

**digital**<sup>™</sup>

*Storage***Works** 

## UltraSCSI Bus Expanders and Converter (DWZZC series)

---

### User's Guide

EK-DWZZC-UG. B01

---

## November, 1997

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference and (2) This device must accept any interference that may cause undesirable operation.

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

## Japanese VCCI Statement

この装置は、第一種情報処理装置（商工業地域において使用されるべき情報処理装置）で商工業地域での電波障害防止を目的とした情報処理装置等電波障害自主規制協議会（VCCI）基準に適合しております。  
従って、住宅地域またはその隣接した地域で使用すると、ラジオ、テレビジョン受信機等に受信障害を与えることがあります。  
取扱説明書に従って正しい取り扱いをして下さい。

Digital Equipment Corporation makes no representations that the use of its products in the manner described in this publication will not infringe on existing or future patent rights, nor do the descriptions contained in this publication imply the granting of licenses to make, use, or sell equipment or software in accordance with the description.

Possession, use, or copying of the software described in this publication is authorized only pursuant to a valid written license from Digital or an authorized sublicensor.

The following are trademarks of Digital Equipment Corporation: DEClaser, DIGITAL, OpenVMS, PATHWORKS, VAX DOCUMENT, and the DIGITAL logo.

# Contents

---

<b>About This Guide</b> .....	v
<b>Revision Record</b> .....	ix
<b>1 Introducing the UltraSCSI Expanders/Converter</b>	
Product Description .....	1-2
Single-Ended Bus Expander.....	1-2
Differential Bus Expander .....	1-5
Product Features .....	1-7
Operating Environments .....	1-8
<b>2 Using a Single-Ended Expander</b>	
Installing an Expander .....	2-2
SCSI Bus Segments .....	2-2
SCSI Cables.....	2-2
Expander Bus Configurations .....	2-2
End-Bus Configuration .....	2-3
Bus Segment Cabling and Connections .....	2-4
Setting the Termination Switches.....	2-5
Mid-Bus Configuration.....	2-7
Bus Segment Cabling and Connections .....	2-8
Setting the Termination Switches.....	2-9
TERMPOWER Error Status.....	2-11

### 3 Using a Differential Expander

Installing an Expander .....	3-2
SCSI Bus Segments .....	3-2
SCSI Cables.....	3-2
Expander Bus Configurations .....	3-2
End-Bus Configuration .....	3-2
Bus Segment Cabling and Connections .....	3-3
Setting the Termination Switches.....	3-5
Mid-Bus Configuration.....	3-7
Bus Segment Cabling and Connections .....	3-8
Setting the Termination Switches.....	3-9

### Appendix A—VHDCI Cables and Connectors

Cables.....	A-3
Adapter Cables .....	A-4
Connectors.....	A-7

### Glossary

### Figures

Figure 2-1 Mid-Bus Configuration Bus Segments .....	2-7
Figure 3-1 Mid-Bus Configuration Bus Segments .....	3-7

### Tables

Table 1-1 Single-Ended Expander Product Specifications .....	1-4
Table 1-2 Differential Expander Product Specifications .....	1-6

## *About This Guide*

---

*The DIGITAL StorageWorks UltraSCSI Bus Expanders/Converter (DWZZC series) User's Guide describes the functions, operation, components, configurations, assembly, and specifications of this product.*

---

This guide describes the procedures for installing, configuring, and using the table top single-ended (DS-DWZZC-AA) expander and the differential (DS-DWZZC-DA) UltraSCSI bus expander/converter.

### **Intended Audience**

This document is for use by personnel responsible for designing, configuring, assembling, installing, and operating UltraSCSI subsystems using a DWZZC series expander.

### **Structure**

This manual is organized as follows:

#### **Chapter 1**

An overview of the UltraSCSI expanders including product description, specifications, and operating environments.

#### **Chapter 2**

Procedures for using a single-ended expander including installation, bus segments, cables, DIGITAL-supported configurations, and error status.

#### **Chapter 3**

Procedures for using a differential expander/converter including installation, bus segments, cables, and DIGITAL-supported configurations.

## Appendix A

Describes the UltraSCSI cables, adapters, trilinks, and terminators compatible with the tabletop expanders.

### Glossary

## Documentation Conventions

The documentation conventions used in this publication are as follows:

<b>boldface type</b>	Boldface type indicates the first instance of terms being defined in the text, the glossary, or both.
<i>italic type</i>	Italic type indicates emphasis and publication titles. Italic type in the glossary indicates a cross-reference.
A/R	As required
	Single-ended SCSI bus
	Differential SCSI bus

## Related Documents

The following publications contain additional information about the ultra SCSI RAID subsystem.

<b>Publication Title</b>	<b>Order Number</b>
<i>DIGITAL StorageWorks 16-Bit SBB User's Guide</i>	EK-SBB16-UG
<i>DIGITAL StorageWorks SBB Shelf I/O Modules</i>	EK-SBBIO-UG
<i>DIGITAL StorageWorks UltraSCSI RAID SBB Shelf (DS-BA356-Series)</i>	EK-BU356-UG
<i>Digital StorageWorks Using an UltraSCSI SBB Shelf Differential I/O Module</i>	EK-35XDX-UG
<i>StorageWorks Solutions SBB User's Guide</i>	EK-SBB35-UG
<i>StorageWorks Solutions UltraSCSI Configuration Guidelines</i>	EK-ULTRA-CG



## *Revision Record*

---

*This Revision Record provides a concise publication history of this manual. It lists the manual revision levels, release dates, and summary of changes.*

---

The following revision history lists all revisions of this publication and their effective dates. The publication part number is included in the Revision Level column, with the last entry denoting the latest revision. This publication supports StorageWorks UltraSCSI Bus Expander/Converter (DS-DWZZC-Series).

<b>Revision Level</b>	<b>Date</b>	<b>Summary of Changes</b>
EK-DWZZC-UG	December 1997	Original release.



# 1

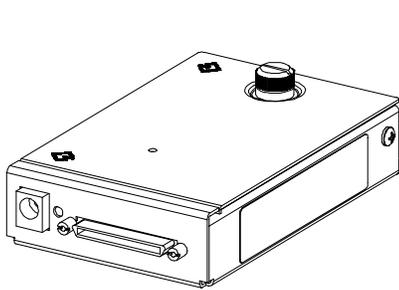
## *Introducing the UltraSCSI Expanders/Converters*

---

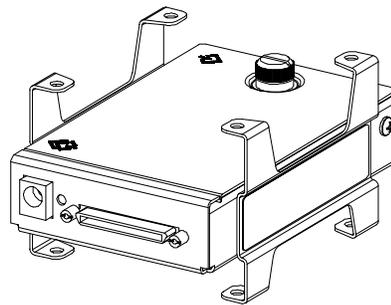
*This chapter contains product descriptions and specifications for the single-ended expander and differential expander/converters.*

---

The StorageWorks DWZZC series tabletop expanders/converters are UltraSCSI (FAST 20) compliant and include single-ended to single-ended (DS-DWZZC-AA) and differential to single-ended (DS-DWZZC-DA) devices. These devices can transfer data at rates up to 40 MB/sec.



**Single-ended Expander**



**Differential Expander/Converter**

These expanders are compatible with any UltraSCSI device. Connections between the expanders and all other devices require **VHDCI** (Very High Density Cable Interconnect) compatible cables and connectors.

Each expander uses a different model ac-dc converter for power. Although these converters are physically similar in appearance, the output voltages are different. *These ac-dc converters are not interchangeable.*



**CAUTION**

The ac-dc converters are expander model-specific and are not interchangeable.

