions are described in the sections below.

5.2 BUS FREE Phase

- 59 | ANSI SCSI-1 specification, Section 5.1.1.
Required for compatibility with all Digital implementations.
- 60 | The target device shall not drive any SCSI bus line after the deassertion of BSY, except during selection or reselection.

5.3 ARBITRATION Phase

- 61 | ANSI SCSI-1 specification, Section 5.1.2.
Required for compatibility with all Digital implementations.
- 62 | The device shall support the ARBITRATION phase.

5.4 SELECTION Phase

- 63 | ANSI SCSI-1 specification, Section 5.1.3.
Required for compatibility with all Digital implementations.
[BASED ON RZ22 SPEC TEXT]
- 64 | The device shall use the following SELECTION phase timeout procedure.

- 65 Selection is timed out if the initiator does not detect a BSY signal from the target after waiting a minimum of a selection timeout delay.
- 66 If this occurs, the initiator will continue to assert SEL and release the DATA BUS. If the initiator has not detected BSY to be true after at least a selection abort time plus two deskew delays, it will release SEL allowing the SCSI BUS to go to the BUS FREE phase.
- 67 The device shall ensure, when responding to selection, that selection was still valid within a selection abort time of their assertion of the BSY signal. Failure to comply with this requirement could result in improper selection.
- 68 The device shall not respond to selection if more than two SCSI ID bits are asserted during the SELECTION phase.

5.5 RESELECTION Phase

- 69 ANSI SCSI-1 specification, Section 5.1.4.
Required for compatibility with all Digital implementations.
- 70 The device shall support RESELECTION.
- 71 When the initiator responds to a target reselection by asserting the BSY signal, the target shall deassert the SEL signal within 500 microseconds of the BSY assertion. The target shall also assert REQ for the first command or message byte within 500 microseconds of the BSY assertion.
- 72 The device shall not respond to selection if more than two SCSI ID bits are asserted during the RESELECTION phase.
- 73 Additional restrictions on disconnection and reselection are defined in section 5.15.
- 74 TZ30 IMPLEMENTATION NOTE
- 75 The reselection time out is 250 msec and the TZ30 retries the reselections 3 more times immediately after the first reselection timeout. The TZ30 performs the reselection time out when the TO bit in the MODE SELECT parameter is not set.
- 76 If the TZ30 detects the reselection time out condition, it resets both the controller and the drive in the same way as when it receives a bus-reset. The next command is then completed with CHECK CONDITION and UNIT ATTENTION.
- 77 RZ22 IMPLEMENTATION NOTE
- 78 The RZ22 does not check parity during reselection. It checks only whether more than two SCSI ID bits are asserted on the DATA BUS.
- 79 The RZ22 makes four attempts to reselect the initiator. If a timeout occurs, the following procedure is used to clear the SCSI BUS.

- 80 The drive continues to assert SEL I/O and releases the DATA BUS signals. If the drive has not detected BSY to be true after at least a selection abort time plus two deskew delays, the drive releases SEL and I/O allowing the SCSI BUS to go to the BUS FREE phase. (This is option 2 of the reselection timeout procedures in SCSI-1.)

5.6 | **COMMAND Phase**

- 81 ANSI SCSI-1 specification, Section 5.1.6.
Required for compatibility with all Digital implementations.
- 82 The device shall enter the command phase exactly once per command. Linked commands shall not be used.

5.7 | **STATUS Phase**

- 83 ANSI SCSI-1 specification, Section 5.1.8.
Required for compatibility with all Digital implementations.
- 84 A device shall enter the STATUS phase exactly once per command.
- 85 Storage devices shall not enter the STATUS phase following a WRITE command until the data has been written to nonvolatile media.
- 86 [Ando: During buffer mode write operations, the TZ30 returns complete status as soon as all the data from the host is stored in the device's internal buffer, whether the data has been written to the tape or not.]

5.8 | **ATTENTION Condition**

- 87 ANSI SCSI-1 specification, Section 5.2.1.
Required for compatibility with all Digital implementations.
- 88 The device shall respond to an ATTENTION condition at every phase transition as long as the initiator sets the ATN signal before it asserts the ACK signal for the last byte of the previous phase. During the data phase, the device shall also respond to an ATTENTION condition at least once per millisecond.

5.9 | **RESET Condition**

- 89 ANSI SCSI-1 specification, Section 5.2.2.
Required for compatibility with all Digital implementations.
- 90 Bus resets shall be done only by the primary initiator on the bus. In single cpu configurations the primary initiator is the cpu. In multiple cpu configurations one cpu must be established as the primary initiator.

- 91 | The device shall implement the hard reset alternative.
- 92 | The device shall behave as follows following a bus reset, except when the reset occurs as a result of a power-on.
- 1. If the device is block oriented and a write operation is active, the device shall complete the write to the media.
 - 2. The device shall be able to respond to a SCSI bus selection within 5 seconds of the bus reset. The device is permitted to return one of the following status values once it begins to accept bus selections:
 - a. BUSY status.
 - b. CHECK CONDITION status followed by NOT READY sense key in response to the next REQUEST SENSE command.
 - c. CHECK CONDITION status, followed by UNIT ATTENTION sense key in response to the next REQUEST SENSE command. UNIT ATTENTION may only be returned once per power-up/bus-reset, as described in the SCSI-1 standard.
 - 3. The device shall be able to respond to normal commands within 10 seconds of the bus reset.
- 93 | The device shall be able to handle multiple bus resets in succession with no ill effects. The device shall recover within the time limits specified above following the last bus reset.
- 94 | TZ30 IMPLEMENTATION NOTE
- 95 | When the TZ30 detects a SCSI bus reset, it initializes the controller to its power up condition, and performs its power-on self test. However, the drive will not be initialized by the bus reset. If a tape is loaded, it will be repositioned to BOT.

5.10 Message System Description

- 96 | ANSI SCSI-1 specification, Section 5.5.
Required for compatibility with all Digital implementations.
- 97 | [Blair: classify messages as supported by target or supported by initiator.]
- 98 | The following messages that are optional in SCSI-1 shall be supported:
- 1. ABORT
 - 2. BUS DEVICE RESET
 - 3. COMMAND COMPLETE
 - 4. DISCONNECT
 - 5. IDENTIFY

- 6. INITIATOR DETECTED ERROR
- 7. MESSAGE PARITY ERROR
- 8. MESSAGE REJECT
- 9. NO OPERATION
- 10. RESTORE POINTERS
- 11. SAVE DATA POINTER
- 12. SYNCHRONOUS DATA TRANSFER REQUEST (Devices that support synchronous data transfers.)

5.11 ABORT

- 99 ANSI SCSI-1 specification, Section 5.5.2
Required for compatibility with all Digital implementations.
- 100 The ABORT message shall be implemented so that when the target receives an ABORT message, it terminates the current operation.
- 101 The device shall stop in a manner that does not cause side effects. For example, parity errors shall not be written to the media, and devices which store user data in volatile memory shall write the data back to nonvolatile media before honoring the ABORT.
- 102 Following the abort operation the device shall operate as described above in the guidelines for recovery from a RESET condition.

5.12 COMMAND COMPLETE

- 103 ANSI SCSI-1 specification, Section 5.6.5.
Required for compatibility with all Digital implementations.
- 104 The device shall not hold the BSY signal for more than 10 microseconds after sending the COMMAND COMPLETE message.

5.13 DISCONNECT

- 105 ANSI SCSI-1 specification, Section 5.6.6.
Required for compatibility with all Digital implementations.
- 106 The device shall adhere to the following rules for disconnecting from the bus and reselecting the initiator.
 - 1. The device shall proceed "quickly" through all phases of a SCSI command, and shall not hold the bus for "long" periods without disconnect-

ing. The device shall disconnect when it is unable to transfer the next byte or proceed to the next phase within 500 microseconds.

2. The device shall not hold the BSY signal for more than 10 microseconds after sending the DISCONNECT message.
3. While the device is disconnected from the bus, it shall respond to a selection with ATN by entering the MESSAGE OUT phase and accepting the message from the initiator. The device shall be prepared to properly handle either the ABORT or the BUS DEVICE RESET message at this time.
4. The device shall employ the second option described in this section of the standard to release the bus, that is, the device shall not assert the RST signal. If the initiator fails to respond to reselection, the device shall time out the reselection attempt after 250 milliseconds as described in the Reselection Timeout Procedure, section 5.1.4.2 of the SCSI-1 standard.
5. After a reselection timeout, the target should retry the host at least four times, but it shall not retry more than 10 times. In order to prevent the retries from timing out other devices, the device shall delay at least 20 microseconds between retry attempts.

