StorageWorks™

UltraSCSI Configuration Guidelines

*Be sure to read and understand these guidelines before configuring an **external** (out of the system box) UltraSCSI storage subsystem for your DIGITAL workstation or server. Refer to your system manual for configuring storage devices internal to your system enclosure.*

INTRODUCTION

DIGITAL has recently introduced several new UltraSCSI StorageWorks components. The introduction of these new components also introduces new configuration rules; these rules are required to enable your storage subsystem to run at UltraSCSI speeds and take advantage of new configuration features. This document was developed to provide some guidelines to help make your transition to UltraSCSI successful. A general familiarity with SCSI terminology (but not UltraSCSI terminology) is assumed for readers of this document. This document contains the following sections:

- WHAT IS STORAGEWORKS ULTRASCSI?

- STORAGEWORKS ULTRASCSI COMPONENTS

- ULTRASCSI COMPONENT CONFIGURATION GUIDELINES

- ULTRASCSI BUS CONFIGURATION GUIDELINES

- EXAMPLE CONFIGURATIONS

This document covers the UltraSCSI products that will be offered by DIGITAL in the third calendar quarter of 1997. This document will be updated to reflect future UltraSCSI components as they are released.

WHAT IS STORAGEWORKS ULTRASCSI?

UltraSCSI is an improvement in SCSI technology that was developed by the StorageWorks Engineering Group at Digital Equipment Corporation in late 1993, and subsequently standardized by the ANSI SCSI committee (X3T10). UltraSCSI incorporates several improvements over its predecessor **Fast SCSI**.

UltraSCSI increases the maximum transfer rate on the SCSI bus from 10 MHz to 20 MHz; for a Wide SCSI bus this means an increase in maximum bus bandwidth from 20 MB/sec to 40 MB/sec.

UltraSCSI incorporates smaller cables and connectors -- UltraSCSI uses a **VHDCI** connector that is approximately half the size of the **HD68** connector used in Fast SCSI. UltraSCSI cables are also thinner than Fast SCSI cables.

Because of UltraSCSI's higher speed, Single-Ended UltraSCSI signals cannot maintain their signal integrity over the same distances as Single-Ended Fast SCSI signals. However, the UltraSCSI bus can run over much greater distances than Fast SCSI in either Single-Ended or Differential mode. To attain these greater distances, UltraSCSI defines the concepts of bus segments and bus expanders, and StorageWorks UltraSCSI implements these concepts.

An UltraSCSI **bus segment** is defined as an unbroken electrical path consisting of conductors (in cables or on backplanes) and connectors. Every UltraSCSI bus segment must have two **terminator**s, one at each end of the bus segment. Bus segments can either be **Single-Ended** or **Differential**, depending on the type of terminators used in that segment. In other words, an UltraSCSI bus segment corresponds to what in Fast SCSI was usually considered an entire SCSI bus. As in Fast SCSI, a bus segment can only support devices of the same type as its terminators; you cannot, for example, put a Differential SCSI device on a Single-Ended bus segment.

A **bus expander** is a SCSI device that couples two bus segments together without any impact on SCSI protocol. The familiar DWZZB StorageWorks product, for example, is a Fast SCSI version of a bus expander that couples a Differential bus segment to a Single-Ended bus segment. UltraSCSI bus expanders are incorporated into the UltraSCSI standard. They can be used to extend the effective length of an UltraSCSI bus; to couple Differential bus segments to Single-Ended bus segments allowing the mixing of Differential and Single-Ended devices on the same bus; and to allow isolation of bus segments from each other for maintenance reasons. The name used to describe this single logical UltraSCSI bus composed of multiple diverse bus segments is an **UltraSCSI Domain.**

The UltraSCSI domain shown below is composed of 3 bus segments, with their terminators indicated by a "**T**". There are two bus expanders in this domain, a DWZZC-DA standalone bus expander and a BA35X-FA personality module in a BA356 shelf. The DWZZC-DA couples Differential bus segment 1 and Single-Ended bus segment 2 together. The BA35X-FA couples bus segment 2 and the shelf's internal bus segment 3 together.
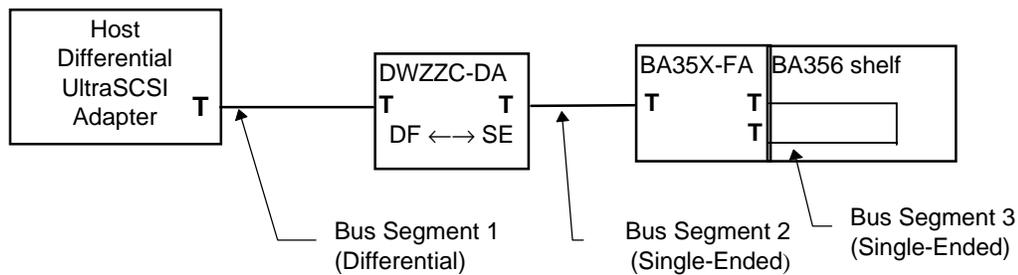
Bus expanders do not have to be placed at the physical ends of the bus segments that they couple; they can also be used to create a "branch" from the middle of an existing bus segment. Thus, an UltraSCSI domain can actually consist of a tree structure of bus segments. An interesting application of this aspect of bus expander technology is the **UltraSCSI Hub.** An UltraSCSI Hub consists of a set of multiple (more than 2) bus expanders each coupling a common, short, Single-Ended bus segment internal to the UltraSCSI Hub to an external bus segment. Some of the external bus segments can be Single-Ended and some can be Differential. All of the external bus segments are coupled to the internal bus segment of the UltraSCSI Hub, and therefore they are all coupled to each other. This creates a radial bus topology as part of the UltraSCSI domain containing the UltraSCSI Hub.

Note that bus expanders and the equipment that incorporates them, such as UltraSCSI Hubs, do not have a SCSI ID. SCSI devices that have a SCSI ID are known as **nodes**, to distinguish them from SCSI devices that do not. An UltraSCSI domain is limited to 16 nodes, and they each must have a unique SCSI ID in the range 0-15.

STORAGEWORKS ULTRASCSI COMPONENTS

Disk Drives

Part #	Description
DS-RZ1BB-VW	2.1 GB, 7200 RPM, UltraSCSI, Wide, 3.5" Blue SBB
DS-RZ1CB-VW	4.3 GB, 7200 RPM, UltraSCSI, Wide, 3.5" Blue SBB
DS-RZ1DB-VW	9.1 GB, 7200 RPM, UltraSCSI, Wide, 3.5" Blue SBB

Host Adapters and Host RAID Controllers

Host adapters and host RAID controllers are nodes that plug in to a host system's PCI bus. They contain one or more ports, each of which connects to an UltraSCSI domain.