The single-ended expander ac-dc converter output is **+5Vdc** and is not sufficient to operate the differential expander.

The differential expander ac-dc converter output is **+9Vdc** and can damage a single-ended expander.

**Product Description**

Each of the two expander types has a specific function and they are not interchangeable.

**Single-Ended Bus Expander**

The single-ended bus expander extends the bus between two single-ended devices by up to 20.5 m (67.3 ft). Either of the VHDCI connectors can connect to either device.

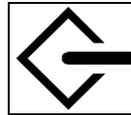
At one end of the expander is the dc input power connector, a TERMPOWER status LED, and a VHDCI connector.

The LED displays one of the following statuses:

- The LED is ON when external TERMPOWER is present.
- The LED is OFF when external TERMPOWER is missing.
- The LED is FLASHING when TERMPOWER has been lost and then restored.

You can readily identify the single-ended expander in two ways:

- The *two* single-ended SCSI bus labels

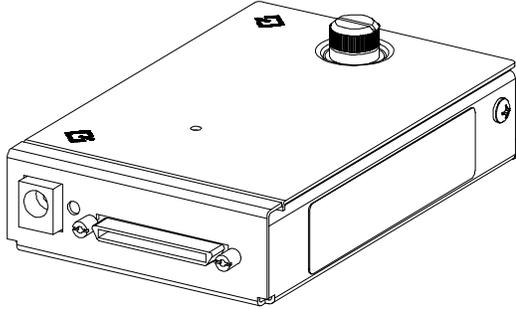


- The absence of a frame.

By loosening the thumbscrew you can remove the cover to either change the bus termination or to reset the expander after correcting an error condition. You can also reset the expander by inserting a thin, nonconducting tool through the hole in the cover.

Table 1-1 lists the product specifications for this expander.

**Table 1-1 Single-Ended Expander Product Specifications**

<b>Single-Ended UltraSCSI Bus Expander/Converter (Model DS-DWZZC-AA)</b>	
	
<b>Dimensions</b>	
Height	31 mm (1.2 in)
Width	74 mm (2.9 in)
Depth	114 mm (4.5 in)
Weight	<b>0.23 kg (0.51 lb)</b>
<b>AC-DC Converter Input Power</b>	
110-240 V ac, 50-/60-Hz, Single Phase	
<b>AC-DC Converter Output Power</b>	
+ 5 V dc @ 3000 mA	

## Differential Bus Expander

The differential bus expander extends the bus between a differential UltraSCSI device and a single-ended UltraSCSI device by up to 25.5 m (83.7 ft). This expander has a dedicated differential connector (J1) and a dedicated single-ended connector (J3).

- The differential connector can connect only to a differential device.
- The single-ended connector can connect only to a single-ended device.



### CAUTION

Connecting the single-ended device cable to the expander differential connector, or the differential device cable to the expander single-ended connector will cause the bus to cease operating.

At one end of the expander is the differential bus label, the dc input power connector, and the differential VHDCI connector.

At the other end is the single-ended bus label and the single-ended connector.

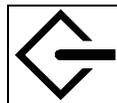
You can readily identify differential expander in two ways:

- The frame that allows air to flow around the expander, thereby ensuring maximum heat dissipation to ensure proper operation.

- The differential SCSI bus label



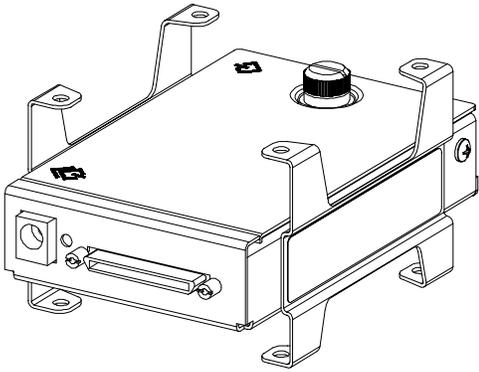
- The single-ended bus label



By loosening the thumbscrew you can remove the cover to change the bus termination.

Table 1-2 lists the product specifications for this expander.

**Table 1-2 Differential Expander Product Specifications**

<b>Differential UltraSCSI Bus Expander/Converter (Model DS-DWZZC-DA)</b>	
	
<b>Installed Dimensions</b>	
Height	53 mm (2.1 in)
Width	76 mm (3.0 in)
Depth	114 mm (4.5 in)
Weight	0.3 kg (0.67 lb)
<b>AC-DC Converter Input Power</b>	
110-240 V ac, 50/60-Hz, Single Phase	
<b>AC-DC Converter Output Power</b>	
+ 9 V dc @ 2000 mA	

## Product Features

These products have the following features:

Features	
<b>SCSI ID</b>	No SCSI IDs (device addresses) are used.
<b>Overload Protection</b>	Both <b>DTERMPOWER</b> and <b>STERMPOWER</b> have a 1.5 A self-resetting thermal fuse
<b>Shielding</b>	Enclosures and connectors are shielded for ESD, EMI, and safety requirements
<b>Power-Up Reset</b>	Automatically clears: Initiator detection circuit Target detection circuit BSY glitch filter
<b>SCSI Bus Reset</b>	Automatically clears: Initiator detection circuit Target detection circuit BSY glitch filter
<b>SCSI Bus Extension</b>	<b>Single-Ended Expander</b> —20.5 m (62.6 ft) <b>Differential Expander</b> —25.5 meters (83.6 feet)
<b>Data Timing</b>	The relationship between the data and the control signals is brought to SCSI compatibility before transmission to the other SCSI bus.
<b>Design</b>	High reliability <b>SMT</b> (surface mount technology)
<b>Cable Fault</b>	<b>DIFFSENSE</b> support
<b>Glitch Elimination</b>	100% glitch free operation during power-up <b>BUSY GLITCH</b> trap eliminates cable length constraint due to wired-OR glitches on the BSY line
<b>Termination</b>	Switch-selectable for either connector as one of the following: Full termination No termination

## Operating Environments

DIGITAL recommends maintaining the following environments to ensure proper operation of all models of this product.

Condition	Specification
<b>Optimum Operating Environment</b> (Suggested for optimum operation)	
Temperature	18°C to +24°C (+64°F to +75°F) with an average rate of change of 3°C/hour maximum and a step change of 3°C or less
Relative humidity	40% to 60% (noncondensing) with a step change of 10% or less (noncondensing)
Altitude	Up to 2400 m (8000 ft)
Air quality	Not to exceed a maximum of 500,000 particles, 0.5 micron or larger, per cubic foot of air.
<b>Minimum Operating Environment</b> (Required for proper operation)	
Temperature	+10°C to +35°C (+50°F to +95°F) Reduce rating by 1.8°C for each 1000 m altitude (1.0°F for each 1000 ft altitude)
Relative humidity	10 to 85% at maximum wet bulb temperature of +32°C (+90°F) and a minimum dew point of +2°C (+36°F)
Altitude	Up to 2400 m (8000 ft)
Air quality	Not to exceed a maximum of 500,000 particles, 0.5 micron or larger, per cubic foot of air.
<b>Non-Operating Operating Environment</b> (Shipping or short term storage)	
Temperature	-40°C to +66°C (-40°F to +150°F)
Relative humidity	10% to 80% noncondensing
Altitude	4900 m (16,000 ft)

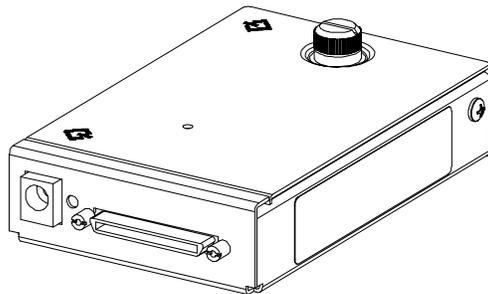
# 2

## *Using a Single-Ended Expander*

---

*This chapter discusses how to effectively use a single-ended UltraSCSI bus expander by establishing configurations, using compatible cables, terminating the buses, and installing the expander.*

---



### **NOTE**

The term controller means any one of the following devices: (1) a controller, (2) a host computer, or (3) an adapter.

