

# Expanding the SCSI Bus

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*SCSI Parallel Interface Technology -  
a path to the future!*



## ***EXPANDING THE SCSI BUS***

The Small Computer Systems Interface (SCSI) has been in existence for over 15 years. This parallel bus has become the most widely utilized mass storage interface in the computer industry. Its strong position in the market place permeates from the high end server applications through workstations down to the low end single user computer. The SCSI interface is projected by most industry analysts to maintain its hold on the mass storage market through the year 2005. This is due in large part to SCSI's inherent protocol flexibility, large support infrastructure, continued speed increases and the acceptance of SCSI Expanders in applications where the following needs have arisen:

### **Longer SCSI Cable Lengths**

The parallel SCSI interface has increased in speed while using the same physical transmission mediums defined when the bus was more than 10 times slower. Low cost single ended SCSI applications have attained these higher speeds at the cost of having to go to shorter cable lengths. In stand alone applications, where all of the devices are internal, this may not be a problem, but in applications where external device packages are to be used in a system, the short single ended cabling becomes a serious issue. High Voltage Differential (HVD) applications allow for longer cable lengths, but add an additional expense per device. There are also limits to the variety of HVD devices available, as not all SCSI device manufacturers make HVD versions of their devices.

The new Low Voltage Differential (LVD) applications which will become prevalent in 1998 will help to solve these issues. LVD devices will have the low cost of single ended devices and the longer cable lengths and higher signal stability of HVD devices. They will also be able to operate at the faster Ultra 2 SCSI transmission rates. Even with LVD there are cable length issues. The larger SCSI based systems of today have varying requirements that exceed the maximum cable lengths of all of the current Parallel transmission mediums. The answer to cable length issues resides in the use of expanders as SCSI bus extenders (see fig. 1).

Parallel SCSI Expanders used as extenders separate a SCSI bus (SCSI domain) into more than one physical segment, each of which can have the full SCSI cable length for that type. Two expanders can increase the extension of the bus, creating 3 segments. If no other devices are connected to the center segment, the point to point communications between two expanders will allow for a longer than normal cable length in that segment. Serial Expanders are similar in function as two Parallel expander implementations, with the point to point serial transmissions in place of the middle SCSI segment.

All of the above SCSI Expanders have certain characteristics. The expanders are transparent to the software and firmware on the bus. They don't take up a device ID. They are able to provide termination if located at the end of a bus segment. They can have termination disabled if they are in the middle of a bus segment. They can provide termination power, and they provide a complete regeneration of the SCSI bus signals as each SCSI bus segment must maintain the complete physical bus characteristics of a SCSI bus in and of itself.