Part #	Description
KZPBA-CA	Wide Single-Ended single port host adapter, HD68 connector
KZPBA-CB	Wide Differential single port host adapter, HD68 connector
KZPAC-AA	Wide Single-Ended single port host RAID controller, 4MB cache, VHDCI connector
KZPAC-CA	Wide Single-Ended 3 port host RAID controller, 4MB cache, VHDCI connectors
KZPAC-CB	Wide Single-Ended 3 port host RAID controller, 8MB cache, VHDCI connectors
SN-KZPBA-CA	Wide Single-Ended single port host adapter, HD68 connector, for Digital Personal Workstations
SN-PCTAZ-DE	Wide Single-Ended single port host adapter, HD68 connector, for Digital Personal Workstations
SN-KZPAC-AA	Wide Single-Ended single port host RAID controller, 4MB cache, VHDCI connector, for Digital Personal Workstations
SN-KZPAC-CA	Wide Single-Ended 3 port host RAID controller, 4MB cache, VHDCI connectors, for Digital Personal Workstations
SN-KZPAC-CB	Wide Single-Ended 3 port host RAID controller, 8MB cache, VHDCI connectors, for Digital Personal Workstations

Standalone RAID Controllers and Related Packaging

A Standalone RAID Controller is a node that typically connects to an UltraSCSI domain containing one or more host systems, and also to one or more UltraSCSI domains containing disk and tape devices.

RA 7000

Part #	Description
DS-HSZ70-AH	RAID controller with one Wide DF UltraSCSI host port and six Wide SE UltraSCSI device ports
DS-BA370-AA	Rack-mountable array enclosure, 2 controller slots, 24 drive slots, 5 power supply slots
DS-SWXRA-HB	RAID Array 7000 Departmental Cabinet: BA370-AA in freestanding pedestal (SW370) with power supplies
DS-SWXRA-HA	SWXRA-HB with two HSZ70-AH controllers installed
DS-SWXRA-HC	SWXRA-HB with one HSZ70-AH controller installed
DS-BNK37-1E	Six 1.5m VHDCI male-male cables kit for connecting BA370's or SW370's together
DS-BA356-MA	"Backwards Compatibility" controller shelf, allows Fast Narrow SCSI drives on HSZ70
DS-BA356-MB	BA356-MA shelf with metric mounting brackets (BA35X-RD)

ESA 10000

Part #	Description
DS-SW600-AA/AB	ESA 10000 (600mm) cabinet with 60/50 Hz power entry -- holds two BA370 enclosures
DS-SWXES-AA/AB	SW600-AA/AB cabinet with 2 BA370 enclosures, 2 HSZ70-AH controllers installed
DS-SWXES-BA/BB	SW600-AA/AB cabinet with 2 BA370 enclosures, 4 HSZ70-AH controllers installed
DS-SWXES-CA/CB	SW600-AA/AB cabinet with 2 BA370 enclosures
DS-SWXES-DA/DB	SW600-AA/AB cabinet with 1 BA370 enclosures,

BA356 UltraSCSI Shelves and Options

Part #	Description
Base BA356	Empty, blue BA356 shelf (bare 7 device shelf, not orderable -- see shelf packages below)
DS-BA35X-HH	180W Power Supply
DS-BA35X-FA	Single port Single-Ended UltraSCSI Personality Module for BA356
DS-BA35X-FB	Dual port Single-Ended UltraSCSI Personality Module for BA356 (split bus mode)
DS-BA35X-DA	Single port Differential UltraSCSI Personality Module for BA356
BA35X-ME	Backplane dual terminator for split bus operation with BA35X-FB
BA35X-MF	Backplane bus jumper for single (or shared, with BA35X-FB) SCSI bus operation
BA35X-RB	RETMA mounting kit for BA356 shelves
BA35X-RD	Metric mounting kit for BA356 shelves
DS-BA35X-VB	Pedestal assembly for UltraSCSI BA356 shelves

BA356 UltraSCSI Shelf Packages

Part #	Description
DS-BA356-SD	Base BA356 + DS-BA35X-FA + BA35X-MF + dual speed blowers (single-bus shelf with Single-Ended interface)
DS-BA356-SE	Base BA356 + DS-BA35X-FB + BA35X-ME + dual speed blowers (split bus shelf with 2 Single-Ended interfaces)
DS-BA356-SF	Base BA356 + DS-BA35X-DA + BA35X-MF + dual speed blowers (single-bus shelf with Differential interface)
DS-BA356-RC	DS-BA356-SD + DS-BA35X-HH + RETMA mounting hardware (single-bus SE shelf with power supply)
DS-BA356-RD	DS-BA356-SE + DS-BA35X-HH + RETMA mounting hardware (split bus SE shelf with power supply)
DS-BA356-JD	DS-BA356-SD + DS-BA35X-HH + metric mounting hardware (single-bus SE shelf with power supply)
DS-BA356-JE	DS-BA356-SE + DS-BA35X-HH + metric mounting hardware (split bus SE shelf with power supply)
DS-BA356-JF	DS-BA356-SF + DS-BA35X-HH + metric mounting hardware (single bus DF shelf with power supply)
DS-BA356-KF	DS-BA356-SD + DS-BA35X-HH + DS-BA35X-VB (single bus SE shelf with power supply in freestanding cabinet)
DS-BA356-KG	DS-BA356-SE + DS-BA35X-HH + DS-BA35X-VB (split bus SE shelf with power supply in freestanding cabinet)
DS-BA356-KH	DS-BA356-SF + DS-BA35X-HH + DS-BA35X-VB (single bus DF shelf with power supply in freestanding cabinet)

Standalone Bus Expanders

Part #	Description
DS-DWZZC-AA	Single-Ended to Single-Ended, self contained, tabletop
DS-DWZZC-DA	Differential to Single-Ended, self contained, tabletop

BN37A - VHDCI to VHDCI Cables

Part #	Description
BN37A-0C	0.3 meter VHDCI male to VHDCI male
BN37A-0E	0.5 meter VHDCI male to VHDCI male
BN37A-01	1.0 meter VHDCI male to VHDCI male
BN37A-1E	1.5 meter VHDCI male to VHDCI male
BN37A-02	2.0 meter VHDCI male to VHDCI male
BN37A-2E	2.5 meter VHDCI male to VHDCI male
BN37A-03	3.0 meter VHDCI male to VHDCI male
BN37A-05	5.0 meter VHDCI male to VHDCI male
BN37A-10	10.0 meter VHDCI male to VHDCI male
BN37A-15	15.0 meter VHDCI male to VHDCI male
BN37A-20	20.0 meter VHDCI male to VHDCI male
BN37A-25	25.0 meter VHDCI male to VHDCI male

BN38C - VHDCI to 68HD Cables

Part #	Description
BN38C-02	2 meter VHDCI male to 68HD male
BN38C-03	3 meter VHDCI male to 68HD male
BN38C-05	5 meter VHDCI male to 68HD male
BN38C-10	10 meter VHDCI male to 68HD male
BN38C-20	20 meter VHDCI male to 68HD male

BN38D - VHDCI to 68HD Right Angle Cables

Part #	Description
BN38D-02	2 meter VHDCI male to 68HD Right Angle male
BN38D-03	3 meter VHDCI male to 68HD Right Angle male
BN38D-05	5 meter VHDCI male to 68HD Right Angle male
BN38D-10	10 meter VHDCI male to 68HD Right Angle male

