

Simple Expanders Extend SCSI Bus Reach into the Future

Getting the most from your SCSI connection

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SCSI expanders are active interconnect components that logically connect and physically isolate segments of a SCSI domain. In addition to isolating segments, expanders allow for a significant increase in overall attainable SCSI bus length and SCSI domain diameter. SCSI expanders are available in two basic types, simple and bridging. For the purpose of this summary, we will largely concentrate on simple expanders. Simple expanders available today do not consume a SCSI ID and are capable of handling Single-ended (SE), and/or one of two modes of differential (Diff), Low Voltage Differential (LVD) or High Voltage Differential (HVD) SCSI transmission on either side.

Figure 1 shows a simple SCSI domain with a single expander between the host adapter and SCSI device. Note that the transmission mode may be the same or different on each side, depending on the transmission mode of the adapter or device.

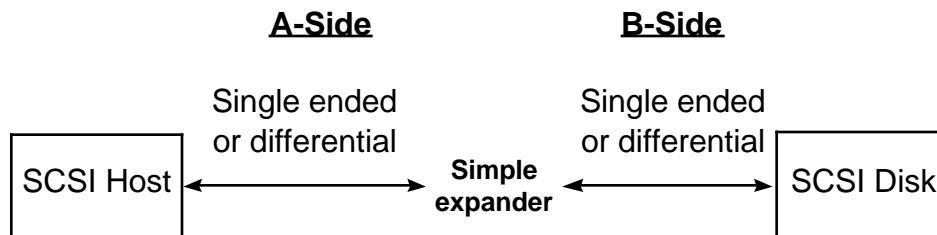


Figure 1 - SCSI Domain using a single simple expander

The simple expander shown above can operate as a repeater when the transmission modes are the same on both sides, "A" & "B", or as a converter when side "A" uses a different transmission mode than side "B" (SE to Diff. or Diff. to SE).

Domain bandwidth is shared among all the bus segments connected via expanders. Activity on one bus segment shows up on the other segments, as the segments are coupled together and not acting independently.

Uses for simple expanders

- Bus isolation:

- Isolates slower SE devices (e.g., enclosure management devices, tape drives) from higher performing LVD devices (e.g. disk drives). In this type of configuration, the expander is also functioning as a converter (see Figure 2 and Figure 4). SE devices require the whole bus segment to run in SE mode. This limits the speed of devices on that segment to Ultra (40 MB/sec). By isolating such devices behind an LVD to SE expander, the main bus segment remains LVD and devices on that segment can continue running at Ultra2 (80 MB/sec) speeds or faster.

- Allows more devices than a single segment can electrically support. Although SCSI supports 16 devices, electrical requirements may not allow a single bus segment to support that many devices. Expanders can be used to separate the devices into different electrical segments.

- Isolates point-to-point segments from multi-drop segments. Point-to-point segments can be 25m, while multi-drop segments are limited to 12m. With an expander, a 25m point-to-point cable can be connected to a 12m multi-drop environment thereby extending the total bus length. In this environment up to four expanders can be cascaded together.

- Radial wiring; connects multiple server systems to shared storage via hubs (see Figure 2).
- Bus extender; point-to-point bus segments are limited to 25m, normally limiting the entire SCSI bus domain to that length. With an expander at the end of a segment, multiple 25m segments can be chained together, extending the length (diameter) of the SCSI domain.
- SCSI bus transmission mode converter; SE to HVD, HVD to SE, SE to LVD or LVD to SE (see Figure 2).
- Device isolation; expanders can electrically isolate components within a system so they do not interfere with each other (see Figure 3 and Figure 4). This technique is commonly used in system networking such as hubs.
- Fault isolation; one use for electrical isolation is in isolating failed segments in a SCSI domain. This allows multi-modes in an enclosure, without jeopardizing performance.