107 TZK50 IMPLEMENTATION NOTE

108 If the controller receives a message reject from the initiator after sending the DISCONNECT message or the SAVE POINTERS message, no further attempt is made to disconnect during the current command.

109 This message is used by the TK50 controller to ensure efficient use of the SCSI bus. The TK50 controller disconnects upon any of the following conditions.

1. The controller is instructed to do a REWIND or LOAD/UNLOAD without the immediate bit set.
2. The controller does a tachometer calibration pass.
3. The controller is instructed to reposition by a SPACE command.
4. During the DATA TRANSFER phase, the controller's data buffer becomes full during a write, empty during a read, or waiting for data during a verify with data compare.
5. During a verify without the byte compare bit set.
6. During the performance of requested diagnostics.

110 The controller reconnects for the following conditions.

1. Upon completion of the command.
2. Upon buffer becoming available during a write.

3. Upon data becoming available during a read or verify.

111 TZ30 IMPLEMENTATION NOTE

- 112 The TZ30 disconnects upon any of the following conditions if the initiator showed that it supports disconnection in its IDENTIFY message. The TZ30 disconnects immediately after receiving the command and reconnects when the command processing is completed.

1. LOAD/UNLOAD/REWIND command without the IMMEDIATE bit set.
2. READ/WRITE/WRITE FILEMARKS/SPACE/ERASE command.
3. Level-1/Level-2 diagnostics.

5.14 RESTORE POINTERS

- 113 ANSI SCSI-1 specification, Section 5.5.2.

114 VMS IMPLEMENTATION NOTE

- 115 VAX/VMS always performs an implicit restore pointers operation when the target reselects. The target should not use this message when reselecting as it can waste roughly 200 microseconds of cpu time per I/O operation.

116 RZ55 IMPLEMENTATION NOTE

- 117 The drive issues a restore data pointers message if it detects a parity error during the DATA OUT phase or COMMAND phase. If a parity error is detected during the MESSAGE phase the drive will request all messages again.

5.15 SAVE DATA POINTER

- 118 ANSI SCSI-1 specification, Section 5.5.2.

119 VMS IMPLEMENTATION NOTE

- 120 This message is used to save the context of an operation while a device is disconnected from the bus. However, this message is not necessary or useful when the target disconnects before starting to transfer data.

- 121 On VAX/VMS systems, the target should not use this message when disconnecting before starting to transfer data as it can waste roughly 200 microseconds of cpu time per I/O operation.

- 122 After the device has transferred data, it must issue the SAVE DATA POINTERS message before disconnecting.

Chapter 6

SCSI Commands and Status

6.1 Logical Unit Number

- 123 ANSI SCSI-1 specification, Section 6.2.2.
- 124 Logical Unit numbers may range from 0 to 7. SUBLUNs shall not be used.
- 125 RZ22 IMPLEMENTATION NOTE
- 126 Since the drive has only one logical unit, the logical unit number must be set to zero.

6.2 Unit Attention Condition

- 127 ANSI SCSI-1 specification, Section 6.9.
Required for all Digital implementations.
- 128 A UNIT ATTENTION condition shall be created for each initiator whenever a MODE SENSE parameter has been changed or the drive has been reset or the removeable media may have been changed.
- 129 If a REQUEST SENSE command is received from an initiator with a pending UNIT ATTENTION condition (before the drive reports CHECK CONDITION status), then the drive shall report any pending sense data and preserve the UNIT ATTENTION condition for that initiator. (This is option 1 of the procedures in SCSI-1 section 6.1.3.)

Chapter 7

All Device Types

130 The following commands shall be supported by all devices.

7.1 INQUIRY Command

131 ANSI SCSI-1 specification, Section 7.1.3. CCS page 11.
Required for CCS compatibility.

132 Inquiry data shall be returned in the following format.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Peripheral Device Type							
1	RMB	Device Type Qualifier						
2	ISO Vers		ECMA Version			ANSI Version		
3	Reserved				Response Data Format			
4	Additional Length (1FH)							
5	Request Sense Length							
6-7	Reserved							
8-15	"DEC"							
16-31	"abcd (C) DEC"							
32-35	"defg"							

133 Notes:

- ab = Digital device type identifier, e.g. ab = RZ for RZ22.
- cd = Digital model number identifier, e.g. cd = 22 for RZ22.
- ef = ROM Level in hex
- gh = RAM Level in hex
- Bytes 8-35 shall be ASCII characters.
- Spaces in bytes 8-35 shall be set to (20H).

134 The Response Data Format field shall be set to either (01H) to indicate compliance with the Common Command Set or to (00H) to indicate that the device does not comply with the Common Command Set.

135 The ANSI version field shall contain (01H) to indicate that the device complies with ANSI X3.131-1986 (SCSI-1).

136 The RMB bit shall be set to one.

7.2 REQUEST SENSE Command

137 ANSI SCSI-1 specification, Section 7.1.2. CCS page 6.
Required for SCSI-1 compatibility.

138 The following format shall be used for the EXTENDED SENSE DATA.

Bit	7	6	5	4	3	2	1	0
Byte								
0	VAL	Error Class			Error Code			
1	Segment Number							
2	Reserved				Sense Key			
3	Logical Block Address (MSB)							
4	Logical Block Address							
5	Logical Block Address							
6	Logical Block Address (LSB)							
7	Additional Sense Length							
8	Reserved							
9	Reserved							
10	Reserved							
11	Reserved							
12	Additional Sense Code							
13	Reserved							

14	Reserved
15	Reserved
16	Reserved
17	Reserved
18	Number of Header Retries
19	Number of Data Retries

- 139 The Error Class/Error Code fields shall be set to (70H) to indicate the extended sense data format.
- 140 [House: Tapes report (71H) for deferred error because they do write caching. Should this (i.e. all of request sense) be put into the individual device specific chapters?]
- 141 Sense Key values (7H) through (AH) and (CH) through (EH) shall not be used.
- 142 The REQUEST SENSE Error Codes shall be device specific. Refer to the device specification to determine the values chosen for a given device.

7.3 SEND DIAGNOSTIC Command

- 143 ANSI SCSI-1 specification, Section 7.1.6. CCS page 11.
Required for CCS compatibility.

7.4 TEST UNIT READY Command

- 144 ANSI SCSI-1 specification, Section 7.1.1.
Required for CCS compatibility

Chapter 8

Direct-Access Devices

- 145 The following commands shall be supported by all direct-access devices.

8.1 FORMAT UNIT Command

- 146 ANSI SCSI-1 specification, Section 8.1.2. CCS page 7.
Required for SCSI-1 compatibility.

- 147 [House: Should this be required?]

- 148 If the interleave value is zero, the drive shall use its default interleave value of 1:1. If the interleave value is one, the drive shall place consecutive logical blocks in contiguous ascending order. All other values are Digital specific and defined in the Device Specification.

- 149 Three bits specify the format for the defect list sent to the drive. The following defect list formats shall be supported.

Bit Reference					Description
4	3	2	1	0	
Fmt Dat	Cmp Lst	Defect List		Format	
0	X	X	X	X	Format with no Defect Data sent from the initiator to the drive.
1	0	0	X	X	Format adding the defects specified in the Defect List to the known defects (see Block Format).
1	1	0	X	X	Format using defects in the Defect List as the full set of known defects (see Block Format).
1	0	1	0	0	Format adding the defects specified in the Defect List to the known defects (see Bytes From Index Format).

- 1 1 1 0 0 Format using defects in the Defect List as the full set of known defects (see Bytes From Index Format).
- | 1 X 1 1 X To clear an existing set of grown defects. X = 1 or 0 (i.e., don't care)
- 150 Each defect descriptor for the block format shall specify a four byte defect block address that contains the defect. The defect descriptors shall be in ascending order.
- 151 RZ22 IMPLEMENTATION NOTE
- 152 The RZ22 drive always uses the default interleave value of 1:1.

