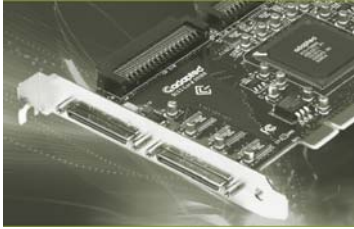


SCSI



Overview

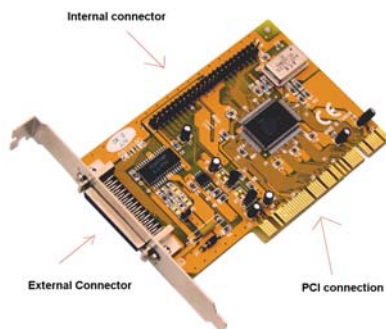
- **In this part, you will learn to**
 - Create a functional SCSI chain
 - Describe the different flavors of SCSI
 - Troubleshoot problems with SCSI installations
 - Describe the benefits of using SCSI

SCSI Chains

SCSI

- **S**mall **C**omputer **S**ystem **I**nterface
- Introduced by Shugart in 1979
- System independent means of mass storage
- Comes in a number of flavors such as SCSI-1, SCSI-2, and SCSI-3
- **C**ommon SCSI devices are
 - Hard drives
 - Tape backup units
 - Removable hard drives
 - Scanners
 - CD-ROM drives
 - Printers

SCSI Card (PCI)



SCSI Card (ISA)



SCSI Chains

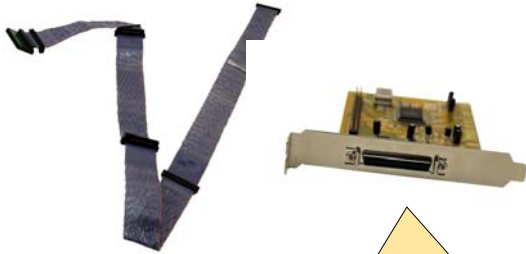
- A **SCSI chain** is a series of SCSI devices working together through a host adapter
- The host adapter is a device that attaches the SCSI chain to the PC
- All SCSI devices are divided into internal and external groups
- The maximum number of devices, including the host adapter, is 8 or 16

Internal Devices

- **Internal SCSI devices** are installed inside the PC and connect to the host adapter through the internal connector
- All internal devices are connected to the host adapter and to each other with a **68-pin ribbon cable**
- Multiple internal devices can be connected together by using a cable with more connectors

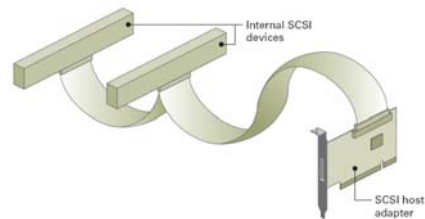


68-Pin SCSI Ribbon Cable



50-pin HD port on SCSI host adapter. External devices connect using either a 68-pin or 50-pin high-density (HD) connector.

Connecting Internal Devices

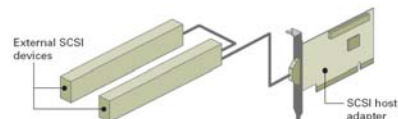


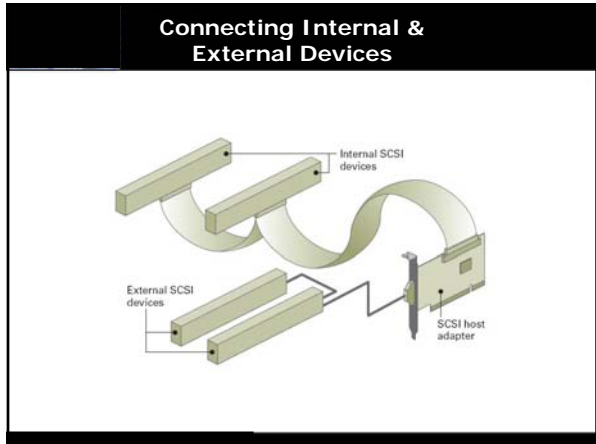
External Devices

- **External SCSI devices** are connected to the host adapter through the special SCSI external connection of the host adapter
- All external devices have two connections in the back, to allow for **daisy-chaining** of multiple external devices
- A standard SCSI chain can connect eight or sixteen devices, including the host adapter



Connecting External Devices





Warning

IDE devices that are plugged in wrong just don't work.