BN21K - HD68 to HD68 Right Angle SCSI-3 Cables

Part #	Description
BN21K-01	1 meter HD68 male to Right HD68 male
BN21K-02	2 meter HD68 male to Right HD68 male
BN21K-03	3 meter HD68 male to Right HD68 male
BN21K-05	5 meter HD68 male to Right HD68 male
BN21K-10	10 meter HD68 male to Right HD68 male
BN21K-15	15 meter HD68 male to Right HD68 male
BN21K-20	20 meter HD68 male to Right HD68 male

Technology Adapter Cables

Part #	Description
BN37B-0B	0.2 meter VHDCI female to Right HD68 male
BN38A-0B	0.2 meter VHDCI male to Straight HD50 female
BN38B-01	1.0 meter VHDCI male to Straight HD68 female
BN38E-0B	0.2 meter VHDCI female to Straight HD68 male

Miscellaneous Interconnect Components

Part #	Description
H8861-AA	VHDCI Tri-Link connector, 2 female, 1 male port
BN37C-0C	'Y'-Cable, 0.6 meter, one VHDCI male to 2 VHDCI females
BN21W-0B	'Y' Cable, 0.15 meter, one HD68 male to two HD68 female

Terminators

Part #	Description
H8863-AA	VHDCI UltraSCSI Wide Differential Terminator (male)
H8865-AA	VHDCI UltraSCSI Wide Single-Ended Terminator (male)
H879-AA	HD68 SCSI-3 Wide Differential Terminator (male)

UltraSCSI Hubs

Part #	Description
DS-DWZZH-21	Hub emitting 2 Single-Ended bus segments and 1 Differential bus segment in 3.5" SBB.
DS-DWZZH-03	Hub emitting 3 Differential bus segments in 3.5" SBB.

<u>ULTRASCSI COMPONENT CONFIGURATION GUIDELINES</u>

UltraSCSI Adapters and Host RAID Controllers

1. All UltraSCSI adapters and host RAID controllers utilize the new VHDCI connectors, except for single channel adapters such as the KZPBA-CA Single-Ended and KZPBA-CB Differential adapters which utilize the HD68 connector.

2. All DIGITAL UltraSCSI adapters and host RAID controllers include on-board SCSI terminators. If an UltraSCSI adapter is connected to the bus via a tri-link connector, its on-board terminator must be disabled.

3. All DIGITAL UltraSCSI host adapters and host RAID controllers support UltraSCSI disks at UltraSCSI speeds in blue BA356 UltraSCSI shelves <u>only</u>. Older, non-UltraSCSI BA356 shelves are supported with UltraSCSI host adapters and host RAID array controllers as long as they contain no UltraSCSI disks; however this is a <u>potentially</u> <u>dangerous</u> configuration. Later addition of an UltraSCSI disk to the non-UltraSCSI BA356 shelf will cause an <u>unsupported</u> configuration to exist, and can result in bus errors and/or data corruption. Because of this, DIGITAL recommends that you upgrade existing BA356 shelves to blue UltraSCSI BA356 shelves when connecting them to an UltraSCSI adapter or host RAID controller, or "lock down" the UltraSCSI host adapter or host RAID controller to Fast SCSI speeds in that situation. The KZPAC family of host RAID controllers can be "locked down" to Fast SCSI speeds via a management utility (RCU). Host adapters can sometimes be "locked down" by the host Operating System through its management facility or a utility, consult your O/S manual.

4. Differential UltraSCSI adapters maybe connected to both a non-UltraSCSI BA356 shelf (via a DWZZB-VW) and the new blue UltraSCSI BA356 shelf (via the DS-BA35X-DA) at the same time. The differential bus cannot exceed 25 meters. The UltraSCSI adapter will negotiate maximum transfer speeds with each SCSI device. Again, this is a <u>potentially</u> <u>dangerous</u> configuration. Later addition of an UltraSCSI disk to the non-UltraSCSI BA356 shelf will cause an <u>unsupported</u> configuration to exist, and can result in bus errors and/or data corruption.

5. In workstation configurations, UltraSCSI disks may be connected only to bus segments with homogeneous cable types. Attaching UltraSCSI disks to a bus segment containing both devices internal to the workstation box (via ribbon cables) and devices external to the workstation box (via BN37A-xx cables) is not supported.

6. The KZPAC UltraSCSI backplane RAID Controller has the following SCSI configuration restrictions with its current firmware 2.x architecture:
   - SCSI ID's greater than 7 are not recognized
   - the maximum logical drive size supported is 32GB
   - the maximum number of logical drives supported is 8

Standalone UltraSCSI RAID Controllers and their Shelves

1. The HSZ70 standalone UltraSCSI RAID controller has a Wide Differential UltraSCSI host bus with a VHDCI connector. HSZ70 controllers will work with Fast Wide Differential SCSI adapters (e.g., KZPSA) at Fast SCSI speeds; use a BN38E-0B converter cable to convert the adapter's HD68 connector to a VHDCI connector.

2. The HSZ70 has six Wide Single-Ended UltraSCSI drive busses. The BA370 enclosure holds a pair of HSZ70 controllers plus 24 drives, four drives per UltraSCSI bus. The BA370 includes six I/O modules in the rear. The I/O modules contain VHDCI connectors for cables to extend the six UltraSCSI drive busses to a second or third BA370 enclosure to extend the subsystem to 48 or 72 drives. Sets of six 1.5m cables (BNK37-1E) are used for this purpose.

Refer to the BA370 manual (EK-BA370-UG) for details. The BA370 I/O modules each contain an UltraSCSI bus expander, so cables longer than 1.5 meters may be used to connect BA370 shelves or SW370 cabinets, as long as the UltraSCSI Bus Configuration Rules (below) are followed.

3. The BA356-MA controller shelf is designed to provide backwards compatibility between HSZ70 controllers and older, non-UltraSCSI BA356 device shelves as well as Narrow BA350 device shelves. The HSZ70 host bus is still Wide Differential UltraSCSI, but in the BA356-MA shelf the six drive interfaces are "locked down" to Fast Narrow SCSI, so the device shelves and device busses do not have to follow the UltraSCSI Configuration Rules.

4. The HSZ70 does not incorporate an internal SCSI bus terminator on its host interface. The HSZ70 enclosures (BA370 and BA356-M) all incorporate internal bus terminators on all six drive buses.

5. BA356 shelves should not be used to extend HSZ70 standalone RAID controller subsystems in BA370 shelves. This is not an UltraSCSI issue; it is due to the different Fault Management styles used in the BA370 and BA356.

6. Only BA35X-HH power supplies should be used in BA370 shelves. Only BA35X-MK cooling fans should be used in SW370 cabinets. BA35X-BC blue battery SBB's are interchangeable with older green battery SBB's.

7. Fast Wide SCSI devices (part number ends in -VW) in green SBB's are supported in BA370 shelves. Narrow SCSI devices (part number ends in -VA) are not supported in BA370 shelves.

8. 5¼" SBB's are not supported in the BA370 shelf.

UltraSCSI Disks

1. All DIGITAL UltraSCSI disks are offered in Wide (16-bit) Single-Ended variants only, in blue Storage Building Blocks (SBB's). Fast Narrow SCSI disks (part number ends in -VA) will continue to be offered in green SBB's.