8.2 INQUIRY Command

- 153 Required for all devices for CCS compatibility. See Chapter 7.

8.3 MODE SELECT Command

- 154 ANSI SCSI-1 specification, Section 8.1.7. CCS page 18. Required for RZ22 compatibility.
- 155 [House: Should the PF bit be required?]
- 156 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (15H)							
1	LUN = 0			Reserved			SP	
2	Reserved							
3	Reserved							
4	Parameter List Length							
5	Reserved		Reserved			Flag		Link

- 157 If the Save Parameter (SP) bit is set to one, it indicates that the drive shall

1. update the current mode values with the values defined in the following pages,
 2. save all savable pages, and
 3. report command complete with no CHECK CONDITION status when successfully completing the above.
- 158 Savable pages are pages for which preceding MODE SENSE commands returned the PS bit of the page header set to one.
- 159 If the SP bit is set to zero, it indicates that the drive shall
1. update the current mode values with the values defined in the following pages,
 2. not save the savable pages, and
 3. report command complete with no CHECK CONDITION status when successfully completing the above.
- 160 The ERROR RECOVERY PARAMETERS page shall be supported by the MODE SELECT command.
- 161 The Parameter List Length value shall be either 0 or 8, indicating 0 or 1 block descriptors per MODE SELECT command.
- 162 The following format shall be used for the MODE SELECT Parameter List.

Byte	MODE SELECT Header
0	Reserved
1	Medium Type
2	Reserved
3	Block Descriptor Length
	Block Descriptors
0	Density Code
1	Number of Blocks (MSB)
2	Number of Blocks
3	Number of Blocks (LSB)
4	Reserved

5	Blocks Length (MSB)
6	Block Length
7	Block Length (LSB)

163 The Number of Blocks field may be ignored if the drive supports only all-user-blocks formatting.

164 The Block Length field shall contain 512.

8.4 MODE SENSE Command

165 ANSI SCSI-1 specification, Section 8.1.10.
Required for RZ22 compatibility.

166 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (1AH)							
1	LUN = 0			Reserved				
2	PCF	Page Code						
3	Reserved							
4	Allocation Length							
5	Reserved		Reserved				Flag	Link

167 Page Control Field (PCF): Defines the type of page parameter values to be returned to the initiator. They are as follows:

168 Bit 7 = 0 Bit 6 = 0 Report Current Values:

169 If the Page Code is equal to 3F(H), all pages implemented by the drive will be returned to the initiator with all fields and bits set to current values.

- 170 If the Page Code is different than 3F(H), the page defined by the Page Code, if supported by the drive, will be returned to the initiator with fields and bits set to current values.
- 171 The current values are one of the following:
1. As set in the last successfully completed MODE SELECT command.
 2. Identical to the Saved Values if saving is available and no MODE SELECT command has yet been issued since the last power on.
 3. Identical to the Default Values if no saving is available or if no Saved Values are available.
- 172 Fields and bits not supported by the drive will be set to zero. The Page Length byte value of each page returned by the drive indicates how many bytes are supported within the particular page.
- 173 Bit 7 = 0 Bit 6 = 1 Report Changeable Values:
- 174 If the Page Code field is equal to 3F(H), all pages implemented by the target are to be returned to the initiator with bits and fields that are allowed to be changed by the initiator set to one. Fields and bits not allowed to be changed by the initiator will be set to zero.
- 175 If the page code is different than 3F(H), the page defined by the Page Code, if supported by the drive, will be returned to the initiator with bits and fields that are allowed to be changed by the initiator set to one. Fields and bits not allowed to be changed by the initiator will be set to zero.
- 176 The Page Length byte value of each page returned by the drive indicates how many bytes are supported within the particular page.
- 177 Bit 7 = 1 Bit 6 = 0 Report Default Values:
- 178 If the Page Code is equal to 3F(H), all pages implemented by the drive will be returned to the initiator with fields and bits set to the drive's default values.
- 179 If the Page Code is different than 3F(H), the page defined by the Page Code, if supported by the drive, will be returned to the initiator with fields and bits set to the drive's default values. Fields and bits not supported by the drive will be set to zero.
- 180 The Page Length byte value of each page returned by the drive indicates how many bytes are supported within the particular page.
- 181 The value of the fields returned with this code is intended to avoid confusion over whether the value of zero is the default or the unsupported value.
- 182 Bit 7 = 1 Bit 6 = 1 Report Saved Values:
- 183 If the page code is equal to 3F(H), all pages implemented by the drive will be returned to the initiator with the fields and bits set to the saved values.

184 If the Page Code is different than 3F(H), the page defined by the Page Code, if supported by the drive, will be returned to the initiator with bits and fields set to the saved values. The saved values are either:

1. The saved values during the last successfully completed MODE SELECT command.
2. Identical to the default values if saving is not available.

185 Fields and bits not supported by the drive will be set to zero. The Page Length byte value of each page returned by the drive indicates how many bytes are supported by the drive.

186 Page Code: Indicates which pages to return. The following Page Codes shall be supported:

Page Code	Meaning
(01H)	Error Recovery Parameters
(02H)	Disconnect/Reconnect Control Parameters
(03H)	Direct Access Device Format Parameters
(04H)	Rigid Disk Drive parameters
(05H)	Flexible Disk Geometry Parameters
(25H)	DEC Unique Page

8.5 Mode Sense Data

187 ANSI SCSI-1 specification, Section 8.1.10. CCS page 32.

188 [There is a problem here because some of the optional CCS bits aren't supported by our devices. I need to figure out exactly which ones we want and don't want to support.]

189 The Vendor-unique page codes 20h - 3Eh shall be further subdivided as follows.

1. (20H) - (24H) Digital Device Unique
2. (25H) Digital Special Function Control Page
3. (26H) - (3EH) Vendor Specific

190 The Error Recovery Parameters page (01H) shall be supported.

191 The Disconnect/Reconnect Control Parameters page (02H) shall be supported.

192 The Direct Access Device Format Parameters page (03H) shall be supported.

193 The Rigid Disk Drive Geometry Parameters page (04H) shall be supported if the device is a rigid disk drive.

194 The Flexible Disk Drive Geometry Parameters page (05H) shall be supported if the device is a flexible disk drive.

195 The Digital Special Function Control page (25H) shall be supported. This page shall contain non-volatile storage of Digital specific control information.

196 This page shall be formatted as follows.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Rsvd	Rsvd	Page Code = (25H)					
1	Page Length = (17H)							
2	Reserved							SPD
3-24H	Reserved							

197 A Spin-up Disable (SPD) bit of 1 shall indicate that the drive will not spin up on initial power up. A Spin-up Disable bit of 0 shall indicate that the drive will spin up upon initial power up.

8.6 READ Command

198 ANSI SCSI-1 specification, Section 8.1.4.
Required for SCSI-1 compatibility.

8.7 READ BUFFER Command

199 CCS page 39. ANSI SCSI-2 specification, Section 7.2.12.
Required for RZ22 compatibility.

200 There shall be no access to the drive's medium during the execution of this command.

201 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (3CH)							

1	LUN = 0	Reserved	BCV=0
2		Reserved	
3		Reserved	
4		Reserved	
5		Reserved	
6		Reserved	
7		Allocation Length (MSB)	
8		Allocation Length (LSB)	
9	Reserved	Reserved	Flag Link

- 202 The Allocation Length specifies the number of bytes that the initiator has allocated for returned data. The allocation length contains a four byte header, followed by the READ BUFFER data called the available length.
- 203 An allocation length of zero shall cause no bytes to be transferred. This is not an error condition.
- 204 If the allocation length is greater than the available length added to the four bytes of the READ BUFFER header, then the READ BUFFER header and the available length will be transferred to the initiator. It is not an error to request an allocation length less than the available length.
- 205 The drive shall terminate the DATA-IN phase when the allocation length has been transferred or when the READ BUFFER header and the available length have been transferred to the initiator, whichever is less.
- 206 The following format shall be used for the READ BUFFER Header.

Bit	7	6	5	4	3	2	1	0
Byte								
0		Reserved						
1		Reserved						
2		Available Length (MSB)						
3		Available Length (LSB)						

4	Data Byte 0
5	Data Byte 1
N+4	Data Byte N

207 The Available Length field shall specify the drive's buffer size.

8.8 READ CAPACITY Command

208 CCS page 11. ANSI SCSI-2 specification, Section 8.2.7.
Required for CCS compatibility.

209 The READ CAPACITY command shall provide a means for the initiator to request information regarding the capacity of the drive.