## **Installing an Expander**

Complete the following procedure to install and use an expander:

1. Determine the SCSI configuration (that is, end-bus or mid-bus)
2. Determine the maximum bus length.
3. Select the VHDCI cables.
4. Set the expander bus termination.
5. Connect the cables.
6. Connect the ac-dc converter to the expander.
7. Apply power to the system and verify that the bus is operational.

## **SCSI Bus Segments**

The SCSI bus segment length is the total distance between the two terminators that define the segment.

When you are using expanders there are at least two external bus segments, one on each side of the expander.

## **SCSI Cables**

Both the single-ended and the differential expanders use the VHDCI cables, terminator blocks, adapters, and connectors listed in Appendix A.

## **Expander Bus Configurations**

The UltraSCSI subsystem requirements determines the expander bus configuration. There are two expander configurations:

- Full termination (end-bus)
- No termination (mid-bus)

For a complete description of UltraSCSI bus configuration rules see *StorageWorks Solutions UltraSCSI Configuration Guidelines*.

### End-Bus Configuration

A typical end-bus configuration has two *external* bus segments as shown in the next section, “Bus Segment Cabling and Connections.”

1. The controller to the expander bus segment.
2. The expander to SBB shelf I/O module segment.

**NOTE**

The factory default configuration for all expanders is the end bus configuration with full termination.

### Bus Segment Cabling and Connections

This configuration requires at least one single-ended UltraSCSI expander. By adding one expander you create the following external bus segments:

External Bus Segments			Cable Length	
No.	From	To	Segment	Total
1	Controller	Expander (DS-DWZZC-AA)	20.2 m (66.3 ft) <sup>1</sup>	20.2 m (66.3 ft)
2	Expander (DS-DWZZC-AA)	SBB Shelf I/O Module (DS-BA35X-F series)	20 m (65.6 ft)	40.2 m (131.9 ft)

CX05988A

① Adapter or controller

**Bus Segment 1:**

② Optional adapter 0.2 m (0.6 ft) cable. (BN38A-0B)

③ 20 m (65.6 ft) VHDCI cable (BN37A-20)

④ DWZZC

**Bus Segment 2:**

⑤ 20 m (65.6 ft) VHDCI cable (BN37A-20)

**Total Cable Length**

40.2 m (131.9 ft)

<sup>1</sup> With BN37A-20 cable and an optional BN38A-0B cable.

### **Setting the Termination Switches**

Use the following procedure to change the expander termination configuration from mid-bus to an end-bus.



#### **CAUTION**

Removing the cover with power applied and the bus operational could corrupt data transmissions or cause damage to the expander. Always quiesce the bus and disconnect the ac-dc converter before removing the cover.

To protect the electronic circuits against ESD damage, DIGITAL recommends that you use an ESD wrist strap.

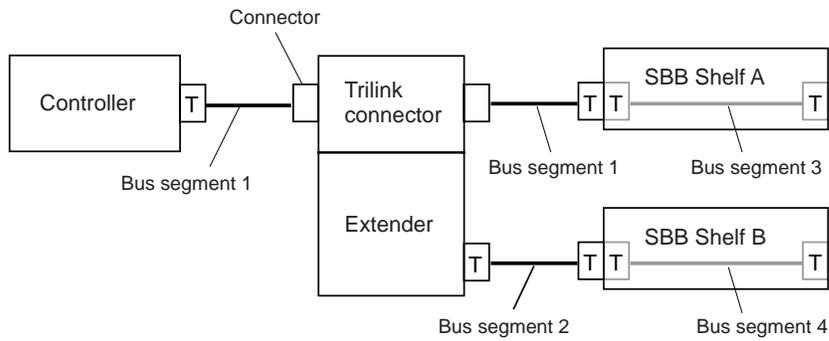
<b>Procedure for Setting the End-Bus Termination</b>	
<ol style="list-style-type: none"> <li>1. Quiesce the UltraSCSI bus.</li> <li>2. If you cannot quiesce an individual bus you must shut down the controller and remove power from the expander bus segments.</li> <li>3. Disconnect the ac-dc power converter from the expander.</li> <li>4. Disconnect the cables from the expander.</li> <li>5. Loosen the expander thumbscrew and remove the cover.</li> </ol>	
<p style="text-align: right;">CXO5989A</p>	
<p>6. Set the termination switches ① as shown:</p> <p style="text-align: center;"><b>Note</b></p> <p>Switches 1 and 2 control connector ② (J3) termination. Switches 3 and 4 control the connector ③ (J1) termination.</p>	<p>OFF ON</p> <p style="text-align: center;">CXO5993A</p>
<ol style="list-style-type: none"> <li>7. Replace the cover and tighten the thumbscrew.</li> <li>8. Connect the cables to the expander.</li> <li>9. Connect the ac-dc converter to the expander.</li> <li>10. Apply power the subsystem and verify that UltraSCSI bus is operational.</li> </ol>	

## Mid-Bus Configuration

A typical mid-bus configuration has a total for four bus segments.

- One from the controller through the tralink on the expander to SBB shelf A
- One from the expander to the SBB shelf B
- An internal bus on both shelves

**Figure 2-1 Mid-Bus Configuration Bus Segments**



CXO5994A

### Bus Segment Cabling and Connections

This configuration requires at least one tabletop, single-ended Ultra SCSI expander. By adding one expander you create the following external bus segments:

External Bus Segments			Cable Length	
No.	From	To	Segment	Total
1	Controller through trilink	SBB Shelf A I/O Module	20.2 m (66.3 ft)	20.2 m (66.3 ft)
2	Expander (DS-DWZZC-AA)	SBB Shelf B I/O Module	20.5 m (67.3 ft)	45.5 m (149.3 ft)

CX05987A

① Adapter or controller

**Bus Segment 1:**

② Optional adapter 0.2 m (0.6 ft) cable. (BN38A-0B)

③ BN37A-series cable

⑥ BN37A-series cable

**Total segment cable length must be less than 20.5 m (67.3 ft)**

④ DWZZC with trilink connector

**Bus Segment 2:**

⑤ 20 m (65.6 ft) VHDCI cable (BN37A-20)

**Total Cable Length**  
40.2 m (131.9 ft)

### **Setting the Termination Switches**

Use the following procedure to change the expander termination configuration from an end-bus to a mid-bus (no termination).



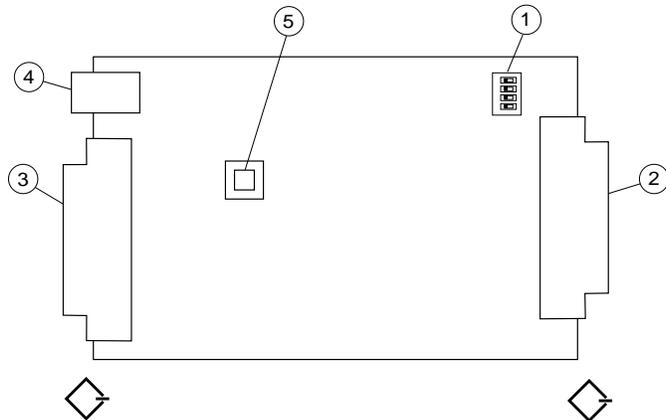
#### **CAUTION**

Removing the cover with power applied and the bus operational could corrupt data transmissions or cause damage to the expander. Always quiesce the bus and disconnect the ac-dc converter before removing the cover.