2. UltraSCSI drives will run in both Fast 10 (F10) and Ultra mode. This is automatically negotiated between the adapter/controller and the drive.

BA356 UltraSCSI Shelf and Options

1. The blue BA356 UltraSCSI shelf is required for UltraSCSI configurations.

2. The 180W power supply (BA35X-HH) is required to support a full load of UltraSCSI devices and the UltraSCSI personality module within a BA356 UltraSCSI shelf.

3. Fast Wide SCSI drives (part number ends in -VW) in green SBB's may be used in the blue BA356 UltraSCSI shelf. Fast Narrow SCSI drives (part number ends in -VA) in green SBB's should not be used in any shelf which could assign the drive a SCSI ID greater than 7, as it will not work in such a shelf.

4. The blue BA356 UltraSCSI shelf incorporates enhanced EMI shielding to meet FCC Class B requirements when loaded with UltraSCSI disk drives. An older BA356 that has been retrofitted with a BA35X-HH power supply and an UltraSCSI Personality Module is not equivalent to a blue BA356 UltraSCSI shelf.

5. The UltraSCSI Personality Module couples the host SCSI bus segment to the BA356 shelf SCSI bus segment; provides a terminator for the external SCSI bus segment; and provides both terminators for the internal SCSI bus segment. If an UltraSCSI BA356 shelf is connected to an external bus segment via a tri-link connector, the terminator on its Personality Module must be disabled via the DIP switches on the Module. Refer to the Shelf I/O Module Users Guide (EK-SBBIO-UG).

6. The UltraSCSI Personality Module has VHDCI connectors on it. This enables you to distinguish it from older Personality Modules that have the larger HD68 connector on them and do not support UltraSCSI.

7. An UltraSCSI Personality Module incorporates SCSI bus expander logic and terminators, and consumes logic power (+5V). The extra power consumed by this module can cause a shelf with a full load of UltraSCSI disk drives to exceed the capacity of the older 150W green power supply. It is therefore required that the new, blue 180W power supply (BA35X-HH) be used in any shelf incorporating an UltraSCSI Personality Module.

8. The BA356 Personality Module has the ability through DIP switch settings to change the BA356 slot-assigned SCSI ID's from 0-6 to 8-14. This feature allows up to fourteen (14) 3.5" devices to be supported in dual shelf configurations. Refer to the Shelf I/O Module Users Guide (EK-SBBIO-UG).

9. UltraSCSI drives and F10 drives can be mixed together in a blue BA356 UltraSCSI shelf. The drives will independently negotiate maximum transfer speeds with the UltraSCSI adapter/controller.

10. The dual port BA35X-FB UltraSCSI Personality Module is intended for use in two ways:

    - Split-bus configurations with the BA35X-ME BA356 internal dual bus terminator -- see Figure 2 below. This is the default configuration for BA356-SE and BA356-JE shelves, and for BA356-KG pedestals.

    - Dual initiator environment where two hosts share the shelf storage. The BA356 jumper (BA35X-MF) should be used -- see Figure 1 below.

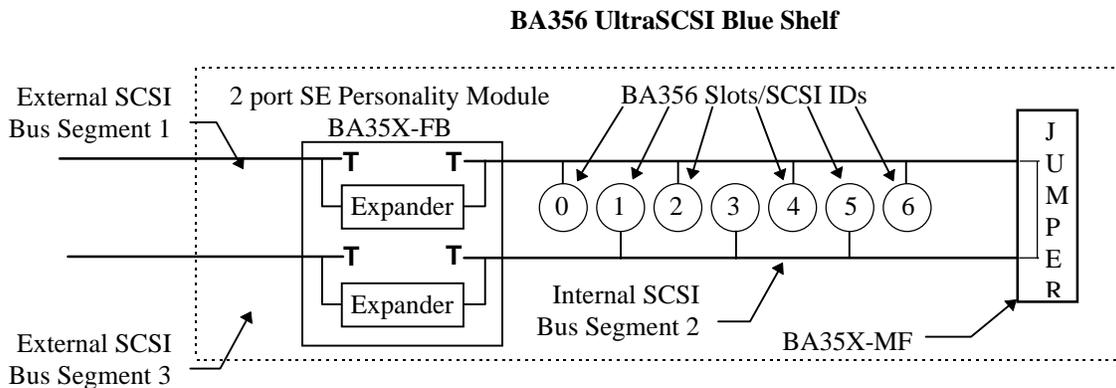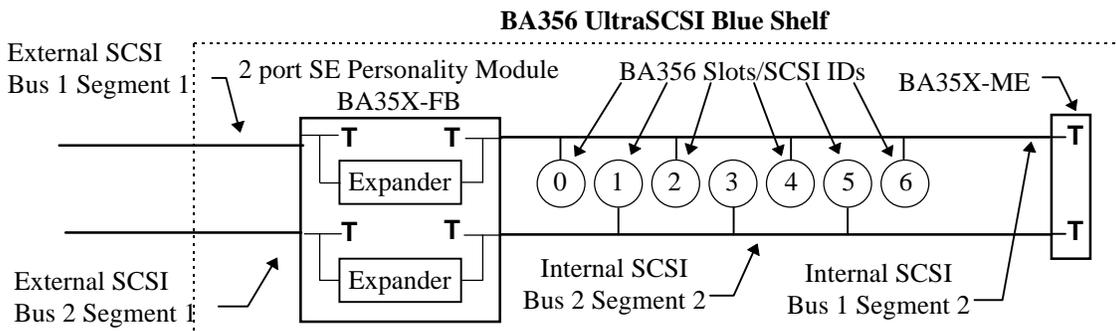**Figure 1 -- Personality Module Termination Scheme (Shared Bus)**

BA356 UltraSCSI Blue Shelf

Figure 2 -- Personality Module Termination Scheme (Split bus)

BA356 UltraSCSI Blue Shelf

ULTRASCSI BUS CONFIGURATION RULES

You can use one of two methods to verify that a SCSI configuration is legal. The simple but restrictive method is to only use configurations that appear in the Examples, or configurations similar to the Examples but with shorter cable lengths or fewer components (for example, one host instead of two). If you choose this method you only have to read the General Guidelines below; you can skip the remainder of this section. A more complex method, which allows you to take fuller advantage of UltraSCSI's capabilities, is to follow the Bus Segment Rules and UltraSCSI domain Rules given below in addition to the General Guidelines.

General Guidelines

You can build many UltraSCSI configurations using either Single-Ended bus segments, Differential bus segments, or a mixture of the two. Single-Ended SCSI components are generally less expensive; however, Single Ended bus segments have less electrical noise margin than Differential bus segments, and should not be run between freestanding cabinets in environments that have inadequate electrical grounding. Well-constructed modern computing facilities generally have adequate-to-excellent grounding; but, if you are running a bus segment between buildings or between floors of a building, or between two computer rooms, or in an environment whose electrical grounding system is suspect, you should use a Differential bus segment in preference to a Single-Ended bus segment.

The presence of a Narrow SCSI device in any UltraSCSI domain restricts the host bus adapters, backplane controllers and the narrow devices to SCSI ID's 0-7.