210 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (25H)							
1	LUN = 0			Reserved				RelAd
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved		Reserved				PMI	
9	Reserved		Reserved				Flag	Link

- 211 The Partial Medium Indicator (PMI) bit, when set to zero, indicates that the information returned in the READ CAPACITY data will be the logical block address and block length (in bytes) of the last logical block of the drive. The logical block address of the command descriptor block must be set to zero for this option.
- 212 A PMI bit of one indicates that the information returned will be the last logical block address and block length (in bytes) of the last logical block address after which a substantial delay in data transfer will occur. This logical block address will be greater than or equal to the logical block address specified in the command descriptor block.
- 213 The following format shall be used for the READ CAPACITY Data

Bit	7	6	5	4	3	2	1	0
Byte								
0	Logical Block Address (MSB)							
1	Logical Block Address							
2	Logical Block Address							
3	Logical Block Address (LSB)							
4	Block Length (MSB)							
5	Block Length							
6	Block Length							
7	Block Length (LSB)							

- 214 A drive shall indicate zero or unknown capacity by returning the value zero in the Block Length field.

8.9 READ DEFECT DATA Command

- 215 ANSI SCSI-2 specification, Section 8.2.8.
Required for RZ22 compatibility.
- 216 The READ DEFECT DATA command requests that the drive transfer the medium defect data to the initiator.
- 217 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (37H)							
1	LUN = 0			Reserved				
2	Reserved			P	G	Defect List Fmt		
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	Allocation Length (MSB)							
8	Allocation Length (LSB)							
9	Reserved			Reserved			Flag	Link

- 218 When the Primary (P) bit is set to one, the drive shall return the primary list of defects to the initiator.
- 219 When the Growing (G) bit is set to one, the drive shall return the growing list of defects to the initiator.
- 220 When both the P and the G bits are set to one, the drive shall return both the primary and growing list of defects. The primary shall be followed by the growing list.
- 221 The Allocation Length specifies the number of bytes that the initiator has allocated for returned defect data. An allocation length of zero indicates that no defect data is to be returned. Any other value indicates the maximum number of bytes that will be returned. The drive shall terminate the DATA-IN phase when all allocation length bytes have been sent or when all available defect data has been sent, whichever is less.
- 222 Three bits specify the Defect List Format which is the format for the defect list returned to the initiator.

223 Reference Bit Description

2 1 0

- | | | | |
|---|---|---|---|
| 0 | x | x | The initiator requests that the defect list be returned in Logical Block Format. |
| 1 | 0 | 0 | The initiator requests that the defect list be returned in Bytes From Index Format. |
| 1 | 0 | 1 | The initiator requests that the defect list be returned in Physical Sector Format. |
- 224 Logical Block Format shall be supported by all drives.
- 225 For all types of defect list formats, the defect list shall contain a four byte header followed by one or more defect descriptors as shown in the following table.
- 226 The following format shall be used for the DEFECT LIST HEADER.
- | | | | | | | | | |
|------|--------------------------|---|---|---|---|-----------------|---|---|
| Bit | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Byte | | | | | | | | |
| 0 | Reserved | | | | | | | |
| 1 | Reserved | | | P | G | Defect List Fmt | | |
| 2 | Defect List Length (MSB) | | | | | | | |
| 3 | Defect List Length (LSB) | | | | | | | |
- 227 When the Primary (P) bit is set to one, it indicates that the primary defect list has been returned by the drive.
- 228 When the Growing (G) bit is set to one, it indicates that the growing defect list has been returned by the drive.
- 229 The Defect List Format specifies the format for the returned defect list.
- 230 The Defect List Length specifies the total length in bytes of the defect list. For the logical block format, the defect list length is equal to four times the number of defect descriptors. For the bytes from index format, the defect list length is equal to eight times the number of defect descriptors. This length does not include the four bytes of header.
- 231 The format for the Defect Descriptors for the logical block format and bytes from index format are shown in the following tables.
- 232 The following format shall be used for the Logical Block Format Defect Descriptors.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Defect Block Address (MSB)							
1	Defect Block Address							
2	Defect Block Address							
3	Defect Block Address (LSB)							

233 The Defect Block Address is a four byte value specifying the physical block number of the defect.

234 The following format shall be used for the Bytes from Index Format Defect Descriptors.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Cylinder Number of Defect (MSB)							
1	Cylinder Number of Defect							
2	Cylinder Number of Defect (LSB)							
3	Head Number of Defect							
4	Defect Bytes from index (MSB)							
5	Defect Bytes from index							
6	Defect Bytes from index							
7	Defect Bytes from index (LSB)							

235 The Cylinder Number is a three byte value specifying the cylinder number of the defect.

236 The Head Number is a one byte value specifying the head number of the defect.

- 237 Bytes From Index is a four byte value specifying the number of bytes from index that the defect is located.
- 238 The following format shall be used for the Physical Sector Format Defect Descriptors.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Cylinder Number of Defect (MSB)							
1	Cylinder Number of Defect							
2	Cylinder Number of Defect (LSB)							
3	Head Number of Defect							
4	Defect Sector Number (MSB)							
5	Defect Sector Number							
6	Defect Sector Number							
7	Defect Sector Number (LSB)							

- 239 The Cylinder Number is a three byte value specifying the cylinder number of the defect.
- 240 The Head Number is a one byte value specifying the head number of the defect.
- 241 The Sector Number is a four byte value specifying the sector where the defect is located.

8.10 READ LONG Command

- 242 ANSI SCSI-2 specification, Section 8.2.9.
This command is optional.
- 243 The READ LONG command shall transfer the specified sector of data and ECC bytes to the initiator. The drive shall not correct the data field or the ECC bytes.
- 244 The number of bytes transferred to the initiator will be the sector size (512 bytes) plus the number of bytes contained in the ECC field (6 bytes).

245 This command is intended for diagnostic purposes.

246 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (3EH)							
1	LUN = 0			Reserved				RelAd
2	PHAD	Logical Block Address (MSB)						
3	Logial Block Address							
4	Logial Block Address							
5	Logial Block Address (LSB)							
6	Reserved							
7	Reserved							
8	(01H) or (02H)							
9	Reserved		Reserved				Flag	Link

247 The Logical Block Address specifies the Logical Block Address where the READ LONG operation will begin.

248 The optional PHAD bit, if set to sone, specifies that the address is to be interpreted as a physical address. If set to zero, the address is to be interpreted as a logical address. If the drive does not support the PHAD bit, a READ LONG command with the PHAD bit set shall be returned with a CHECK CONDITION status.

8.11 REASSIGN BLOCKS Command

249 ANSI SCSI-1 specification, Section 8.1.3.
Required for RZ22 compatibility.

250 This command shall be supported by all rigid disk drives and by all flexible disk drives of over 10 MegaByte capacity.

251 The data for the reassigned block shall be written on the media before the
old block is modified. A system of non-volatile flags shall be used to protect
the data in case of problems during the reassignment process.

252 RZ22 IMPLEMENTATION NOTE

253 This drive has a microcode bug that allows the drive to accept a "Reassign
Block" command with a defect list length that is not four times the number
of defect descriptors, without issuing a "Check Condition". The drive will ac-
cept the command, but it will not reassign the block. This could cause a pro-
grammer to believe the command was successful, but upon issuing a "Read
Defect" command with the "Grown List" bit enabled the block would not
have been logged as reassigned.

8.12 RELEASE Command

254 ANSI SCSI-1 specification, Section 8.1.9. CCS page 11.
Required for CCS compatibility.

255 The Extent Release option of the RELEASE command shall be supported.

8.13 REQUEST SENSE Command

256 Required for all devices for SCSI-1 compatibility. See Chapter 7.

257 The non-extended sense data shall be as follows.

Bit	7	6	5	4	3	2	1	0
Byte								
0	ADVAL Error Class Error Code							
1	Logical Block Address (MSB)							
2	Logical Block Address							
3	Logical Block Address (LSB)							

258 The Address Valid (ADVAL) bit indicates that the bytes containing the
logical block address contain valid information related to the error.