SCSI devices plugged in wrong (such as the cable backwards) can be damaged!

- ### SCSI IDs
- Each SCSI device must have a unique **SCSI ID**
 - The values of ID numbers range from 0 to 7 or 15
 - No two devices connected to a single host adapter can share the same ID number
 - There is no order for the use of SCSI IDs, and any SCSI device can have any SCSI ID
-
- The diagram shows a SCSI host adapter with three SCSI IDs (1, 6, 7) and three SCSI devices connected to it. Each device has a jumper set to a specific SCSI ID: SCSI ID 1, SCSI ID 6, and SCSI ID 7.

- ### SCSI IDs
- The SCSI ID for a particular device can be set by configuring jumpers and switches on it
 - Most internal SCSI devices use jumpers to set their SCSI ID
 - Devices may not allow all values
 - The jumpers follow a set and predictable pattern
 - Most manufacturers of host adapters use a SCSI ID of 0 or 7 for the host adapter, although a few older ones require SCSI ID 6
 - To make a SCSI device bootable, set the ID to the value defined as bootable (usually 0 or 7)

- ### SCSI IDs
- Most internal SCSI devices use three jumpers to set the SCSI ID
 - The value of the jumper does not necessarily match the label. In the drawing, the first jumper has a value of 1, the second has a value of 2, and the third has a value of 4. This is common.
- Just add the values of the pins jumpered to determine the ID. For example, if pins 1 and 3 are jumpered, add the value of the two pins (1+4) to determine SCSI ID 5.
-
- The photograph shows a SCSI hard drive with three jumpers on its back panel. The jumpers are connected to pins 1, 2, and 4, which corresponds to a SCSI ID of 5 (1+2+4).

SCSI Hard Drive Documentation

Drive ID	A0 Pin 7	A1 Pin 8	A2 Pin 9	A3 Pin 10	Signal
ID 0	OFF	OFF	OFF	OFF	SCSI ID (A0)
ID 1	N	OFF	OFF	OFF	SCSI ID (A1)
ID 2	OFF	ON	OFF	OFF	SCSI ID (A2)
ID 3	ON	ON	OFF	OFF	SCSI ID (A3)
ID 4	OFF	OFF	ON	OFF	LED Power (+5V)
ID 5	ON	OFF	ON	OFF	LED Power (+5V)
ID 6	OFF	ON	ON	OFF	LED Power (+5V)
ID 7	ON	ON	ON	OFF	LED Power (+5V)
ID 8	OFF	OFF	OFF	ON	LED Power (+5V)
ID 9	ON	OFF	OFF	ON	LED Power (+5V)
ID 10	OFF	ON	OFF	ON	LED Power (+5V)
ID 11	ON	ON	OFF	ON	LED Power (+5V)
ID 12	OFF	OFF	ON	ON	LED Power (+5V)
ID 13	ON	OFF	ON	ON	LED Power (+5V)
ID 14	OFF	ON	ON	ON	LED Power (+5V)
ID 15	ON	ON	ON	ON	LED Power (+5V)

Remote Busy and Fault Displays

Busy and Fault status of the drive can be monitored remotely by connecting a remote (external) Busy and/or Remote Fault display LEDs to the appropriate pins on the 13-pin Option Connector or the 28-pin Secondary Option Connector.

Remote Busy LED on the 13-pin Option Connector Connect the cathode side of the remote Busy LED to pin 8, Busy LED. Connect the anode side of the LED to pin 11, +5V.

Remote Busy LED on the 28-pin Secondary Option Connector Connect the cathode side of the remote Busy LED to pin 16, Busy LED. Connect the anode side of the LED to pin 17, +5V.

Remote Fault on the 13-pin Option Connector Connect the cathode side of the remote Fault LED to pin 2, Fault LED. Connect the anode side of the LED to pin 11, +5V.