Bus Segment Rules

1. Single-ended bus segments may be up to 20.5 meters long provided the segment is point-to-point; that is, there are no devices on the bus segment other than at the ends of the bus segment.
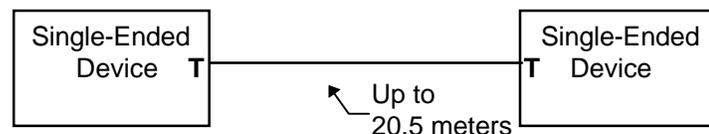
2. Single-ended bus segments containing devices that are spaced at least 1 meter apart may be up to 4 meters long.
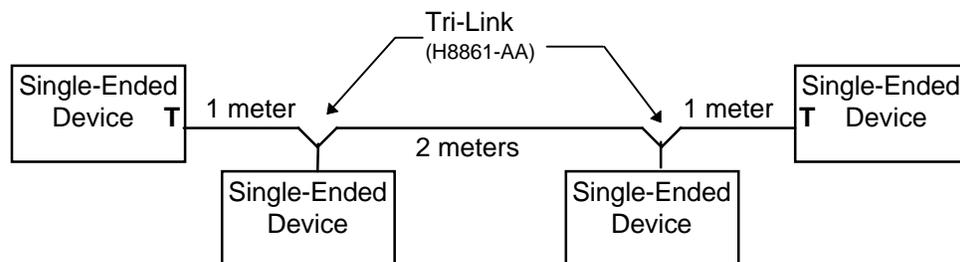
3. Single-ended bus segments that do not meet either of the above two conditions may be up to 1.5 meters long.

4. Differential bus segments may be up to 25.5 meters long and support multiple devices with arbitrary spacing.

5. The DWZZA and DWZZB Single-ended to differential converters will not convert bus traffic at UltraSCSI speeds. They should not be placed in blue UltraSCSI BA356 shelves; use the BA35X-DA personality module instead. The DWZZB may be put into a BA370 standalone RAID controller shelf, but only if it is used to connect to Fast Wide Differential SCSI devices (tape libraries, and tape drives in tape libraries).

6. Do not put tri-link connectors on UltraSCSI Hub ports. The terminators on these devices cannot be disabled, so they must always sit at the end of a SCSI bus segment.

7. A legal UltraSCSI domain is a tree of bus segments -- it cannot contain any loops. It is possible to set up loops; for example you will get an obvious loop if you cable two ports of an UltraSCSI Hub together.

8. Every bus segment requires at least one source for termination power. Adapters and controllers supply termination power. A DWZZC bus expander also supplies termination power. Ultra Personality Modules supply term power internal to the blue Ultra BA356 shelf only. They do not supply term power outside the shelf. UltraSCSI Hubs do not supply termination power. They are instead designed to shutdown in the event of loss of term power to prevent the passing of improperly terminated signals.

9. UltraSCSI Hubs cannot be directly tied to one another because there is no term power source for that segment.

UltraSCSI Domain Rules -- Restrictions on the Size of an UltraSCSI Domain

DIGITAL's UltraSCSI components allow an UltraSCSI domain to extend for considerably longer distances than the older Fast SCSI bus, but there are still limits. These limits are somewhat more difficult to determine than for the Fast SCSI bus, because they are based on worst-case signal delays rather than signal integrity. Furthermore, because the use of bus expanders allows UltraSCSI domains to look like a tree, rather than a straight line, the concept of "bus length" must be replaced with the concept of "UltraSCSI domain diameter." The UltraSCSI domain diameter is the maximum path length between any two nodes in the UltraSCSI domain. The path between two nodes consists of the wires (cables and backplanes) and logic devices (bus expanders and UltraSCSI Hubs) that a signal must traverse to travel between the two nodes. The length of a path is calculated by summing the length of every wire, and the equivalent length of every logic device, along the path. Note that the paths between all nodes, even nodes that do not talk directly to each other on the SCSI bus (for example, two disk drives), must be considered when calculating the UltraSCSI domain diameter.

In practice, you do not have to calculate the path length between every pair of nodes, because all you need to determine the legality of the UltraSCSI domain is the <u>maximum</u> path length. Paths that are obviously short do not have to be counted, and groups of paths with essentially identical lengths (for example, the paths from an adapter to each disk drive in a BA356 shelf) can be calculated just once. The rules below assume this, and only calculate the path lengths between major components (adapters, shelves, etc).

UltraSCSI domain diameters must be no greater than the equivalent of 74 meters of cable. The following list gives the equivalent length, in meters, of every DIGITAL UltraSCSI component that can exist in the path between two nodes:

1. Every meter of cable adds 1 meter. Thus, a BN37A-20 adds 20 meters of cable to any path that includes it.

2. A DWZZC-AA adds 3.7 meters of cable to any path that goes through it.

3. A DWZZC-DA adds 13 meters of cable to any path that goes through it.

4. Any Single-Ended BA356 shelf (BA356-SD, BA356-SE, BA356-JD or BA356-JE) or pedestal (BA356-KF or BA356-KG) adds 4.7 meters of cable to the path to any device in that shelf.

5. A BA356-SE or BA356-JE shelf, or BA356-KG pedestal, which is used in shared-bus mode (that is, with a BA35X-MF jumper) adds 8.4 meters of cable to any path that goes completely through the shelf or pedestal.

6. Any Differential BA356 shelf (BA356-SF or BA356-JF) or pedestal (BA356-KH) adds 14 meters of cable to the path to any device in the shelf.

7. An UltraSCSI Hub adds cable length to any path that goes through it according to the following schedule:

   • 7.4 meters of cable to any path from a single-ended bus segment to a single-ended bus segment

   • 16.7 meters of cable to any path from a single-ended bus segment to a differential bus segment

   • 18.5 meters of cable to any path from a differential bus segment to a differential bus segment

   Note that while UltraSCSI Hubs come in SBB's and are deployed inside a StorageWorks shelf, they have no signal connections to that shelf; therefore, the paths through the shelf do not affect the paths through the Hub.

8. A tri-link connector adds no length to any path that goes through it.

9. The new BN37C-0C "Y" cable adds 0.6 meters of cable length to any path that goes through both branches of the assembly. The branches are 0.2 meters and 0.4 meters.

Bonus Optimization: The previous rules slightly overestimate the diameter of the UltraSCSI domain whenever you have one or more differential bus segments between two single-ended segments, or vice-versa. To compensate for this, you can subtract 7.4 meters of cable from the length of a path for every PAIR of changes between single-ended and differential bus segments along the path. (Ignore the "hidden" single-ended bus segment inside an UltraSCSI Hub, as it has already been counted in the UltraSCSI Hub path lengths above.)