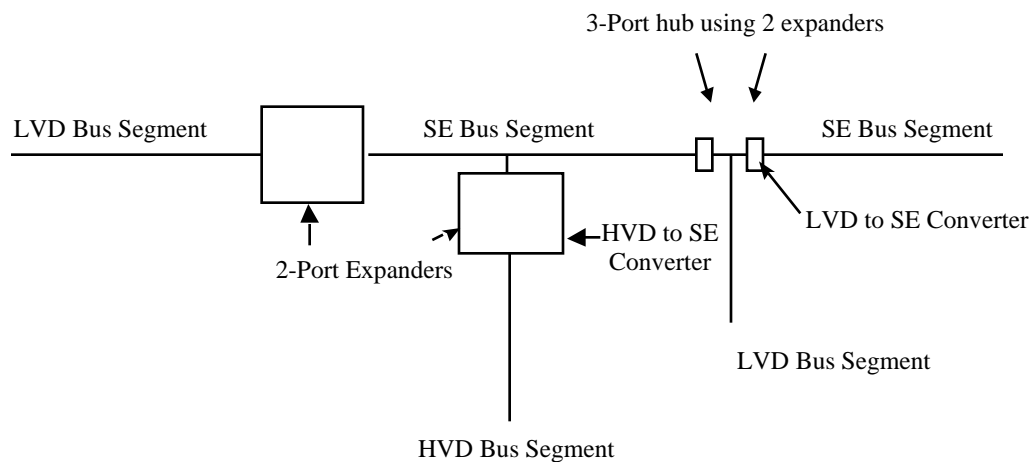


Figure 2 - Example of a more complex SCSI Domain using simple expanders

Notes:

1. LVD = Low Voltage Differential; HVD = High Voltage Differential; SE = Single Ended.
2. Maximum diameter of the SCSI domain is approximately 75 meters.
3. In a simple expander configuration, the maximum number of addresses is 16, or 15 devices plus 1 host connection.

Compatibility

Since SCSI devices are forward and backward compatible, it is possible to connect new devices to legacy systems. This means, for example, that Ultra2 (80 MB/sec) expanders might end up between an Ultra160 host adapter and Ultra160 disk drives. In this situation, transfer speeds must be limited to Ultra2 (80 MB/sec) even though the host adapter and disk drives can negotiate for Ultra160 (160 MB/sec). A procedure called domain validation detects performance capability of the system interconnect, including expanders. Before running at Ultra160, the host adapter tests the negotiated speed and falls back to the Ultra2 speed if Ultra160 data transmission fails. The same technique will be used to verify the capability of Ultra2 and Ultra160 expanders placed between Ultra320 devices.

Simple expanders extend SCSI's capability

As SCSI speeds and functionality continue to increase, expanders become more and more crucial. With Ultra320 on the near horizon, expanders allow for more creative and higher performance SCSI configurations. Ultra320 includes mechanisms for domain validation software to communicate with expanders, enabling software to build topology

maps, perform enhanced domain validation, and control the segments that are connected to the domain. SCSI expanders enhance the applications environment for their use today. Companies are already doing this including system level applications.

Domain divider switches (DDS)

When the expander is used as a DDS, two segments, or sub domains, of a larger SCSI domain can share the same devices, and/or add fail-over capabilities (See Figure 3.). When the switch is open the sub-domains are isolated and each sub-domain has the full bandwidth of a single bus available. Since there are two sub-domains the total working bandwidth is doubled. When the switch is closed a single shared storage domain exists, the available bandwidth reduces to a single bus and the opportunity to do shadowing and backups is now possible.

