



Advances in Storage Connectivity

ATTO Ultra320 SCSI – The Next Generation

A Technical Brief

Introduction:

Ultra320 SCSI represents the 7th generation of SCSI technology, an I/O interface that is committed to increased performance while maintaining backward compatibility and legacy support.

From its roots in 5 MB/sec. transfer rates, SCSI has evolved as the leading interface for disk drive connections in high-performance servers. With maximum data transfer rates of 320 MB/sec., full backward compatibility with

older versions of SCSI protocols and several additional features to improve performance and reliability, Ultra320 SCSI demonstrates that SCSI technology is alive and well.

SCSI Evolution:

Over the past 20 years since its inception, SCSI technology has continued to evolve, providing faster data-transfer speeds, improved reliability and fewer cabling limitations. The following chart illustrates how SCSI has evolved.

Narrow	Fast/Narrow	Ultra	UltraWide	Ultra2	Ultra3 Ultra160	Ultra320
<5 MB/sec.	10 MB/sec.	20 MB/sec.	40 MB/sec.	80 MB/sec.	160 MB/sec.	320 MB/sec.
SCSI-1	SCSI-2	SCSI-3	SCSI-3	SCSI-3	SCSI-3	SCSI-3
SPI-1	SPI-1	SPI-1	SPI-1	SPI-2	SPI-3	SPI-4
Single-Ended	Single-Ended HVD	Single-Ended HVD	Single-Ended HVD	LVD Single-Ended	LVD Single-Ended	LVD Single-Ended



SCSI Advantages:

- Backward compatible with older versions of SCSI. Newer adapters will negotiate to the lower speeds of legacy devices.
- Minimal investment for upgrading technology. Older equipment may still be used in tandem with newer equipment. Upgrading does not require a wholesale replacement of infrastructure.
- It is still the fastest desktop and server storage technology. Ultra320 SCSI is 2.5 times faster than Gigabit Ethernet, 60% faster than 2-Gigabit Fibre Channel, and 3.2 times faster than standard Fibre Channel.

What's New in Ultra320?

The Ultra3 SCSI specifications originally included five features:

- Double Transition Clocking
- Domain Validation
- Cyclic Redundancy Check (CRC)
- Packetization
- Quick Arbitration Select (QAS)

Packetization and QAS were ultimately removed as requirements, and the specification was released as Ultra160 SCSI.

Ultra320 SCSI supports **all five** Ultra3 features and the following additional features:

- Free-Running Clock
- Read and Write Data Streaming
- Flow Control
- Training Pattern
- Pre-Compensation
- Asynchronous Information Protection (AIP)

Each of these additional features delivers key benefits. The chart below summarizes the features and benefits.

Features	Benefits
<p>Double Transition Clocking Increases the data line frequency to equal that of the request signal, allowing sampling on both the leading and trailing edges of the request signal. Clocking can be settable to ensure compatibility with legacy devices</p>	<p>Increased performance, especially in environments that use extended transfer lengths or have many SCSI devices on a single bus</p>
<p>Packetization Creates information units (IUs) comprising commands, data, status information and other things. These IUs are passed as synchronous transfers</p>	<p>Maximizes bus utilization, minimizes command overhead and allows multiple commands to be transferred in a single connection</p>
<p>Quick Arbitration Select (QAS) Arbitration, the process of devices negotiating for control of the bus, is a critical part of the SCSI specification. This process has built-in "quiet times" so that both fast and legacy devices have an opportunity to take control of the bus. Although fair, this process is somewhat inefficient. QAS speeds up the arbitration process by eliminating the bus free phase</p>	<p>When combined with Packetization, reduces command overhead and maximizes bus utilization</p>



Features	Benefits
<p>Read and Write Data Streaming Minimizes data transfer overhead by allowing a target to send one data stream (LQ) packet followed by multiple data packets</p>	<p>Minimizes overhead of data transfers because the target can send one data stream packet followed by multiple data packets</p>
<p>Flow Control The target indicates to the initiator when the last packet of a data stream will be transferred so that the initiator can flush FIFOs and terminate pre-fetch sooner than previously possible. Basically, the target is warning the initiator that the transfer is almost complete so that it can prepare for the next transfer while the target completes the current transfer</p>	<p>Optimization, which allows faster transition between transfers</p>
<p>Training Pattern SCSI is a parallel bus technology. Therefore, it is dependent on signals being transmitted on parallel wires simultaneously. At higher speeds, minute differences in wire lengths and transmission characteristics could cause problems. Training pattern testing measures these minute differences and compensates for them</p>	<p>Helps measure and compensate for cable variations</p>
<p>Pre-Compensation Although SCSI transfer speeds have changed dramatically over the past several generations, cable specifications have remained constant. Higher speed (higher frequency, too) signals have a greater potential for reflection and distortion over distance. Pre-compensation techniques slightly modify the SCSI signal to reduce the chance of these types of problems</p>	<p>Ensures a cleaner signals</p>
<p>Asynchronous Information Protection (AIP) Although most Ultra320 traffic is sent synchronously and protected by CRC, some information is still sent asynchronously. AIP implements CRC-level error checking on asynchronous traffic. This ensures end-to-end data integrity</p>	<p>CRC class protection for asynchronous traffic</p>