To protect the electronic circuits against ESD damage, DIGITAL recommends that you use an ESD wrist strap.

**Procedure for Setting the Mid-Bus Termination**

1. Quiesce the UltraSCSI bus.
2. If you cannot quiesce an individual bus you must shut down the controller and remove power from the expander bus segments.
3. Disconnect the ac-dc power converter from the expander.
4. Disconnect the cables from the expander.
5. Loosen the expander thumbscrew and remove the cover.

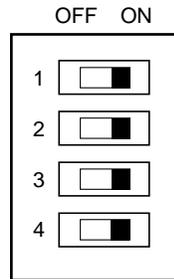


CXO5989A

6. Set the termination switches ① as shown.

**Note**

Switches 1 and 2 control connector ② (J3) termination. Switches 3 and 4 control the connector ③ (J1) termination.

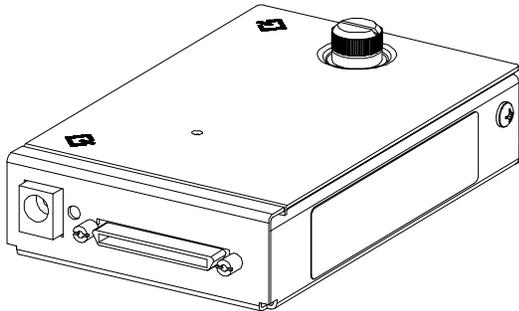


CXO5992A

7. Replace the cover and tighten the thumbscrew.
8. Connect the cables to the expander.
9. Connect the ac-dc converter to the expander.
10. Apply power the subsystem and verify that UltraSCSI bus is operational.

### TERMPOWER Error Status

The LED adjacent to the dc power input is normally ON. Should this LED be either OFF or FLASHING, there is a TERMPOWER error condition.



- When the LED is OFF there is no TERMPOWER and the expander is nonoperational.
- When the LED is FLASHING, either:
  - There was a TERMPOWER error
  - There is an intermittent TERMPOWER error

To clear the error status requires you to *carefully* insert a thin, nonconducting tool through the pin hole in the cover and press the RESET switch. Verify that the LED is ON; if it is FLASHING or OFF, an error condition still exists.

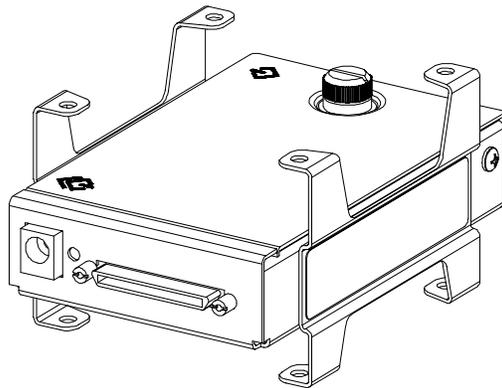
# 3

## *Using a Differential Expander*

---

*This chapter discusses how to effectively use a differential UltraSCSI bus expander by establishing configurations, using compatible cables, terminating the buses, and installing the expander.*

---



### **NOTE**

The term controller means any one of the following devices: (1) a controller, (2) a host computer, or (3) an adapter.

## Installing an Expander

Complete the following procedure to install and use an expander:

Procedure for Installing an Expander
<ol style="list-style-type: none"><li>1. Determine the SCSI configuration (that is, end-bus or mid-bus)</li><li>2. Determine the maximum bus length.</li><li>3. Select the VHDCI cables.</li><li>4. Set the expander bus termination.</li><li>5. Connect the cables.</li><li>6. Connect the ac-dc converter to the expander.</li><li>7. Apply power to the system and verify that the bus is operational.</li></ol>

## SCSI Bus Segments

The SCSI bus segment length is the total distance between the two terminators that define the segment.

When you are using expanders there are at least two external bus segments—one on each side of the expander.

## SCSI Cables

Both the single-ended and the differential expanders use the VHDCI cables, terminator blocks, adapters, and connectors listed in Appendix A.

## Expander Bus Configurations

The UltraSCSI subsystem requirements determines the expander bus configuration. There are two expander configurations:

- Full termination (end-bus)
- No termination (mid-bus)

For a complete description of UltraSCSI bus configuration rules see *StorageWorks Solutions UltraSCSI Configuration Guidelines*.

### End-Bus Configuration

A typical end-bus configuration has two external bus segments as shown in the next section, “Bus Segment Cabling and Connections”:

1. The controller to the expander bus segment.
2. The expander to SBB shelf I/O module segment.

**NOTE**

The factory default configuration for all expanders is the end bus configuration with full termination.

### Bus Segment Cabling and Connections

This configuration requires at least one single-ended UltraSCSI expander. By adding one expander you create the following external bus segments:

External Bus Segments			Cable Length	
No.	From	To	Segment	Total
1	Controller	Expander (DS-DWZZC-DA)	20.2 m (66.3 ft) <sup>1</sup>	20.2 m (66.3 ft)
2	Expander (DS-DWZZC-DA)	SBB Shelf I/O Module (DS-BA35X-F series)	20 m (65.6 ft)	40.2 m (131.9 ft)

CXO5995A

① Adapter or controller

**Bus Segment 1:**

② Optional adapter 0.2 m (0.6 ft) cable. (BN38A-0B)

③ BN37A-series cable

**Total segment cable length must be less than 25 m (82 ft)**

④ DWZZC-DA

**Bus Segment 1 Length**  
25 m (82 ft)

**Bus Segment 2:**

⑤ 20 m (65.6 ft) VHDCI cable (BN37A-20)

**Total Cable Length**  
45 m (147.6 ft)

<sup>1</sup> With BN37A-20 cable and an optional BN38A-0B cable.

### **Setting the Termination Switches**

Use the following procedure to change the expander termination configuration from mid-bus to an end-bus.



#### **CAUTION**

Removing the cover with power applied and the bus operational could corrupt data transmissions or cause damage to the expander. Always quiesce the bus and disconnect the ac-dc converter before removing the cover.

To protect the electronic circuits against ESD damage, DIGITAL recommends that you use an ESD wrist strap.