**Fig. 1: Longer SCSI Cable Lengths Using Expanders**

Length in Meters, Point to Point = No devices between expanders

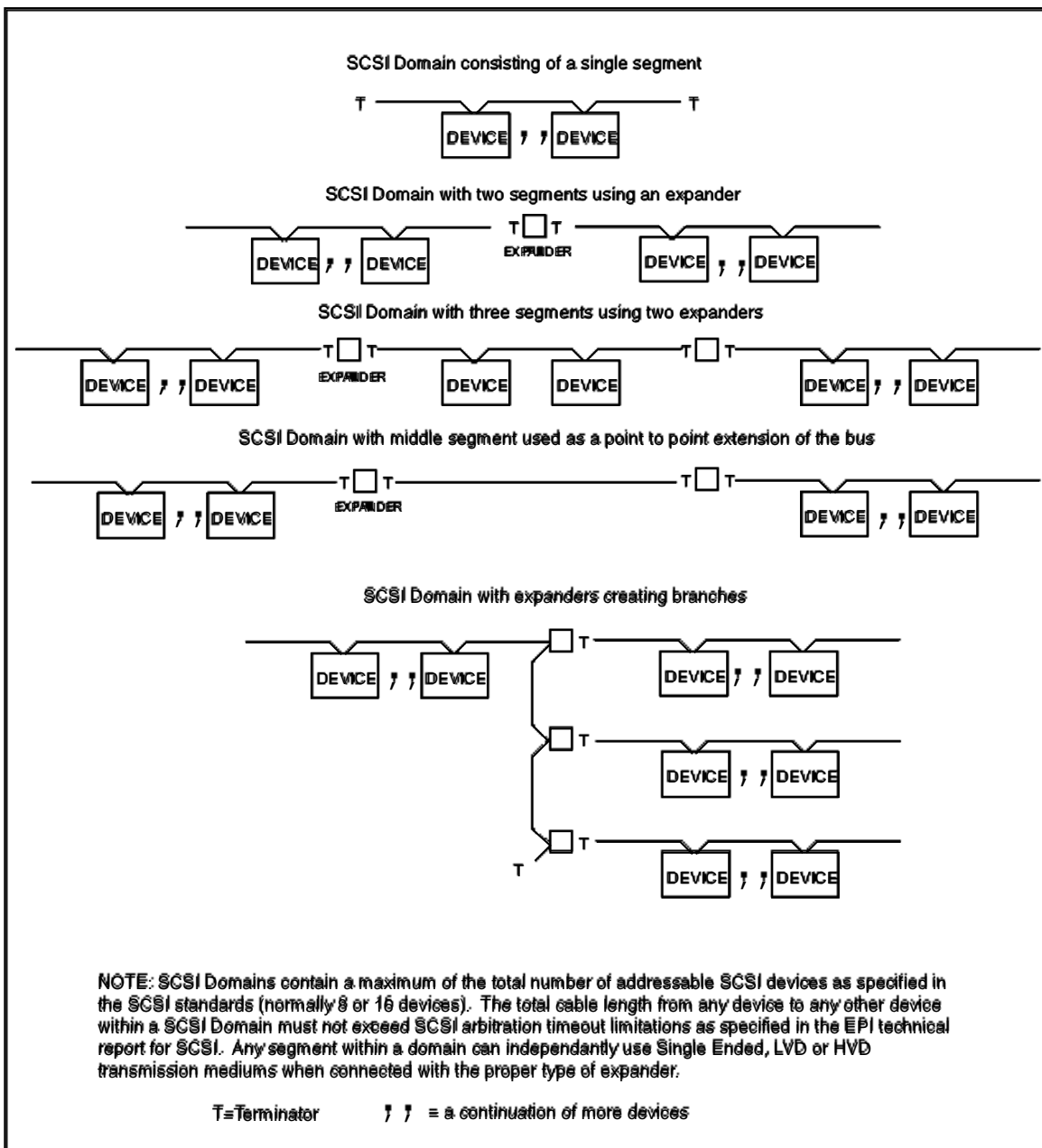
	ASYNC/SLOW	FAST	ULTRA	ULTRA2
<b>S.E. SCSI</b>				
No Expanders	6	3	1.5	NA
1 Expander	12	5	3	NA
2 Expanders	18	9	4.5	NA
2 (point to point)	24	12	6	NA
<b>HVD SCSI</b>				
No Expanders	25	25	25	NA
1 Expander	50	50	50	NA
2 Expanders	75	75	75	NA
2 (point to point)	100	100	100	NA
<b>LVD SCSI</b>				
No Expanders	*	*	*	12
1 Expander	*	*	*	24
2 Expanders	*	*	*	36
2 (point to point)	*	*	*	48

S.E. = Single Ended, HVD = High Voltage Differential, LVD = Low Voltage Differential

- = LVD can go longer distances at slower transmission rates

Note: Cable segments of different types can be used in the same SCSI domain with converting expanders. Longer cable lengths are possible with serial expanders.

**Fig. 2: A Few Examples of How Expanders Can Affect Segments within a SCSI Domain**



### Compatibility between Various SCSI Transmission Mediums

Devices that transmit Single Ended SCSI signals cannot normally communicate with HVD SCSI based devices. The LVD specifications have a definition for Multimode LVD that allows a multimode LVD based bus segment to switch down to Single Ended transmissions if a Single Ended device is connected to it. This allows for compatibility at the cost of degrading the speed and cable lengths of the total bus segment when single ended device is physically connected to the segment.

LVD and HVD devices are also incompatible with each other. Add the problems of connecting narrow SCSI (8bit) devices with wide SCSI (16 bit) devices and it starts to get complex. This is where SCSI expanders are used as converters to become the glue that brings these divergent transmission types within a single SCSI domain.