Examples:

A) 25 + 13 + 5 + 13 + 25 - (7.4 Bonus Optimization) = 73.6 **m**eter **e**quivalents

   physical distance = 55 meters
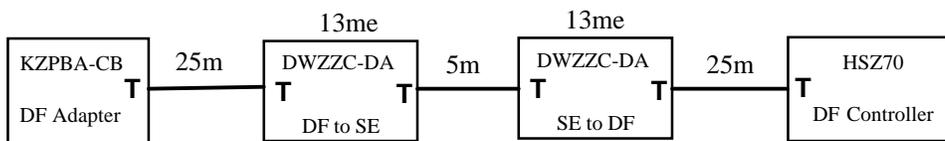
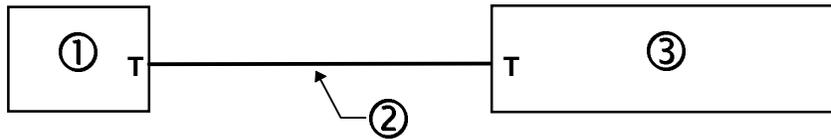B) 20 + 3.7 + 20 + 3.7 + 20 + 4.7 = 72.1 **m**eter **e**quivalents

   physical distance = 60 meters
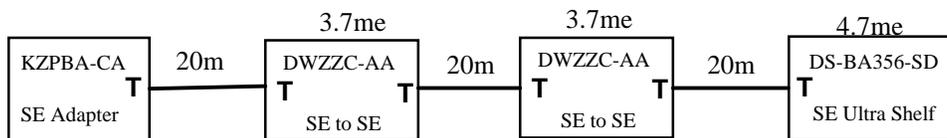
EXAMPLE CONFIGURATIONS -- Non-Hub Based

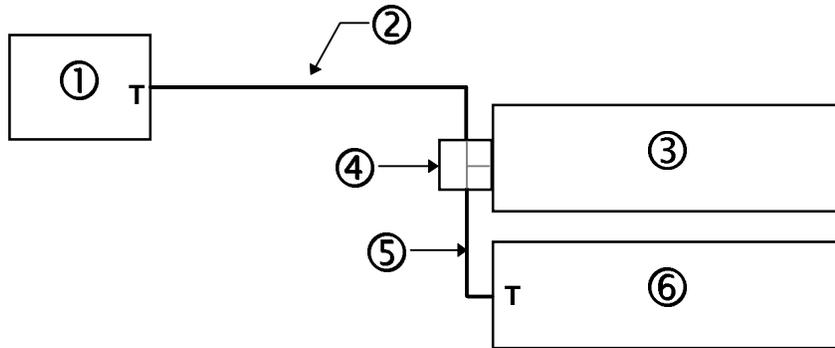### Configuration #1 – Single Host Attaching to a Single Storage Shelf

Single Ended Attachment:

KEY	DESCRIPTION
1	Any of the following: • KZPBA-CA adapter -- requires additional BN38E-0B HD68-to-VHDCI adapter cable • KZPAC-AA host RAID controller • One port of a KZPAC-CA host RAID controller • One port of a KZPAC-CB host RAID controller
2	BN37A-20 or shorter cable. Extend length with one or two DWZZC-AA standalone bus expanders and one or two BA37A-20 or shorter cables (up to 60 meters total cable)
3	Any of the following: • BA356-SD shelf • BA356-JD shelf • BA356-KF pedestal • One half of a BA356-SE split bus shelf • One half of a BA356-JE split bus shelf • One half of a BA356-KG split bus pedestal

Differential Attachment:

KEY	DESCRIPTION
1	KZPBA-CB adapter-- requires additional BN38E-0B HD68-to-VHDCI adapter cable
2	BN37A-25 or shorter cable. Extend length with one pair of DWZZC-DA standalone bus expanders with a BN37A-01 or smaller cable between them, and one BN37A-15 or shorter cable (up to 41 meters total cable)
3	Any of the following: • BA356-SF shelf • BA356-IF shelf • BA356-KH pedestal

Configuration #2 – Single Host Attaching to Two Storage Shelves
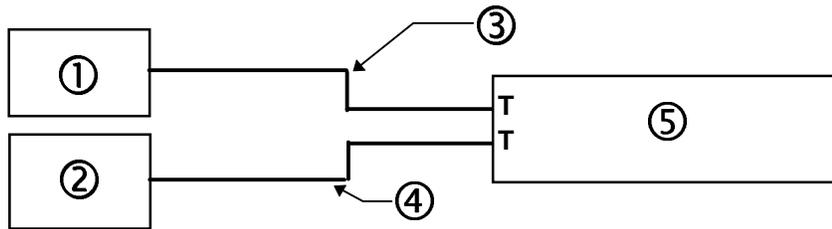

Single Ended Attachment:

KEY	DESCRIPTION
1	KZPBA-CA adapter -- requires additional BN38E-0B HD68-to-VHDCI adapter cable
2, 5	BN37A-xx cables, each a least 1 meter long, the sum of whose lengths (plus the length of any adapter cables) is no more than 4 meters. Extend cable #2 on host side with one DWZZC-AA standalone bus expander and a BN37A-20 or shorter cable.
3, 6	Any of the following: • BA356-SD shelf • BA356-JD shelf • BA356-KF pedestal Set the SCSI ID jumpers on the Personality Module of one of these shelves to the high range (8-14) setting
4	H8861-AA Tri-link adapter. Disable terminator on personality module of shelf #3.

Differential Attachment:

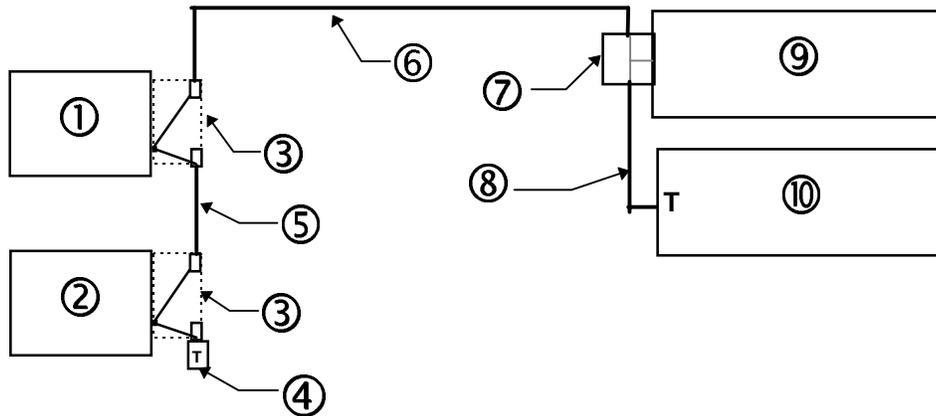| KEY	DESCRIPTION
1	KZPBA-CB adapter-- requires additional BN38E-0B HD68-to-VHDCI adapter cable
2, 5	BN37A-xx cables, the sum of whose lengths is no more than 25 meters. Extend cable #2 on host side with one pair of DWZZC-DA standalone bus expanders with a BN37A-01 or smaller cable between them, and one BN37A-15 or smaller cable (up to 41 meters total cable length).
3, 6	Any of the following: • BA356-SF shelf • BA356-JF shelf • BA356-KH pedestal Set the SCSI ID jumpers on the Personality Module of one of these shelves to the high range (8-14) setting
4	H8861-AA Tri-link adapter. Disable terminator on personality module of shelf #3.