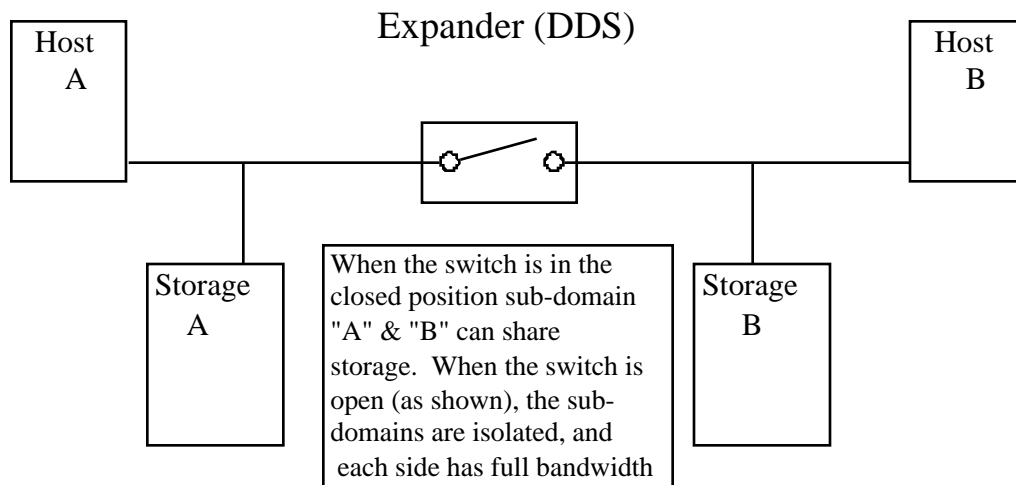


Figure 3 -Example of an expander used as a DDS

Use of older SCSI devices in the same domain as high-performance devices

Simple expanders allow devices, which support multiple transmission modes, to be attached to a single SCSI bus in the device enclosure as shown in Figure 4. A configuration such as this could be used to deliver full SCSI performance during I/O intensive periods and still have the older, slower devices available when needed. This would be done by communicating with a high-performance SCSI device when higher performance is needed. Off-peak hours could be used for activities such as backup to slower tape devices.

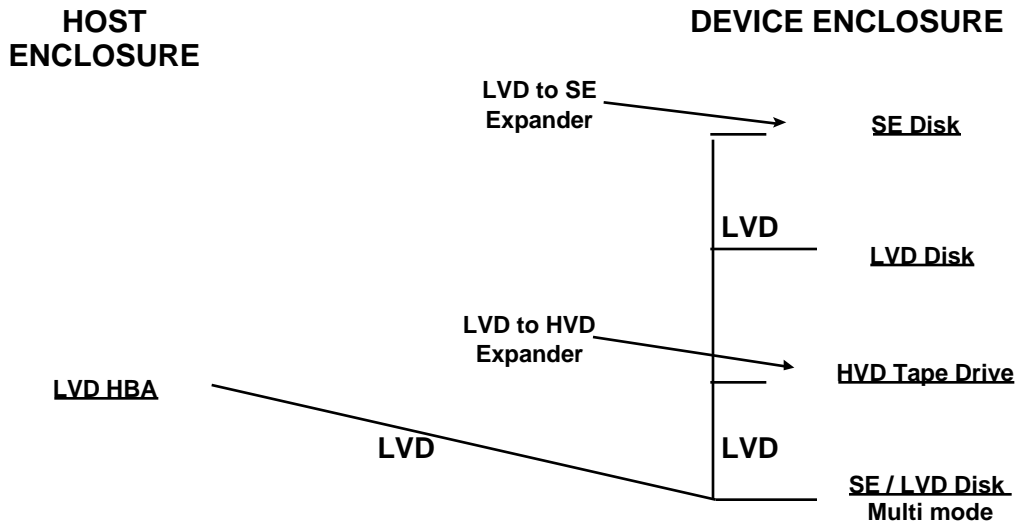


Figure 4 - Multi-segment SCSI Domain with multiple expanders

Bridging expanders

In addition to the simple expanders described in this paper, higher level classes of expanders can also be useful. For example a LUN (logic unit number) bridge allows expansion of the addressing capability from a single host port to 960 targets while still providing the electrical isolation and performance of a simple expander. This topic will be explored further in a future paper.