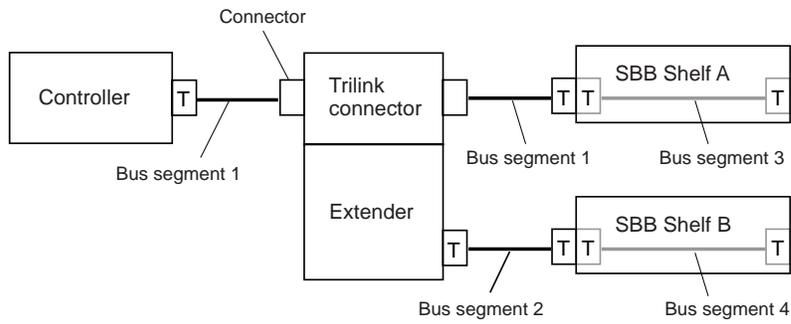
<b>Procedure for Setting the End-Bus Termination</b>	
<ol style="list-style-type: none"> <li>1. Quiesce the UltraSCSI bus.</li> <li>2. If you cannot quiesce an individual bus you must shut down the controller and remove power from the expander bus segments.</li> <li>3. Disconnect the ac-dc power converter from the expander.</li> <li>4. Disconnect the cables from the expander.</li> <li>5. Loosen the expander thumbscrew and remove the cover.</li> </ol>	
<p>The diagram shows a rectangular expander unit with a thumbscrew on the left side. Four termination points are labeled with circled numbers: 1 (top right), 2 (middle right), 3 (middle left), and 4 (top left). A connector labeled J3 is at the top right, and connector J1 is at the top left. The model number CXO5990A is printed at the bottom right.</p>	
<ol style="list-style-type: none"> <li>6. Set the termination switches ① as shown.</li> </ol> <p style="text-align: center;"><b>Note</b></p> <p>Switches 1 and 2 control connector ② (J3) termination.</p> <p>Switches 3 and 4 control the connector ③ (J1) termination.</p>	<p>The diagram shows four switches labeled 1, 2, 3, and 4. Above them are the labels 'OFF' and 'ON'. Switch 1 is in the 'ON' position (black bar on the right). Switch 2 is in the 'OFF' position (white bar on the right). Switch 3 is in the 'ON' position (black bar on the right). Switch 4 is in the 'OFF' position (white bar on the right). The model number CXO5993A is printed at the bottom.</p>
<ol style="list-style-type: none"> <li>7. Replace the cover and tighten the thumbscrew.</li> <li>8. Connect the cables to the expander.</li> <li>9. Connect the ac-dc converter to the expander.</li> <li>10. Apply power the subsystem and verify that UltraSCSI bus is operational.</li> </ol>	

### Mid-Bus Configuration

A typical mid-bus configuration has a total for four bus segments .

- One from the controller through the trilink on the expander to SBB shelf A
- One from the expander to the SBB shelf B
- An internal bus on both shelves

**Figure 3-1 Mid-Bus Configuration Bus Segments**

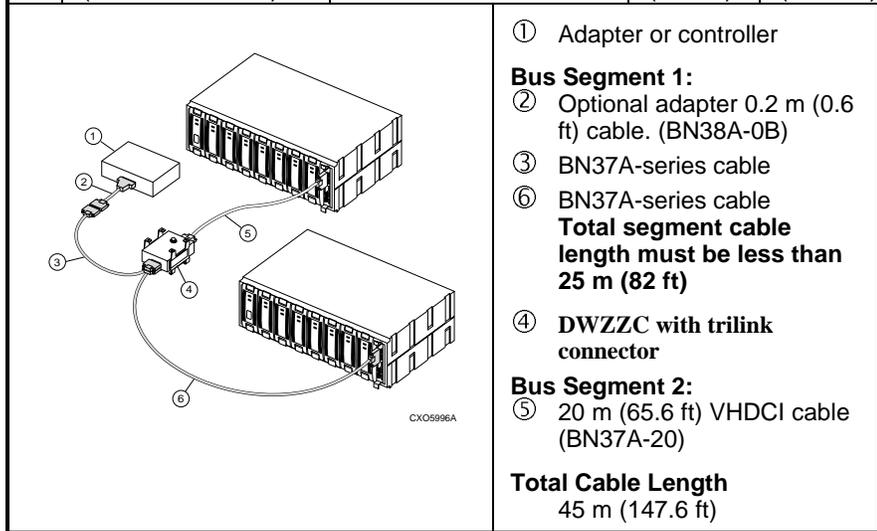


CXO5994A

### Bus Segment Cabling and Connections

This configuration requires at least one tabletop, differential Ultra SCSI expander. By adding one expander you create the following external bus segments:

External Bus Segments			Cable Length	
No.	From	To	Segment	Total
1	Controller through trilink	SBB Shelf A I/O Module	20.2 m (66.3 ft) <sup>2</sup>	20.2 m (66.3 ft)
2	Expander (DS-DWZZC-DA)	SBB Shelf B I/O Module	20.5 m (67.3 ft)	45.5 m (149.3 ft)



<sup>2</sup> With BN38A-0B and BN37A-20 cables.

### **Setting the Termination Switches**

Use the following procedure to change the expander termination configuration from an end-bus to a mid-bus (no termination).



#### **CAUTION**

Removing the cover with power applied and the bus operational could corrupt data transmissions or cause damage to the expander. Always quiesce the bus and disconnect the ac-dc converter before removing the cover.

To protect the electronic circuits against ESD damage, DIGITAL recommends that you use an ESD wrist strap.

<b>Procedure for Setting the Mid-Bus Termination</b>																
<ol style="list-style-type: none"> <li>1. Quiesce the UltraSCSI bus.</li> <li>2. If you cannot quiesce an individual bus you must shut down the controller and remove power from the expander bus segments.</li> <li>3. Disconnect the ac-dc power converter from the expander.</li> <li>4. Disconnect the cables from the expander.</li> <li>5. Loosen the expander thumbscrew and remove the cover.</li> </ol>																
<p style="text-align: right;">CXO5990A</p>																
<ol style="list-style-type: none"> <li>6. Set the termination switches ① as shown.</li> </ol> <p><b>Note</b> Switches 1 and 2 control connector ② (J3) termination. Switches 3 and 4 control the connector ③ (J1) termination.</p>	<table border="1"> <thead> <tr> <th></th> <th>OFF</th> <th>ON</th> </tr> </thead> <tbody> <tr> <td>1</td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>2</td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>3</td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> <tr> <td>4</td> <td><input type="checkbox"/></td> <td><input checked="" type="checkbox"/></td> </tr> </tbody> </table> <p style="text-align: center;">CXO5992A</p>		OFF	ON	1	<input type="checkbox"/>	<input checked="" type="checkbox"/>	2	<input type="checkbox"/>	<input checked="" type="checkbox"/>	3	<input type="checkbox"/>	<input checked="" type="checkbox"/>	4	<input type="checkbox"/>	<input checked="" type="checkbox"/>
	OFF	ON														
1	<input type="checkbox"/>	<input checked="" type="checkbox"/>														
2	<input type="checkbox"/>	<input checked="" type="checkbox"/>														
3	<input type="checkbox"/>	<input checked="" type="checkbox"/>														
4	<input type="checkbox"/>	<input checked="" type="checkbox"/>														
<ol style="list-style-type: none"> <li>7. Replace the cover and tighten the thumbscrew.</li> <li>8. Connect the cables to the expander.</li> <li>9. Connect the ac-dc converter to the expander.</li> <li>10. Apply power the subsystem and verify that UltraSCSI bus is operational.</li> </ol>																





## *VHDCI Cables and Connectors*

---

*Appendix A lists UltraSCSI cables and connectors for both UltraSCSI RAID Subsystems and other configurations.*

---

To connect an UltraSCSI RAID subsystem requires 68-conductor, VHDCI (very high-density connector interface) cables, such as the BN37A-series. However, interfacing to adapters or controllers with other type connectors, such as 50- or 68-pin high-density connectors, requires using special adapter cables. Also special configurations may require the use of “Y” cables, trilink connectors, or terminators. This appendix lists UltraSCSI compatible cables and connectors.

The I/O module can be connected to the external SCSI bus using a combination of:

- VHDCI compatible cables.
- Adapter cables
- Trilink connectors.
- VHDCI terminator blocks.

Selecting a compatible cable requires you to identify the connectors. The things you must consider include the following:

- How many pins does the connector have?
- What is the pin density (low-density high-density very high-density)?
- The connector type (plug or receptacle)?

- The connector orientation (straight or right-angle)?
- How the cable is secured to the connector (jack screws, bale locks, thumb screws, and so forth)?

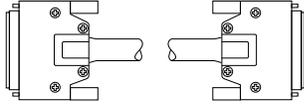
The first step is identifying a cable that has the proper type connectors. Then you can select a specific model cable that meets your precise needs to include connector orientation, securing mechanism, and length.