Configuration #3 – Two Hosts Sharing One Storage Shelf -- Method 1, Single Ended Attachment Only

Single Ended Attachment:

KEY	DESCRIPTION
1, 2	KZPBA-CA adapter -- requires additional BN38E-0B HD68-to-VHDCI adapter cable
3, 4	BN37A-20 or shorter cables. Extend length of one (but not both) cables with a DWZZC-AA standalone bus expander and a BN37A-20 or shorter cable.
5	One of the following: • BA356-SE shelf in shared bus configuration (with BA35X-MF backplane jumper) • BA356-JE shelf in shared bus configuration (with BA35X-MF backplane jumper) • BA356-KG pedestal in shared bus configuration (with BA35X-MF backplane jumper)

**Configuration #4 – Two Hosts Sharing One or Two Storage Shelves -- Method 2, Differential Attachment Only**

Differential Attachment:

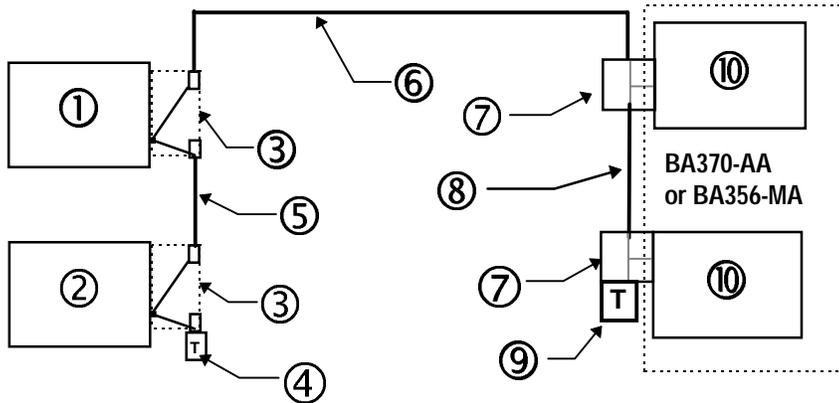| KEY	DESCRIPTION
1, 2	KZPBA-CB adapter
3	BN21W-0B "Y" cable. Remove the differential terminators on the KZPBA-CB host bus adapters. *(refer to note 1)*
4	H879-AA differential terminater
5	BN21K-xx cable (*refer to note 2*)
6	BN38C-xx cable *(refer to note 2,3)*
7	H8861-AA Tri-link adapter. Disable terminator on personality module of shelf #9
8	BN37A-xx cable. (*refer to note 2,3*)
9, 10	Any of the following: • BA356-SF shelf • BA356-JF shelf • BA356-KH pedestal Set the SCSI ID jumpers on the Personality Module of one of these shelves to the high range (8-14) setting

NOTE:

1. The "Y" cable and terminator combination (Keys 3 and 4) used with host adapter (Key 2) is recommended to permit hot-swap of hosts, but can be eliminated (and host terminators left enabled/in place) if hot-swap is not necessary or desired. A SCSI Hub configuration as shown in configuration #9 provides another method of not only eliminating the need for all "Y" cables and "Y" cable & terminator combinations, but also permits hot-swap of hosts.

2. The sum of the lengths of cables 5, 6 & 8 can be no more than 24 meters.

3. Extend either cable (Keys 6 or 8) with one pair of DWZZC-DA standalone bus expanders with a BN37A-01 or smaller cable between them, and one BN37A-15 or smaller cable (up to 40.5 meters total cable length).

**Configuration #5 – One Host connecting to a Standalone RAID Controller Pair
Single-Ended Attachment**
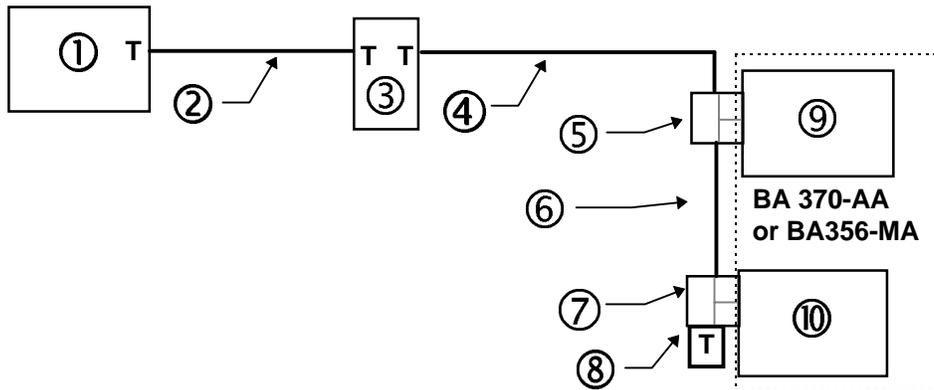
KEY	DESCRIPTION
1	KZPBA-CA adapter - requires additional BN38E-0B HD68-to-VHDCI adapter cable
2	BN37A-20 or shorter cable. Extend with one DWZZC-AA standalone bus expander and one BN37A-10 or shorter cable
3	DWZZC-DA Single-Ended to Differential standalone bus expander, Single-Ended port faces host.
4, 6	BN37A-xx cables, the sum of whose lengths is no more than 25.5 meters.
5, 7	H8861-AA Tri-link adapter.
8	H8863-AA External Differential Terminator
9, 10	HSZ70-AH controllers sharing a BA370 shelf

25

Configuration #6 – One or Two Hosts connecting to a Standalone RAID Controller pair - Differential Attachment

Differential Attachment:

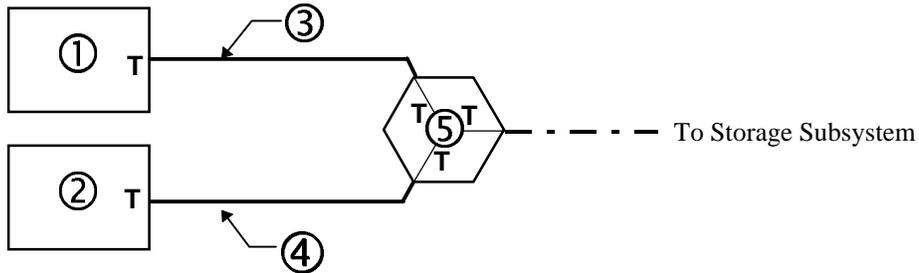| KEY	DESCRIPTION
1, 2	KZPBA-CB adapter
3	BN21W-0B "Y" cable. Remove the differential terminators on the KZPBA-CB host bus adapters.
4	H879-AA Differential Terminator
5	BN21K-xx cable *(refer to note 2)*
6	BN38C-xx cable *(refer to note 2,3)*
7	H8861-AA Tri-link adapter
8	BN37A-xx cable *(refer to note 2,3)*
9	H8863-AA Differential Terminator
10	HSZ70-AH controllers sharing a BA370 shelf

NOTE:

1. The "Y" cables and terminator combination (Keys 3 and 4) used with host adapter (Key 2) is recommended to permit hot-swap of hosts, but can be eliminated (and host terminators left enabled/in place) if hot-swap is not necessary or desired. A SCSI Hub configuration as shown in configuration #9 provides another method of not only eliminating the need for all "Y" cables and "Y" cable & terminator combinations, but also permits hot-swap of hosts.