Ultra320 Value Proposition

When implemented in a PCI-X environment that delivers 1 GB/sec., Ultra320 is a powerful storage technology. Today, all forms of digital content – from e-mail, video, film, and audio, to streaming video, and imaging – are driving the unprecedented growth in storage that pushes the I/O bandwidth and require more advance interfaces to handle the data transfer.

High Definition (HD) Digital Video (DV) applications require over 160 MB/sec. bandwidth per stream. Because most DV users edit multiple streams simultaneously, the merits of Ultra320 technology are easy to see. Data mining and real-time transaction applications will benefit from the new QAS and Flow Control features, allowing servers to search more disks for information in a shorter period of time.

Ultra320 SCSI is more than a simple speed improvement. It provides a rich feature set for improved performance, reliability and efficiency that will allow SCSI to retain its overwhelming market share in the performance storage market.

Definitions

Double Transition Clocking – SCSI transactions (data transfers) include request signals and data lines. Ultra2 and earlier SCSI implementations used single transition clocking whereby the frequency of the data lines was half of the request signal. This allowed data sampling only on the leading edge of the request signal. Double transition clocking increases the data-line frequency to equal that of the request signal, allowing sampling on both the leading and trailing edges of the request signal. Clocking can be settable to ensure compatibility with legacy devices.

Domain Validation – Before sending data, domain validation is performed to verify that the physical connection (cables, connectors, targets, etc.) is capable of handling the negotiated transfer speed. Although a target and initiator may indicate that they are able to sustain Ultra320 transfer rates, during Domain Validation a series of tests is performed to ensure the sustainability and reliability of that connection. If it is determined that Ultra320 speeds are not feasible, a slower speed is enforced.

Cyclic Redundancy Check (CRC) – verifies that the data sent matches with the received data. CRC is more robust than the simple byte parity checks used in pre-Ultra160 SCSI. Increased data rates and longer cable lengths, among other factors, have resulted in the potential for increased error rates, necessitating the use of CRC.

Packetization – Later generations of SCSI are more adversely impacted by an increase in overhead since traffic is negotiated at synchronous and asynchronous speeds. Packetization creates information units (IUs) comprising commands, data, status information and other things. These IUs are passed as synchronous transfers, reducing overhead and improving overall efficiency.



Quick Arbitration Select (QAS) – Arbitration, the process of devices negotiating for control of the bus, is a critical part of the SCSI specification. This process has built-in “quiet times” so that both fast and legacy devices have an opportunity to take control of the bus. Although fair, this process is somewhat inefficient. QAS speeds up the arbitration process by eliminating the bus free phase. Combined with packetization, this significantly improves bus efficiency.

LVD – Low Voltage Differential. It is the SCSI signaling method that combines the benefits of HVD and Single-ended technologies, allowing longer cabling configurations (25 meters point-to-point, 12 meters with multiple devices) while consuming less power than HVD technology.

HVD – High Voltage Differential. It uses two wires, transmitting a signal on one and its inverse on the other. At the receiving end, the difference between the two signals is measured and interpreted. Noise on the bus will affect both the signal and its inverse equally, so the difference between the two lines will remain the same and the noise can not be misread as a signal.

Single-Ended – An electrical signal protocol that transmits information through changes in voltage. Single-ended SCSI uses standard TTL signal and ground pairs to transmit information over the SCSI bus.

Free-Running Clock – Allows use of a higher frequency clock with legacy cables and infrastructure. This is accomplished through the use of a Data Enable signal in addition to the Request signal and Data lines.

Read and Write Data Streaming – Minimizes data transfer overhead by allowing a target to send one data stream (LQ) packet followed by multiple data packets.

Flow Control – The target indicates to the initiator when the last packet of a data stream will be transferred so that the initiator can flush FIFOs and terminate pre-fetch sooner than previously possible. Basically, the target is warning the initiator that the transfer is almost complete so that it can prepare for the next transfer while the target completes the current transfer.

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Asynchronous Information Protection (AIP) – Although most Ultra320 traffic is sent synchronously and protected by CRC, some information is still sent asynchronously. AIP implements CRC-level error checking on asynchronous traffic. This ensures end-to-end data integrity.