259 The Error Class field indicates the type of error that occurred:

Bits Error Class

06 05 04

0	0	0	Disk drive errors
0	0	1	Target/Medium errors
0	1	0	System related errors
0	1	1	Medium errors
1	0	0	Hardware/SCSI interface errors
1	0	1	Medium errors
1	1	0	Unit attention errors
1	1	1	Reserved for extended sense

260 The Error Code field defines the specific error that occurred. This is the same error code that would be presented in the additional sense key field of the extended sense data format.

261 If the ADVAL bit is set, the Logical Block Address field specifies the logical block address associated with the error.

8.14 RESERVE Command

262 ANSI SCSI-1 specification, Section 8.1.8. CCS page 11.
Required for CCS compatibility.

263 The Extent Reservation option of the RESERVE command shall be supported.

8.15 SEND DIAGNOSTIC Command

264 Required for all devices for CCS compatibility. See Chapter 7.

8.16 START STOP UNIT Command

265 ANSI SCSI-1 specification, Section 8.1.11.
Required for RZ22 compatibility.

266 Upon receipt of a START/STOP UNIT command, the drive shall either spin up and position the read/write heads to cylinder zero or spin down and position the read/write heads in the landing zone, as indicated.

8.17 TEST UNIT READY Command

267 Required for all devices for CCS compatibility. See Chapter 7.

8.18 VERIFY Command

268 ANSI SCSI-2 specification, Section 8.2.19.
Should this be a required command?

- 269 The verify command requests that the drive verify the data on the medium.
- 270 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (2FH)							
1	LUN = 0			Reserved	BytCk	RelAdr = 0		
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address (LSB)							
6	Reserved							
7	Verification Length (MSB)							
8	Verification Length (LSB)							
9	Reserved	Reserved				Flag	Link	

- 271 When the Byte Check (BytChk) bit is zero, the verification shall consist of simply a medium verification (ECC).
- 272 A Byte Check value of one may be unsupported. When the Byte Check bit is one, the command may terminate with a CHECK CONDITION status and the sense key set to ILLEGAL REQUEST.
- 273 The Logical Block Address specifies the logical block where the verify operation will begin.
- 274 The Verification Length specifies the number of contiguous logical blocks of data to verify. A verification length of zero indicates no logical blocks will be verified. This is not considered an error condition. Any other value indicates the number of blocks to be verified.
- 275 RZ22 IMPLEMENTATION NOTE

- 276 A BytCk bit of one is not supported. If set to one, the command will terminate with a CHECK CONDITION status and the sense key set to ILLEGAL REQUEST.

8.19 WRITE Command

- 277 ANSI SCSI-1 specification, Section 8.1.5.
Required for SCSI-1 compatibility.
- 278 Storage devices shall not enter the STATUS phase following a WRITE command until the data has been written to nonvolatile media.

8.20 WRITE AND VERIFY Command

- 279 ANSI SCSI-2 specification, Section 8.2.22.
Should this be a required command?
- 280 The WRITE AND VERIFY command requests that the drive write the data transferred from the initiator to the medium and then verify that the data is correctly written.
- 281 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (2EH)							
1	LUN = 0			Reserved				RelAd
2	Logical Block Address (MSB)							
3	Logial Block Address							
4	Logial Block Address							
5	Logial Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved		Reserved				Flag	Link

- =====
- 282 When the Byte Check (BytChk) bit is zero, the verification shall consist of simply a medium verification (ECC).
- 283 A Byte Check value of one may be unsupported. When the Byte Check bit is one, the command may terminate with a CHECK CONDITION status and the sense key set to ILLEGAL REQUEST.
- 284 The Logical Block Address specifies the logical block where the verify operation will begin.
- 285 The Transfer Length specifies the number of contiguous logical blocks of data to transfer. A transfer length of zero indicates no logical blocks will be transferred. This is not considered an error condition. Any other value indicates the number of logical blocks that will be transferred.
- 286 RZ22 IMPLEMENTATION NOTE
- 287 A BytChk bit of one is not supported. If set to one, the command will terminate with a CHECK CONDITION status and the sense key set to ILLEGAL REQUEST.

8.21 WRITE BUFFER Command

- 288 CCS page 28.
Required for RZ22 compatibility.
- 289 The WRITE BUFFER command is used in conjunction with the READ BUFFER command as a diagnostic function for testing the drive's buffer memory and the SCSI bus integrity. There shall be no access to the drive's medium during the execution of this command.
- 290 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (3BH)							
1	LUN = 0			Reserved				BCV
2	Reserved							
3	Reserved							
4	Reserved							

5	Reserved			
6	Reserved			
7	Transfer Length (MSB)			
8	Transfer Length (LSB)			
9	Reserved	Reserved	Flag	Link

- 291 The Buffer Control Valid (BCV) bit may be unsupported. If unsupported, it shall be set to zero.
- 292 The Transfer Length specifies the maximum number of bytes to be transferred and retained in the drive's buffer. The Transfer Length includes a four byte header followed by the WRITE BUFFER data.
- 293 A Transfer Length of zero shall cause no bytes to be transferred. This is not an error condition.
- 294 If the transfer length is greater than the available length plus four returned in the header of the READ BUFFER command, no data will be transferred and the drive will return a CHECK CONDITION status with the sense key set to ILLEGAL REQUEST.
- 295 The Write Buffer Header shall have the following format.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Reserved							
1	Reserved							
2	Reserved							
3	Reserved							
4	Data Byte 0							
5	Data Byte 1							
N+4	Data Byte N							

8.22 WRITE LONG Command

296 ANSI SCSI-2 specification, Section 8.2.23.
Should this be a required command?

297 Upon receipt of a WRITE LONG command the target shall transfer a sector of data and ECC bytes to the drive. The bytes transferred to the drive shall be written in the data and the ECC fields for the particular sector specified in the logical block address.

298 The number of bytes transferred to the drive shall be the sector size (512 bytes) plus the number of bytes contained in the ECC field (6 bytes).

299 This command is intended for diagnostic purposes.

300 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (3FH)							
1	LUN = 0			Reserved				RelAD
2	Logical Block Address (MSB)							
3	Logical Block Address							
4	Logical Block Address							
5	Logical Block Address							
6	Reserved							
7	Reserved							
8	(01H) or (00H) [why?]							
9	Reserved		Reserved				Flag	Link

301 The Logical Block Address specifies the logical block address where the WRITE LONG operation will begin.

8.23 Vendor-Specific Fields and Values

302 ANSI SCSI-1 specification, several sections throughout Chapter 8.

303 Various fields and values throughout the SCSI-1 specification are marked as "vendor-specific". Digital allows vendors free use of these fields and values.

8.24 WRITE EXTENDED Command.

304 The WRITE EXTENDED command requests that the drive write the data transferred by the initiator to the medium.

305 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (2AH)							
1	LUN = 0			Reserved				RelAd
2	Logical Block Address (MSB)							
3	Logial Block Address							
4	Logial Block Address							
5	Logial Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved		Reserved				Flag	Link

306 The Logical Block Address specifies the logical block where the write operation will begin.

307 The Transfer Length specifies the number of contiguous logical blocks of data to transfer. A transfer length of zero indicates no logical blocks will be transferred. This is not considered an error condition. Any other value indicates the number of logical blocks that will be transferred.

8.25 READ EXTENDED Command.

308 The READ EXTENDED command requests that the drive transfer data to the initiator.

309 [House: Should FUA bit be required?]

310 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (28H)							
1	LUN = 0			Reserved				RelAd
2	Logical Block Address (MSB)							
3	Logial Block Address							
4	Logial Block Address							
5	Logial Block Address (LSB)							
6	Reserved							
7	Transfer Length (MSB)							
8	Transfer Length (LSB)							
9	Reserved		Reserved				Flag	Link

311 The Logical Block Address specifies the logical block where the read operation will begin.

312 The Transfer Length specifies the number of contiguous logical blocks of data to transfer. A transfer length of zero indicates no logical blocks will be transferred. This is not considered an error condition. Any other value indicates the number of logical blocks that will be transferred.