2. The sum of the lengths of cables 5, 6 & 8 can be no more than 24 meters.

3. Extend either cable (Keys 6 or 8) with one pair of DWZZC-DA standalone bus expanders with a BN37A-01 or smaller cable between them, and one BN37A-15 or smaller cable (up to 40.5 meters total cable length).

EXAMPLE CONFIGURATIONS -- Hub Based

These diagrams display the host connections to the UltraSCSI Hub and the storage connections to the UltraSCSI Hub independently; any combination of host connections and storage connections will produce a legal UltraSCSI domain.

Configuration #7 – Two hosts connecting to a Hub -- Single Ended Attachment

KEY	DESCRIPTION
1, 2	KZPBA-CA adapter -- requires additional BN38E-0B HD68-to-VHDCI adapter cable
3, 4	BN37A-20 or shorter cables
5	DWZZH-21 Mixed UltraSCSI Hub with its two Single-Ended ports connected to hosts and one Differential port connected to the Storage Subsystem.

Configuration #8 – Two or Four hosts connecting to a Hub -- Differential Attachment

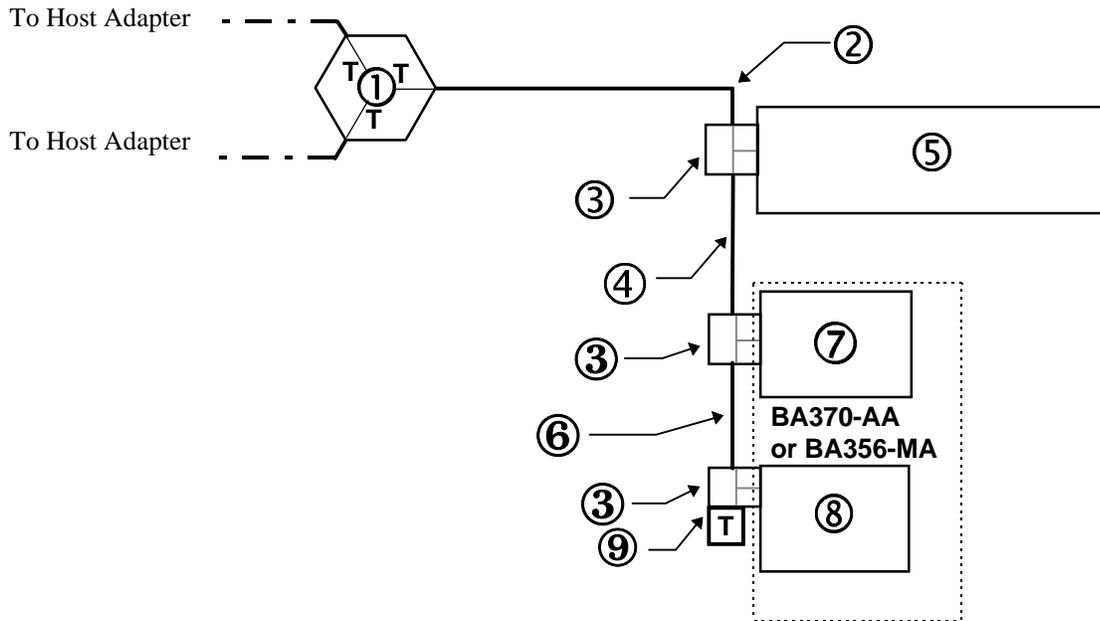| KEY	DESCRIPTION
1, 2, 3, 4	KZPBA-CB adapter.
5	H879-AA Differential Terminator
6	BN21W-0B "Y" cable. Remove the differential terminators on the KZPBA-CB host bus adapters. *(refer to note 1)*
7	BN21K-xx cable *(refer to note 2)*
8	BN38C-xx cables *(refer to note 2)*
9	DWZZH-03, three port Differential UltraSCSI Hub.

NOTE:

1. The "Y" cable and terminator combination (Keys 5 and 6) used with host adapters (Keys 2 and 4) is recommended to permit hot-swap of hosts, but can be eliminated (and host terminators left enabled/in place) if hot-swap is not necessary or desired.

2. The sum of the length of each pair of cables (Keys 7 & 8) can be no more than 24 meters.

Configuration #9 – A Standalone RAID Controller Pair -- Differential Attachment

To Host Adapter

To Host Adapter

BA370-AA
or BA356-MA
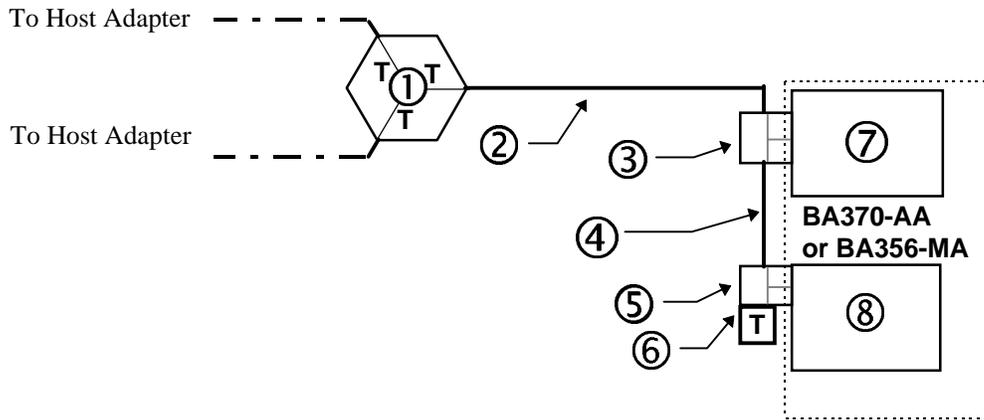
KEY	DESCRIPTION
1	UltraSCSI Hub (DWZZH-21 or DWZZH-03); cable #2 must be connected to a Differential port of the Hub.
2, 4	BN37A-xx cables. The sum of these cable lengths cannot be more than 25.5 meters. ***NO EXTENSIONS ALLOWED!***.
3, 5	H8861-AA Trilink adapter.
6	H8863-AA External Differential Terminator
7, 8	HSZ70-AH controllers sharing a BA370 shelf

Configuration #10 – Hub Connecting to a Storage Shelf and a Standalone RAID Controller Pair – Differential Attachment

To Host Adapter

To Host Adapter

BA370-AA
or BA356-MA

KEY	DESCRIPTION
1	UltraSCSI Hub (DWZZH-21 or DWZZH-03), Differential port connected to drive shelves; cable #2 must be connected to a Differential port of the Hub.
2, 4, 6	BN37A-xx cables, the sum of whose lengths is no more than 15.5 meters. No extensions allowed. If Hub #1 is a DWZZH-21, the sum of these cable lengths cannot be more than 25.5 meters; if Hub #1 is a DWZZH-03, the sum of these cable lengths cannot be more than 15.5 meters.
3	H8861-AA Trilink adapter. Disable terminator on drive shelf #95.
5	Any of the following: • BA356-SF shelf • BA356-JF shelf • BA356-KH pedestal
7, 8	HSZ70-AH controllers sharing a BA370 shelf *(refer to note 1)*
9	H8863-AA External Differential Terminator

NOTE:

1. The controllers supply term power for this hub segment.