Device connectors are almost always receptacles. Therefore, the cable you select should have a matching plug. Adapter cables can have a combination of different connectors such as plugs of different density plugs and receptacles, and so forth.

Cable Connector "A"	Cable Connector "B"	Use a...
68-pin VHDCI plug	68-pin VHDCI plug	BN37A
<b>Adapter Cables</b>		
68-pin VHDCI plug	<b>Two</b> 68-pin VHDCI receptacles	BN37C
68-pin VHDCI plug	68-pin high-density receptacle	BN38B
68-pin VHDCI plug	50-pin high-density receptacle	BN38A
68-pin VHDCI plug	68-pin high-density plug	BN38C
68-pin VHDCI receptacle	68-pin high-density plug	BN38E
68-pin VHDCI receptacle	68-pin high-density right-angle plug	BN37B
<b>Special Connectors</b>		
Differential terminator block (68-pin VHDCI plug)		H8863-AA
Single-ended terminator block (68-pin VHDCI plug)		H8865-AA
Trilink connector (1 ea. 68-pin VHDCI plug, 2 ea. 68-pin VHDCI receptacles)		H8861-AA

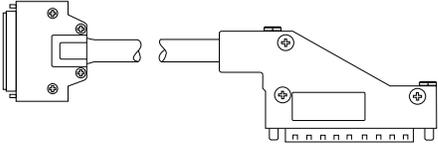
**Cables**

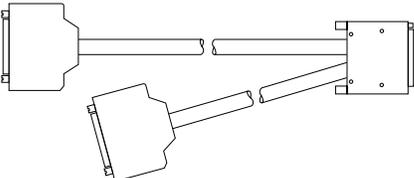
<b>BN37A–Series UltraSCSI Cables</b>			
Use these cables to connect devices with 68-pin VHDCI receptacle connectors.			
<b>Description</b>	<b>Meters</b>	<b>Feet</b>	<b>Part No.</b>
68-conductor, SCSI cable with: 2 ea. 68-pin VHDCI straight-plug connectors with jack screws	0.3	1.0	BN37A–0C
	0.5	1.6	BN37A–0E
	1.0	3.3	BN37A–01
	1.5	4.9	BN37A–1E
	2.0	6.6	BN37A–02
	2.5	8.2	BN37A–2E
	3.0	9.8	BN37A–03
	5.0	16.4	BN37A–05
	10.0	32.8	BN37A–10
	15.0	49.2	BN37A–15
	20.0	65.6	BN37A–20
25.0	82.0	BN37A–25	

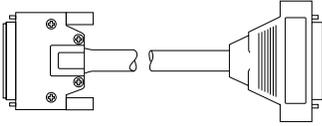


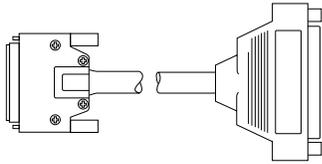
CXO5702A

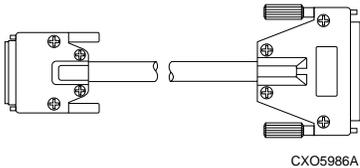
**Adapter Cables**

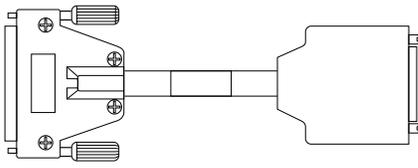
<b>BN37B-Series Cables</b>			
Use this adapter cable to connect devices with 68-pin VHDCI plug connectors to cables or devices with 68-pin high-density receptacle connectors.			
<b>Description</b>	<b>Meters</b>	<b>Feet</b>	<b>Part No.</b>
68-conductor, SCSI, adapter cable with: 1 ea. 68-pin VHDCI straight-receptacle connector with jack screws 1 ea. 68-pin high-density right-angle-plug connector with jack screws	0.2	0.6	BN37B-0B
 CX05738A			

<b>BN37C-Series UltraSCSI Cables</b>			
Use this adapter cable to connect two devices with 68-pin VHDCI plug connectors to cables or devices with a 68-pin high-density receptacle connector.			
<b>Description</b>	<b>Meters</b>	<b>Feet</b>	<b>Part No.</b>
68-conductor, SCSI, adapter cable with: 1 ea. 68-pin VHDCI straight-plug connector with jack screws 2 ea. 68-pin VHDCI straight-receptacle connector with jack screws	Leg A- 0.4 Leg B- 0.2	Leg A- 1.3 Leg B- 0.6	BN37C-0C
 CX05703A			

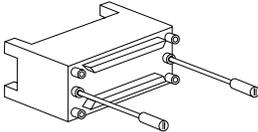
<b>BN38A–Series UltraSCSI Cables</b>			
Use this adapter cable to connect devices with a 68-pin VHDCI receptacle connector to cables or devices with a 50-pin high-density plug connector.			
<b>Description</b>	<b>Meters</b>	<b>Feet</b>	<b>Part No.</b>
68-conductor SCSI adapter cable with: 1 ea. 68-pin VHDCI straight-plug connector with jack screws 1 ea. 50-pin high-density receptacle connector	0.2	0.6	BN38A-0B
 CX05739A			

<b>BN38B–Series UltraSCSI Cables</b>			
Use this adapter cable to connect devices with a 68-pin receptacle, VHDCI connector to cables or devices with a 68-pin high-density plug connector.			
<b>Description</b>	<b>Meters</b>	<b>Feet</b>	<b>Part No.</b>
68-conductor, SCSI, adapter cable with: 1 ea. 68-pin VHDCI straight-plug connector with jack screws 1 ea. 68-pin high-density straight-receptacle connector	1.0	3.3	BN38B-01
 CX05740A			

<b>BN38C-Series UltraSCSI Cables</b>			
Use this adapter cable to connect devices with a 68-pin receptacle, VHDCI connector to cables or devices with a 68-pin high-density receptacle connector.			
Description	Meters	Feet	Part No.
68-conductor, SCSI, adapter cable with: 1 ea. 68-pin VHDCI straight-plug connector with jack screws 1 ea. 68-pin high-density straight-plug connector	1.0	3.3	BN38C-01
	2.0	6.6	BN38C-02
	3.0	9.8	BN38C-03
	5.0	16.4	BN38C-05
	10.0	32.8	BN38C-10
	20.0	65.6	BN38C-20
 CXO5986A			

<b>BN38E-Series UltraSCSI Cables</b>			
Use this adapter cable to connect devices with a 68-pin receptacle, VHDCI connector to cables or devices with a 68-pin high-density plug connector.			
Description	Meters	Feet	Part No.
68-conductor, SCSI, adapter cable with: 1 ea. 68-pin VHDCI straight-receptacle connector with jack screws 1 ea. 68-pin high-density straight-plug connector	0.2	0.6	BN38E-0B
 CXO5927A			

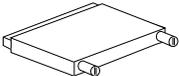
**Connectors**

<b>Trilink Connectors</b>	
Use these trilinks with (1) devices which have a 68-pin VHDCI plug connector, and (2) Cables which have a 68-pin VHDCI receptacle connector.	
<b>Description</b>	<b>Part No.</b>
68–pin trilink connector with: 2 ea. 68–pin VHDCI receptacle connectors 1 ea. 68–pin VHDCI plug connectors.	H8861–AA
 CX05744A	



**CAUTION**

Although these terminator blocks are similar, *they are not interchangeable*. Using an incorrect terminator block, such as a single-ended, terminator block on a differential bus or vice-versa, causes the bus to fail.