8.26 SEEK EXTENDED Command.

313 Should this be a required command?

314 The SEEK EXTENDED command requests that the drive position itself to the specified logical block.

315 The following command format shall be used.

Bit	7	6	5	4	3	2	1	0
Byte								
0	Operation Code (2BH)							
1	LUN = 0			Reserved				
2	Logical Block Address (MSB)							
3	Logial Block Address							
4	Logial Block Address							
5	Logial Block Address (LSB)							
6	Reserved							
7	Reserved							
8	Reserved							
9	Reserved		Reserved				Flag	Link

316 The Logical Block Address specifies the logical block for the drive to seek to.

8.27 Power-Up Characteristics

317 The drive shall default to not spin up on power up. A jumper may be used to enable or disable this feature. The position of the jumper shall be readable using Mode Sense Data Page (25H).

8.28 Bad Block Replacement Algorithm

318 [House: RZ57 will have automatic BBR with forced error flag.]

319 The following algorithm shall be used by all Digital driver software.

- 320 When the disk class driver detects a read or write error, it tries the operation again several times. If appropriate, it reassigns blocks to prevent media defects from causing future errors.
- 321 First, the driver detects an error during a read or write operation.
- 322 If the error is recoverable with retries only then the driver continues with normal operations. No error is logged in the operating system.
- 323 If the original read fails with a non-recoverable error, the driver will retry the operation three times. The first error will be logged with the operating system as an EXT_SNS_DAT error (VMS error code 05). Any additional errors on retries will not be logged. If all three retries fail in the same way, the data is lost and the driver returns SS\$_PARITY status and exits the algorithm. (A reassignment would result in undetected user data corruption because there is no forced error bit in SCSI.) There will not be any additional errorlog entry associated with this exit from the algorithm. If the original operation was a write, the class driver will proceed with the REASSIGN since VMS has the correct data in memory.
- 324 If the error is recoverable with ECC the driver buffers the corrected data in host memory and continues with the algorithm. A recoverable ECC error is logged with the operating system.
- 325 Second, the driver retries the operation three times.
- 326 If a retry is successful (read without ECC), the driver exits the BBR algorithm. Errors encountered on these class driver retries are not logged with the operating system.
- 327 If all three retries require ECC to recover the data, the class driver will log a reassign event with VMS and tell the disk drive to reassign the block.
- 328 If a non-recoverable error is encountered, the algorithm will go straight to a reassign of the block. No error other than the reassign event is logged with the operating system. The reassign event will be logged with the operating system as a REASSIGN_BLK event (VMS error code 07).
- 329 Third, the driver attempts to reassign the block up to three times.
- 330 If the REASSIGN BLOCKS command fails, an error is logged with the operating system and the command is retried up to three times. Each REASSIGN failure will be logged with the operating system as an EXT_SNS_DAT error (VMS error code 05). If three attempts to reassign the block fail, the driver will exit the algorithm. There will not be any additional errorlog entry associated with this exit from the algorithm.
- 331 Fourth, if the reassignment succeeds, the driver writes the original data buffered in host memory to the reassigned block.
- 332 If the write operation after the reassign fails and fewer than three writes to the reassigned block have been performed, an error on the write operation is

logged with VMS and driver returns to retry the command up to three times. If three attempts to rewrite the data fail, the driver will exit the algorithm.

Chapter 9

Sequential-Access Devices

333 The following commands shall be supported by all sequential-access devices.

9.1 ERASE Command

334 ANSI SCSI-1 specification, Section 9.13.
Required for TZK50 compatibility.

335 TZK50 and TZ30 IMPLEMENTATION NOTE

336 If the long bit is a zero, the controller completes this command immediately with Good status. If the long bit is a one, the drive erases from the current position to the end of the media.

9.2 INQUIRY Command

337 Required for all Digital devices. See Chapter 7.

9.3 LOAD/UNLOAD Command

338 ANSI SCSI-1 specification, Section 9.15.
Required for TZK50 compatibility.

339 TZK50 IMPLEMENTATION NOTE

340 The Retention Bit will be unused by the TK50 controller. It will accept this bit either set or cleared, but the bit will have no effect.

341 The load bit of zero will indicate to the controller to unload the tape into the cartridge. The load bit set to a one will be an accepted command but will simply position the tape to the beginning of tape. The TK50 tape can only be loaded from the cartridge via the front panel switch. If the load bit is set to a one and the tape has not been manually loaded, a check condition will be returned and the extended sense data sense key set to NOT READY.

342 TZ30 IMPLEMENTATION NOTE

343 If a tape cartridge is inserted and the Load Bit is zero, TZ30 unloads the tape. If this bit is one, TZ30 tries to load the tape.

344 Since TZ30 implement autocalibration feature, host systems do not need to issue the LOAD command.

9.4 MODE SELECT Command

345 ANSI SCSI-1 specification, Section 9.11.
Required for TZK50 compatibility.

346 TZK50 and TZ30 IMPLEMENTATION NOTE

347 The speed field in the Device-Specific Parameter byte is always zero.

348 If the buffered mode field is a zero, then the controller will transfer all data from the buffer to the tape before it reports a GOOD STATUS on a write. If the buffered mode field is a one, the controller will report a good status on a write command as soon as it has transferred the data into its buffer.

349 The controller will not buffer data for more than one initiator at a time. When data for multiple commands has been buffered and there is an error on a command, the number that is put into the information bytes in the extended sense data will be the total remaining blocks from all commands.

350 The following format is used for the MODE SELECT Parameter List:

Bit	7	6	5	4	3	2	1	0
Byte								
0	0	0	0	0	0	0	0	0
1	Number of Records (MSB)							
2	Number of Records							
3	Number of Records (LSB)							
4	Reserved							
5	Record Length (MSB)							
6	Record Length							
7	Record Length							
8	Vendor Unique Length							
9	VU7	TO	Reserved	NOFEXT	NOF			

351 The controller imposes a limit on the Number of Records field in the MODE SELECT command. It is required to set the block size from current position

- to end of media. Therefore, number of records must be set to 0. Any other value will result in a check condition response and the extended sense data sense key to be ILLEGAL REQUEST.
- 352 The record length, if other than 0, selects fixed record mode of the specified length. A record length of 0, indicates variable length records.
- 353 The following Vendor Unique Parameters are defined.

1. Utilizing the Mode Set command, it is possible to place the drive into a Direct Track Access mode that allows direct specification of the desired track. When in this mode, the tape format has a deviation from the standard. Each track is treated as a separate tape. End of track is either BOT or EOT depending on whether it is an odd track or even track. Block numbering begins at 0 on all tracks.

This mode of operation is specified by setting VU7 to a one. The default mode of operation after a reset or power up is non-direct track access. If VU7 is set to zero, a TRACK SELECT command will terminate with CHECK CONDITION and the sense-key will be ILLEGAL REQUEST.

To ensure proper operation the following guidelines must be followed:

- a. If the previous mode was direct track access and the new mode is non-direct track access, a rewind command should be issued.
 - b. If the previous mode was non-direct track access and the new mode is direct track access, a Track select command should be issued.
2. To enhance the streaming capabilities of the drive between records or when bus data rates drop below 47 Kbytes/sec (TZ50) or 45 (TZ30), it is possible to enable writing of streaming filler blocks to keep the tape streaming. Setting a non zero value into the NOF field enables the writing of streaming fillers. The value of NOF is the allowable number of consecutives fillers the controller may write to enhance streaming. A value of 0 indicates streaming fillers may not be used.

If the drive must still reposition after writing a streaming filler block positions itself to rewrite the previous written streaming filler block(s). A gap sync block is used as the streaming filler block in this case. This means that a streaming filler block will not be included in the ECC calculation and does not count as a block within an ECC entity. The default mode of operation and reset or power up is to disable writing of streaming fillers.

3. The TZ30 (only) treats the NOFEXT (Number of Filler Extension) bit as the fourth bit of NOF field. The initiator can direct the TZ30 to use a filler count of up to 15 by using both NOFEXT bit and the three NOF bits.

4. If the TO bit (Ignore Reselection Time Out) bit is set, the drive never times out when performing RESELECTION.

In summary, the default condition is:

1. Non-direct Track Access Mode
2. Non-buffered Data Mode
3. Fillers Disabled
4. Variable Block Size
5. Reselection time out is enabled

9.5 MODE SENSE Command

354 ANSI SCSI-1 specification, Section 9.14.
Required for TZK50 compatibility.

355 TZK50 and TZ30 IMPLEMENTATION NOTE

356 Device Specific Parameters:

357 The mode sense will reflect the vendor specific values as defined under the mode select command. The mode sense data header is followed by the block descriptors.