Expanders can be used to maintain the faster (Ultra 2) communication rates of LVD devices within an LVD segment, while retaining the long cable lengths of devices within a HVD segment, and supporting low cost devices within a single ended segment. This could all be done within a single SCSI domain, with each segment having its full cable length available to it. Expanders that convert between HVD and Single Ended SCSI are used in HVD systems to add low cost single ended drive packages onto the longer HVD cabling. The newer expanders that implement Multimode LVD on both sides will automatically convert between Single Ended and LVD allowing LVD devices to keep their transmission rates high when communicating within their segment. They do this while still allowing the use of single ended devices. Wide SCSI Expanders also address all of the questions of connecting a narrow SCSI segment with a wide SCSI segment. All signal lines for the wide segment are terminated at the expander eliminating the potential hazards of improper terminations for the wide bus and simplifying the cabling for the narrow segment.

### **Increasing the Number of Addressable Devices**

The majority of current SCSI applications, see the number of devices addressable by a single SCSI port as completely adequate. But in some larger SCSI configurations, where large banks of devices must be accessed, SCSI's total target/initiator devices in the narrow SCSI bus (8 devices) and wide SCSI bus (16 devices) are viewed as a limitation. Logical Unit Number Expanders (LUN Expanders) can increase the number of devices possible through a single SCSI port. They do this by controlling the accessing of target/initiator ID based devices such that the LUN addressing specified in the SCSI standards can be used to address them.

### **Bridging between SCSI and Other Communication Protocols**

Over the years there have been many merges of SCSI and other communication protocols. In the mid nineteen eighties there were a number of applications using SCSI bridges to Ethernet allowing direct Ethernet access to SCSI devices. Today there are still SCSI to Ethernet bridges, but the emphasis has been in bridging the Fiber Channel, SSA, and P1394 protocols to SCSI. All three of these protocols have been trying to make an impact in mass storage communications but have been having a hard time competing with SCSI's comparatively low cost, strong infrastructure, and proliferation of SCSI based devices. Bridges provide a compromise such that these serial architectures get the benefit of accessing readily available SCSI devices, whereas SCSI based applications would have the benefits of the extremely long serial cable implementations achievable with the fiber communications protocols. This area of SCSI Expanders has a large number of companies vying to produce elegant bridge solutions. SCSI Bridge Expanders vary from other expanders in that they do use a SCSI ID location as the bridge point to other communications protocols.

### **Expanders Taking SCSI into the Future**

SCSI Expanders have been in existence in various forms since the mid 1980s. The simpler expanders which are used to transparently convert between single ended and differential transmission mediums have evolved from providing just a bus conversion to being able to provide full SCSI cable lengths on each side of the conversion, and allowing for back to back bus extension for even longer cable lengths. Developing from the converters, bus repeaters/regenerators have become popular in providing that extra cable length, without having to go through a conversion. These types of SCSI expansions have evolved from boards populated with many parts to the first expanders in 1995 providing all of the controls in a single ASIC (Paralan's PAR5780 ASIC used in Ultra SCSI converters and isolating bus regenerators). This evolution continued in 1996 with not only the controls but the single ended drivers built into the ASIC (Symbios Logic's 53C120). The beginning of 1998 will have expander ASICs from a number of manufacturers (including Paralan's PAR7180) which will contain multimode Low Voltage Differential (LVD) drivers for Ultra 2 communications, supplying bus isolation and longer cable lengths for Ultra 2 SCSI implementations and providing an important link between

older SCSI devices and the faster SCSI devices of the future.

The Enhanced Parallel Interface (EPI) group was formed in 1996 by the X3T10 Standards Committee for SCSI. This group describes Expanders as the class of devices that enhance a physical parallel SCSI bus. The EPI group provides recommendations for proper expander implementations and defines methods to implement systems using expanders. The EPI group has a technical document T10/1143D which gives guidance in the development and usage of expanders. The SCSI Trade Association ([www.scsita.org](http://www.scsita.org)) has a link to the X3T10 web site which contains this document available for viewing, along with other information about the parallel SCSI interface. This trade association works in conjunction with the SCSI standards committee to promote and support the usage of SCSI in the computer industry.

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### **Additional Information**

The SCSI Trade Association has a wide variety of documents and information on SCSI Parallel Interface Technology, including presentations, articles in periodicals, seminar material and white papers. Please contact Association offices at:

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