<b>VHDCI Terminator Blocks</b>	
Use these terminator blocks with devices, cables, or trilinks which have 68-pin VHDCI receptacle connectors.	
<b>Description</b>	<b>Part No.</b>
68–pin active, single-ended, SCSI, bus, terminator block	H8865–AA
68–pin differential, SCSI, bus, terminator block	H8868–BA
 CX05745A	



## *Glossary*

---

*The Glossary contains many UltraSCSI terms and provides a concise definition for each.*

---

**branch**

An UltraSCSI bus configuration where an expander located in the middle of a bus segment enables the bus to branch, or create a “tree” configuration, rather than a point to point configuration. Also known as a “tree” configuration.

**bus-path**

The direct electrical connection between two terminators in a bus segment.

**bus-path connector**

Any connector used to provide part of the bus-path.

**bus expander**

Devices that couple bus segments together without any impact on the SCSI protocol, the firmware, or software. These devices include both single-ended to differential and single-ended to single-ended bus extenders. The term expander is a general term that includes “extender,” “repeater” and “isolator.”

**bus extender**

*See* **bus expander**.

**bus segment**

A SCSI bus segment consists of all the conductors and connectors required to attain signal line continuity between every driver, receiver, and two terminators for each signal. It is not necessary that a SCSI bus segment contain any initiators or targets, but it must have at least two devices attached. (Drivers and receivers may be part of extenders as well as part initiators and targets.)

Bus segments can be either single-ended (SE) or differential (DF). The terminator properties determine the bus segment type.

**CAUTION**

The device transceiver type (single-ended or differential) must match the bus segment type. Devices that do not meet this condition cannot operate.

The allowed length of a bus segment depends on the electrical loading, transmission media type, and data transfer rate. In many cases, heavier loading, smaller wires, and higher speeds demand shorter lengths. Loading is produced by increasing the number of devices in a given length of the bus, by using longer stubs, or higher capacitance devices.

**bus segment types**

The following are the SCSI bus segments types:

Single-ended (SE)

High voltage differential (HVD)

The terminator properties (single-ended or differential) determine the bus segment type.

Devices that do not have the same transceiver type as the terminators cannot operate in the segment defined by the terminators.

**cable connector**

Any connector that is physically part of a cable assembly attached to backplanes or other non–device connectors.

**CE-Mark**

A European Economic Community (EEC) certification label that identifies electronic devices authorized for sale within member nations.

**CE-Mark Class A**

Similar to, but more stringent than the FCC Class A certification, this certification label appears on electronic devices that are for use in a commercial environment. You can also use a CE-Mark certified device in the United States.

**CE-Mark Class B**

Similar to, but more stringent than the FCC Class B certification, this certification label appears on electronic devices that are for use in either a home or a commercial environment. You can also use a CE-Mark certified device in the United States.

**channel**

Another term for a SCSI bus.

**controller**

(1) A hardware-firmware device that manages communications on behalf of host systems over the SCSI bus to devices. Controllers typically differ by the type of interface to the host and provide functions beyond those the devices support. (2) A standalone device that connects a host adapter to the storage SCSI bus. This device provides RAID functionality, typically has multiple SCSI bus ports, performs the lower layers of the SCSI protocol, and normally operates in the initiator role. Also referred to as array control or SCSI bus controller.

**converter**

*See* **SCSI signal bus converter**.

**departmental server cabinet**

The smaller StorageWorks cabinets, such as the SW300-, SW370-, SW500-, and SW600-series. The SW500-series cabinets has 50- and 60-Hz cable distribution units (CDUs) and can contain up to 10 SBB shelves. The SW600-series cabinets has 50- and 60-Hz power distribution units (PDUs) can contain either two DS-BA370-series UltraSCSI enclosures or multiple SBB shelves. The SW300- and the SW370- are pedestal type units with a BA355-series RAID subsystem shelf or DS-BA370-series UltraSCSI RAID enclosure, respectively.

**device**

The targets, initiators, hubs, converters, and bus expanders, and similar device interconnected to form a SCSI bus. Connectors, expanders, and hubs do not use a SCSI bus ID.

*See also* **nodes**.

**device connector**

Any connector physically part of a SCSI device.

**differential SCSI bus**

A bus in which the potential difference between two wires determines the signal level.

**DIFFSENSE**

A SCSI bus signal that identifies the node bus type. A low or ground identifies a single-ended node. A high signal (HVD) identifies a differential node.

**disk array controller**

*See* **controller**.

**electromagnetic interference**

*See* **EMI**.

**electrostatic discharge**

*See* **ESD**.

**EMI**

Electromagnetic interference is the impairment of a signal by an electromagnetic disturbance.

**enclosure connector**

Any connector that is physically part of the enclosure (for example, pedestal, desk-side enclosure, cabinet, and so forth).

**end-bus position**

See **SCSI end-bus position**.

**ESD**

Electrostatic discharge is the discharge of a potentially harmful static electric voltage as a result of improper grounding.

**Fast 20**

See **UltraSCSI**.

**FCC**

Federal Communications Commission is the federal agency responsible for establishing standards and approving electronic devices within the United States.

**FCC Class A**

This certification label appears on electronic devices for use only in a commercial environment within the United States. A CE-Mark certified device can be used in the United States in the same environment as the equivalent FCC certification.

**FCC Class B**

This certification label appears on electronic for use in either a home or a commercial environment within the United States. A CE-Mark certified device can be used in the United States in the same environment as the equivalent FCC certification.

**Federal Communications Commission**

See **FCC**.

**host**

The primary or controlling computer (in a multiple computer network) to which storage is attached.

**host adapter**

A device that connects the host system I/O bus (for example, a PCI bus) to the storage SCSI bus. A host adapter performs the lower layers of the SCSI protocol and normally operates in the initiator role.

**host computer**

*See* **host**.

**host controller**

A device that connects the host system I/O bus (for example, a PCI bus) to the storage SCSI bus. A host controller provides RAID functionality, typically has multiple SCSI bus ports, performs the lower layers of the SCSI protocol, and normally operates in the initiator role.

**host port adapter**

A host controller device that adapts the host system I/O bus to the array controller SCSI bus configuration.

**isolator**

*See* **bus** extender.

**logical bus**

A single-ended, physical bus connected to a differential physical bus by a SCSI bus signal converter.

**MB/s**

*See* **MB/sec**.

**MB/sec**

The bus width (8- or 16-bit), the number of bytes per word (1 or 2, respectively), and the bus clock frequency determines the transfer rate in megabytes per second (MB/sec).

**megabytes per second**

*See* **MB/sec.**

**megatransfers per second**

*See* **MT/s.**

**MT/s**

Megatransfers per second is the repetitive rate at which words of data are transferred across a bus. The number of megabytes per second (MB/s) is determined by the bus width (8- or 16-bit), the number of bytes per word (1 or 2, respectively), and the bus clock frequency.

**node**

A SCSI bus target or initiator that uses a SCSI bus ID. For example, disk drives, tape drives, array controllers, and adapters all have a SCSI bus ID and are nodes. Hubs, expanders, and converters are devices and do not have a SCSI bus ID.

An UltraSCSI bus can have a maximum of 16 nodes, SCSI bus addresses 0 through 15.

A narrow bus can have a maximum of eight nodes, SCSI bus addresses 0 through 7.

**physical bus**

Two SCSI terminators separated by cables, connectors, and backplane circuitry.

**port**

(1) A logical route for data in and out of an array controller. A port can contain one or more channels, all of which contain the same type data. (2) The hardware and software that connects a host controller to a CI, SCSI, or SDI bus.