358 The write protect bit when asserted indicates that the drive has detected the write protect tab of the cartridge to be in the position to disable writing to the cartridge. When the write protect bit is a zero, it indicates the currently installed cartridge may be written on.

359 The buffered mode field will reflect the current mode set by a mode select command or, if a mode select command has not been issued, will be a zero to indicate the controller is in the non buffered mode of operation. The above values will be set as indicated under the Mode Select command.

9.6 READ Command

360 ANSI SCSI-1 specification, Section 9.3.
Required for SCSI-1 compatibility.

361 TZK50 IMPLEMENTATION NOTE

362 Bit 7 in Byte 5 in the vendor specific bits of the control byte is used as the PLR (Position Lost Recovery) bit. This bit is used by intelligent host software to allow possible recovery from a hard read error. When this bit is set, the controller searches for the beginning of an object with a number greater than the current object number. The host software must be able to validate the data as no guarantee is made as to the data's validity. The possibility

exists that a read beyond end of data could be performed with this bit set. It is highly recommended that the host not attempt any writes after a read command with the recovery bit set has been issued.

363 TZ30 IMPLEMENTATION NOTE

364 Once the TZ30 receives READ or SPACE FORWARD command, it continues reading without waiting for the next READ or SPACE SCSI command. During a series of READ or SPACE operations, the drive, in many cases, will therefore read the data before receiving the new READ or SPACE command. This feature improves the TZ30 drive performance.

365 If the TZ30 has performed an ECC recovery process in reading and has completed the command successfully, it returns check condition status. The drive reports this status by sending the RECOVERED ERROR sense key with the "correctable ECC error" additional sense byte. The TZ30 reports "correctable ECC error" every time it detects 20 correctable ECC errors.

366 The Position Lost Recovery (PLR) bit is used by intelligent host software to allow possible recovery from a hard read error. When this bit is set, the controller tries to search for the beginning of an object with a number greater than the current object number where the hard read error was detected. The host software must be able to validate the data read by a READ command which PLR set. The possibility exists that a read beyond end of data could be performed with this bit set.

367 It is highly recommended that the host not attempt any writes after a read command with the PLR bit set has been issued.

368 The DMYRED bit is located as follows.

369 If the DMYRED (Dummy Read) bit is set, TZ30 executes dummy read operation. This is, TZ30 sends the fixed 512 byte data in the internal buffer in the TZ30 controller to the host buffer instead of read data on the tape. If the bit is set, TZ30 ignores all the other parameters in the command. This functionality in conjunction with dummy write facilitates to execute SCSI bus loop back test for the initiator's SCSI control hardware.

370 The TZ30 does not support the READ REVERSE command because it is unable to read the tape in reverse. The TZ30 terminates this command with Check-condition. As the response for the next request-sense command, the TZ30 returns the ILLEGAL REQUEST sense key with SCSI INVALID COMMAND error code in the additional sense byte.

9.7 READ BLOCK LIMITS Command

371 ANSI SCSI-2 specification, Section 9.2.5.
Required for TZ30 compatibility.

9.8 RECEIVE DIAGNOSTIC RESULTS Command

- 372 ANSI SCSI-1 specification, Section 7.1.5.
Required for TZ30 compatibility.

9.9 RELEASE UNIT Command

- 373 ANSI SCSI-1 specification, Section 9.12.2.
Required for CCS compatibility.

9.10 REQUEST SENSE Command

- 374 Required for all devices. See Chapter 7.

9.11 RESERVE UNIT Command

- 375 ANSI SCSI-1 specification, Section 9.12.1.
Required for CCS compatibility.

376 TZK50 IMPLEMENTATION NOTE

- 377 The Third Party bit is used to indicate that the initiator is reserving the TK50 for exclusive use by another SCSI device. When this bit is set, the following apply.

1. The TK50 controller will honor the RELEASE UNIT command only from the initiator that originally issued the RESERVE UNIT command. A RELEASE UNIT command from all other initiators will terminate with good status but will not release the unit.
2. The TK50 controller will still accept a BUS DEVICE RESET command from any initiator.
3. The TK50 controller returns RESERVATION CONFLICT status for other commands issued by initiators other than the one specified in the third party device ID except for any RELEASE UNIT command, or a RESERVE UNIT command from the initiator that originally issued the RESERVE UNIT command.
4. The Third Party Device ID is the SCSI bus address of the unit the controller is being reserved for if the third party bit is set.
5. The TZK50 will support superceding reservations. If, while reserved, another RESERVE UNIT command is received from the initiator originally issuing the reserve unit command currently in effect, the new command will supercede the previous reservation.

378 TZ30 IMPLEMENTATION NOTE

- 379 The TZ30 supports the third party release option.
- 380 The Third Party Device ID field is ID of the third party device.
- 381 If the unit is reserved, when TZ30 receives the RESERVE UNIT command from an initiator when the drive is not in operation, the drive becomes "reserved". This state lasts until the drive receives the RELEASE UNIT command from the same initiator.
- 382 While reserved, any SCSI command (except for RELEASE UNIT) received by the device from another initiator completes with the "reservation conflict" status.
- 383 The RELEASE UNIT command from another initiator when the drive is reserved will be ignored and completes with good status.
- 384 If the unit is not reserved, commands that the drive receives from any initiator will be processed as long as the drive is not already performing a command operation.
- 385 If an initiator sends a command to the drive while it is processing a SCSI command, other than a RESERVE UNIT command, which will be queued, or a RELEASE UNIT command, which will be just ignored as described in the previous section, then the command is rejected with busy status.

9.12 REWIND Command

- 386 ANSI SCSI-1 specification, Section 9.1.
Required for SCSI-1 compatibility.
- 387 TZK50 IMPLEMENTATION NOTE
- 388 When the controller has been placed in the direct track access mode by a mode select command, a rewind command will mean to position the tape at the beginning of track as opposed to the beginning of tape.
- 389 When the controller has been placed in the direct access mode of operation, although it will accept a rewind command with the immediate bit set, it will not return status until after the command has completed.
- 390 TZ30 IMPLEMENTATION NOTE
- 391 When the controller has been placed in the direct track access mode by a mode select command, a rewind command will mean to position the tape at the beginning of track as opposed to the beginning of tape.

9.13 SEND DIAGNOSTIC Command

- 392 Required for all devices. See Chapter 7.

9.14 SPACE Command

393 ANSI SCSI-1 specification, Section 9.8.
Required for TZK50 compatibility.

394 TZK50 IMPLEMENTATION NOTE

395 In the code field of the SPACE command, a code of (02H) will not be supported. If this code is set, the controller will return the sense key to ILLEGAL REQUEST and return a status of check condition.

396 TZ30 IMPLEMENTATION NOTE

397 If the drive receives READ or SPACE FORWARD command, it continues reading without waiting for the next READ or SPACE SCSI command. During a series of READ or SPACE operations, the drive, in many cases, will therefore read the data before receiving the new READ or SPACE command. This feature improves the TZ30 drive performance.

398 The code specifies what is to be counted when spacing.

399 A code of (00H) indicates to count records when spacing. If a filemark is encountered when spacing over records, the tape is positioned on the end of tape (EOT) side of the filemarks if spacing forward and on the beginning of tape (BOT) side if spacing in reverse. The command terminates with check condition status. The response for the next REQUEST SENSE will be NO SENSE with both filemark and ILI bits set in the extended sense data. The valid bit will also be set. The information bytes of the sense data will be set to the difference between the requested number of records to be spaced and the actual number of records spaced.

400 A code of (01H) indicates to count filemarks while spacing. The position is on the EOT side of the Nth filemark if spacing forward and on the BOT side if spacing in reverse.

401 A code of (02H) is not supported. If this code is set, the controller sets the sense key to ILLEGAL REQUEST and returns a status of check condition.

402 If the physical end of tape is encountered during a SPACE command with a code of (03H), the controller issues a check condition status, sets the EOM bit, and sets the extended sense key to Medium Error.