**radio frequency interference**

*See* **RFI.**

**repeater**

*See* **bus** extender.

**RFI**

Radio frequency interference. The impairment of a signal by an unwanted radio signal or radio disturbance.

**SCSI**

Small computer system interface. This ANSI interface defines the physical and electrical parameters of a parallel I/O bus used to connect computers and a maximum of seven devices.

**SCSI bus connector**

Any connector used to create a SCSI bus segment. SCSI bus connectors are defined by both their function and their physical placement. There are only two allowed functions: bus–path and stub. There are numerous physical placement descriptions, for example, device stub connector and terminator bus–path connector.

**SCSI bus signal converter**

(1) A connecting device that permits the attachment of accessories or provides the capability to mount or link units. (2) The device that connects a differential SCSI bus to a single-ended SCSI bus. (3) The device that connects a differential SCSI bus operating to a single-ended SCSI bus. (4) The device that extends the length of a differential or single-ended SCSI bus.

**SCSI busing connection**

A connection in the SCSI bus between two terminators, such as the SBB shelf SCSI input connector.

**SCSI device**

A host computer adapter, a peripheral array controller or an intelligent peripheral that can be attached to the SCSI bus.

**SCSI device-side device address**

The 8-bit narrow (0 through 7) or 16-bit wide (0 through 15) device addresses (target IDs) assigned to the SCSI controller and the devices it controls.

*See also* **SCSI host-side device address**.

**SCSI device ID**

The bit-significant representation of the SCSI addressing referring to one of the signal lines numbered 0 through 7 for an 8-bit bus or 0 through 15 for a 16-bit bus. Also known as “target ID”.

**SCSI domain**

A SCSI domain is a logical bus consisting of at least one bus segment, at least one initiator, and at least one target. Domains with multiple bus segments are enabled through the use of bus extenders. Domains are limited by device addressability. Domains are limited to a maximum of 16 initiators and targets without the use of LUN bridges.

**SCSI host-side device address**

The eight device addresses (target IDs) assigned to the host device and the SCSI controllers and the devices it controls.

*See also* **SCSI device-side device address**.

**SCSI ID**

*See* **SCSI device ID**.

**SCSI port**

(1) Software. The channel that controls communications to and from a specific SCSI bus in the system. (2) Hardware. The name of the logical socket at the back of the system unit to which a SCSI device is connected.

A bus in which the voltage of a single wire in relation to ground determines each signal’s logic level.

**Small Computer System Interface**

See **SCSI**.

**STERMPOWER**

Terminator power on a single-ended SCSI bus.

See **TERMPOWER**.

**StorageWorks**

The DIGITAL set of enclosure products that allows customers to design and configure their own storage subsystem. Components include power, packaging, and interconnections in a StorageWorks shelf. SBBs and array controllers are integrated therein to form storage subsystems. System-level enclosures to house the shelves and standard mounting devices for SBBs are also included.

**terminators**

The interconnect components that form the ends of the transmission lines in bus segments. A SCSI domain must have at least one segment and therefore at least two terminators. The terminators ensure that inactive SCSI bus signals are in a known state. There are two basic types of terminators—active and passive.

- Single-ended bus segments use active, linear terminators.
- Differential bus segments use a passive (linear totem pole) terminators.  
*except* for special cases where the electrical transmission lines are very short and only one termination or pull-up is required.

**terminator connector**

Any connectors physically part of a terminator. It is not uncommon for terminators to have both stub and bus-path connectors.

**TERMPower**

The electrical current power required for SCSI bus terminators. This power may be supplied by an external SCSI bus, the shelf power supply or an ac–dc power converter.

**topology**

The physical arrangement and relationship of interconnected nodes and SCSI buses in a network. A legal topology must satisfy all the requirements of the associated SCSI bus (Fast 10, UltraSCSI, and so forth).

**transmission medium**

An electrical conductor has bus termination on each end and possibly stubs. Common examples of media are cables, printed wiring boards, flex circuits, and connectors that create electrical connections between various combinations SCSI devices, bus extenders, and terminators.

**tree**

An UltraSCSI bus configuration where an expander located in the middle of a bus segment enables the bus to “branch,” or create a tree configuration, rather than a point to point configuration. Also known as a “branch” configuration.

**UltraSCSI**

An improvement in SCSI technology invented in 1993 by the Digital Equipment Corporation StorageWorks Engineering Group. Subsequently the ANSI SCSI standards committee issued standard X3T10 for UltraSCSI.

The UltraSCSI improvements over Fast SCSI include the following:

- Maximum transfer rate increases from 10 MHz to 20 MHz.

- Maximum wide bus bandwidth increases from 20 MB/s to 40 MB/s.
- VHDCI (very high density cable interconnect) cables and connectors are significantly thinner and smaller.

**UltraSCSI domain**

A single, logical UltraSCSI bus composed of multiple diverse bus segments.  
*See also* **bus segment**.

**UltraSCSI RAID data center cabinet subsystem**

One or more cabinet mounted, 24-SBB UltraSCSI RAID subsystem  
DS–BA370 enclosures mounted in a cabinet such as an SW600.

**UltraSCSI RAID enclosure**

A 24-SBB RAID enclosure, such as the DS-BA370.

**UltraSCSI RAID subsystem**

One or more UltraSCSI RAID enclosures mounted in either a pedestal or a cabinet.  
Each subsystem requires a Master Enclosure. Installing one or two expansion enclosures and interconnecting all the enclosures with UltraSCSI bus cables creates an expanded subsystem.

**VHDCI**

Very High Density Cable Interface. A 68–pin interface with connectors on 0.8 mm centers. Required for UltraSCSI.

## *Reader's Comments*

**Manual Order Number:  
EK-DWZZC-UG. B01**

Digital is committed to providing the best products and services. Since our manuals are important components of our products, we value your comments, corrections, and suggestions for improvements. Please take a few minutes to fill out and return this form. Attach additional sheets, if necessary. Thank you.

<b>Manual Rating</b>	Excellent	Good	Fair	Poor
Accuracy (correct presentation of facts)	[ ]	[ ]	[ ]	[ ]
Completeness (adequate information)	[ ]	[ ]	[ ]	[ ]
Clarity (easy to understand)	[ ]	[ ]	[ ]	[ ]
Organization (logical sequence of information)	[ ]	[ ]	[ ]	[ ]
Layout (easy to follow subject matter)	[ ]	[ ]	[ ]	[ ]
Indexing (easy to locate desired information)	[ ]	[ ]	[ ]	[ ]

**Errors Noted** (include page, paragraph, table or figure number) \_\_\_\_\_

**Most-Liked Features:** \_\_\_\_\_

**Least-Liked Feature** \_\_\_\_\_

**Suggestions for Improvement** \_\_\_\_\_

<p><b>Return Address:</b>                  Digital Equipment Corporation                  Customer Research                  Response Center                  334 South Street, SHR3-2/W3                  Shrewsbury, MA 01545</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Name</td> <td style="width: 50%;">Phone</td> </tr> <tr> <td colspan="2">Title</td> </tr> <tr> <td colspan="2">Company</td> </tr> <tr> <td colspan="2">Street Address</td> </tr> <tr> <td colspan="2">Mail Stop</td> </tr> <tr> <td>City</td> <td>State</td> <td>ZIP</td> </tr> <tr> <td colspan="3">Country (if other than USA)</td> </tr> </table>	Name	Phone	Title		Company		Street Address		Mail Stop		City	State	ZIP	Country (if other than USA)		
Name	Phone																
Title																	
Company																	
Street Address																	
Mail Stop																	
City	State	ZIP															
Country (if other than USA)																	