9.15 TEST UNIT READY Command

403 Required for all devices. See Chapter 7.

404 The device shall return CHECK CONDITION with NOT READY sense key as the response for this command in any of the following cases.

1. The device is rewinding the tape as the result of a REWIND command with the IMMEDIATE bit set.

2. The device is loading or unloading tape as the result of a LOAD or UNLOAD command with the IMMEDIATE bit set.
3. The device is executing tape loading, unloading, or calibration as the result of an automatic calibration sequence.
4. No tape cartridge is loaded into the device.

9.16 WRITE Command

405 ANSI SCSI-1 specification, Section 9.4.
Required for SCSI-1 compatibility.

406 Storage devices shall not enter the STATUS phase following a WRITE command until the data has been written to nonvolatile media.

407 TZK50 and TZ30 IMPLEMENTATION NOTE

408 If the TK50 controller receives a request to write a record that is less than 512 Bytes, it will fill the remaining bytes in the block with zeros. These bytes are considered used and will not be filled on subsequent writes.

409 If the controller receives a write request that does not fill an ECC entity, it will write filler blocks for the remaining blocks. These blocks are to be considered empty and to be filled with data on subsequent writes and the ECC blocks be recalculated and rewritten.

410 TZ30 IMPLEMENTATION NOTE

411 If the DMYWRT (Dummy Write) bit is set, TZ30 executes dummy write operation. This is, TZ30 pulls out the fixed 512 byte data from the host buffer and stores them into the controller's internal buffer instead of actually write them on the tape. If the bit is set, TZ30 ignores all the other parameters in the command. This functionality in conjunction with dummy read facilitates to execute SCSI bus loop back test for the initiator's SCSI control hardware.

412 [Ando: DMYWRT and DMYRED bits are the 6th bit of the control byte. Picture needed.]

9.17 WRITE FILEMARKS Command

413 ANSI SCSI-1 specification, Section 9.7.
Required for SCSI-1 compatibility.

414 TZK50 IMPLEMENTATION NOTE

415 The TK50 controller imposes a limit of 65535 filemarks for a WRITE FILEMARK command. Therefore the Number of Filemarks (MSB) is always a zero.

416 TZ30 IMPLEMENTATION NOTE

- 417 In conflict with the ANSI SCSI specification, the TZ30 treats a single WRITE FILEMARKS command as a buffered mode write operation. During buffered mode operation, the TZ30 returns the command status as soon as it receives the command without waiting for the filemarks to be actually written on the tape. Two consecutive WRITE FILEMARKS commands terminates the buffered mode, causing two consecutive WRITE FILEMARKS to be written on the tape. Status is returned after the completion of writing the second filemark.
- 418 Also, when the accumulated number of filemarks on a tape becomes more than 65535 in the WRITE FILEMARKS command, the TZ30 generates check condition status. The sense key is VOLUME OVERFLOW with a tape mark overflow error additional sense byte. (Refer to the TZ30 ERROR SPECIFICATION for more detail.)

Chapter 10

Commands for Printer Devices

- 419 All printer devices shall implement the SCSI-1 mandatory commands for printer devices.
- 420 No additional requirements have been identified.

Chapter 11

Processor Devices

- 421 All processor devices shall support the SCSI-1 mandatory commands for processor devices.

11.1 Restrictions Applicable to All Processors

- 422 Required for compatibility with all Digital implementations.
- 423 The fast synchronous transfer option is not supported on any Digital device.
Any device may operate as an initiator for the purpose of selecting and sending a command to the processor in a single processor configuration.
- 424 Any device may operate as an initiator for the purpose of selecting and sending a command to the primary processor in a multi-processor configuration.
- 425 Devices may not select or issue commands to any other device on the bus.

11.2 Restrictions Applicable to Processors Using VMS

- 426 Required for compatibility with all Digital implementations.
- 427 On VAX/VMS systems, the maximum data transfer size is 64 kilobytes. If a device needs to transfer more than this amount of data, the device must allow the data to be returned in multiple SCSI commands. A single SCSI command cannot transfer more than the maximum amount of data.
- 428 For performance reasons, the device should only transfer 16 kilobytes per command.

11.3 Restrictions Applicable to Processors Using Ultrix

- 429 None identified yet.

11.4 Restrictions Applicable to Processors Using MS-DOS

- 430 None identified yet.

Chapter 12

Write-Once Devices

- 431 All write-once optical devices shall support the SCSI-1 mandatory commands for write-once optical devices.
- 432 No additional requirements have been identified.

Chapter 13

CD-ROM Devices

- 433 All CD-ROM devices shall support the SCSI-1 mandatory commands for CD-ROM devices.
- 434 No additional requirements have been identified. I just got a copy of the RRD40 spec today. Don Blair suggests that Chapter 8 be customized to note the specific cdrom issues.

Chapter 14

Scanner Devices

- 435 All scanner devices shall support the SCSI-1 mandatory commands for scanner devices.
- 436 No additional requirements have been identified.

Chapter 15

Optical Memory Devices

- 437 All optical memory devices shall support the SCSI-1 mandatory commands for optical memory devices.
- 438 No additional requirements have been identified.

Chapter 16

Medium Changer Devices

- 439 All medium changer devices shall support the SCSI-1 mandatory commands for medium changer devices
- 440 No additional requirements have been identified.

Chapter 17

Communication Devices

- 441 All communication devices shall support the SCSI-1 mandatory commands for communication devices.
- 442 No additional requirements have been identified.

Appendix A

Power Sequencing Protocol

A.1 Power On Protocols—Initialization Procedure

- 443 Required for compatibility with all Digital implementations.
- 444 The device must meet the following requirements after it is powered on.
1. Within 5 seconds of power on, the device must be able to respond to a SCSI bus selection so that the operating system knows that there is an active device at this SCSI ID. However, the device is permitted to return any of the following errors until it is ready for normal operation.
 - a. BUSY status.
 - b. Check Condition status, followed by NOT READY sense key in response to the next REQUEST SENSE command.
 - c. CHECK CONDITION status, followed by UNIT ATTENTION sense key in response to the next REQUEST SENSE command. (Note that UNIT ATTENTION may only be returned once per power-up/busreset, as described in SCSI-1.)
 2. Within 15 seconds of power-on, the device must be able to successfully complete an INQUIRY command so that the device may be identified.
 3. Devices must be able to respond to normal commands from an initiator within 30 seconds of power-on.
- 445 After power has first been supplied to a device, power shall be continuously supplied for the duration of bus operation.
- 446 Devices shall not be disconnected from the bus when power is applied.

Appendix B

Exceptions

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Appendix C

Device Specific Parameters

The following device parameters are included for reference only.

C.1 Disk Device Specific Information

447 This section contains additional information pertaining to disk devices sold by Digital.

Device	Formatted Capacity	Form Factor
RZ22	52 MBytes	half height 3.5 inch
RZ23	104 MBytes	half height 3.5 inch
RZ55	332 MBytes	full height 5.25 inch
RZ56	665 MBytes	full height 5.25 inch

C.2 Tape Device Specific Information

448 This section contains the detailed information pertaining to the specific sequential devices sold by Digital.

Device	Formatted Capacity	Form Factor
TZ30	96 MBytes	half height 5.25 inch
TZK50	96 MBytes	full height 5.25 inch

C.3 Processor Device Specific Information

449 The following modes of data transfer are supported by the various Digital processors that support SCSI devices.

System	Data Transfer Mode
VAXstation 3100/3150	Asynchronous
MicroVAX 3100/3150	Asynchronous
VAXserver 3100/3150	Asynchronous

VAXstation 3520/3540	Asynchronous and Synchronous (do not support AEN)
DECstation 2100	Synchronous
DECstation 3100	Synchronous
DECsystem 3150	Synchronous
DECstation 210	Asynchronous
DECstation 316	Asynchronous
DECstation 320	Asynchronous

- 450 Whether the processor supports synchronous or asynchronous mode is determined by the type of SCSI interface chip used. The currently used chips are as follows.

Chip	Data Transfer Mode
NCR 5380	Asynchronous
NCR 53C94	Synchronous
SII	Synchronous

C.4 CDROM Device Specific Information

- 451 This section contains the detailed information pertaining to the specific CD-ROM devices sold by Digital.

Device	Formatted Capacity	Form Factor
RRD40	600 MBytes	half height 5.25 inch