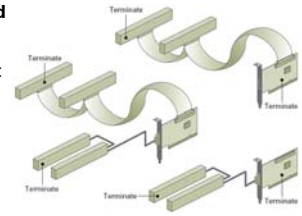
Remote Fault on the 28-pin Secondary Option Connector Connect the cathode side of the remote Fault LED to pin 8, Fault LED. Connect the anode side of the LED to pin 17, +5V.

Logical Unit Numbers (LUNs)

- SCSI supports more than one device per SCSI ID using **Logical Unit Numbers (LUNs)**
 - Up to seven subunits per ID number
 - Used primarily in hard-drive arrays, which create one large logical drive out of several smaller physical drives with NetWare, NT, 2000, and UNIX servers

Termination

- **Terminators** are used to prevent the echo, which is generated when a signal is sent down a wire
- **Pull-down resistors** are usually used as terminators
- **Only the ends of the SCSI chains** need to be terminated
- Most manufacturers build SCSI devices that self terminate



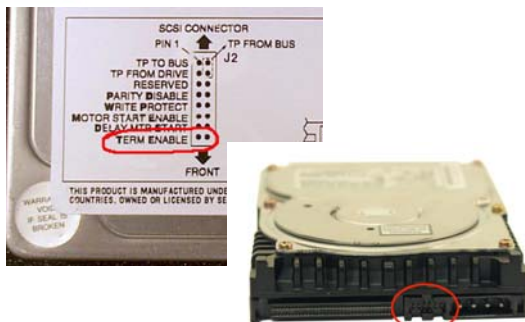
Termination

- Some devices sense that they are on the end of a SCSI chain, and automatically terminate themselves
- Most devices require you to set a jumper or a switch to enable termination
- Some host adapters have termination set through software
- **Care should be taken when terminating SCSI hard drives, because improper termination can damage them**

SCSI Zip Drive



Termination Using Jumpers



Removable Terminating Resistors



Software Termination



SCSI Flavors

SCSI-1

- The **SCSI-1** standard defined an 8-bit, 5 MHz bus, capable of supporting up to eight SCSI devices (including the host adapter)
 - Early SCSI devices had their own command sets, due to lack of an operating standard, and no two command sets were the same
 - SCSI-1 devices transferred data only through 8-bit parallel paths, but supported up to seven devices on the chain
 - Preceded by Shugart Associates System Interface (SASI) in 1979
 - SCSI-1 in 1986

SCSI-2

- The **SCSI-2** standard (July 1990) was detailed and addressed a large number of issues
 - Set of 18 commands called the **common command set (CCS)** that enabled hooking up devices from different manufacturers
 - Included a command queuing feature that enabled a SCSI device to store multiple incoming commands

SCSI-2

- **SCSI-2** also defined the type of connectors to be used
 - Any two SCSI-2 compliant devices could be physically connected
- **SCSI-2** defined two optional 16-bit and 32-bit buses called **wide SCSI**, and a new, optional 10 MHz speed called **fast SCSI**
 - 32-bit buses were expensive, so wide SCSI usually means a 16-bit bus

SCSI-2: Standard and Fast

	Standard SCSI vs. Fast SCSI	
SCSI Type/Bit Width	5 MHz (Standard)	10 MHz (Fast)
SCSI-1: 8-bit	5 MBps	N/A
SCSI-2: 8-bit	5 MBps	10 MBps
SCSI-2: 16-bit (wide)	10 MBps	20 MBps
SCSI-2: 32-bit (wide)	20 MBps	40 MBps

SCSI-2 uses fast synchronous mode for transfers, so requests do not have to be acknowledged. This will help to double the speed.

SCSI Communication

- **Single-ended (SE)**
 - Communicates through one-wire per bit of information
 - Vulnerable to common-mode noise from electrical power cables
 - Limits the total length of the SCSI chain to about six meters
- **Low Voltage Differential (LVD)**
 - Uses less power and is compatible with existing devices
 - Up to 12 meters total length for chain

SCSI Communication

- **High Voltage Differential (HVD)**
 - Employs two wires per bit of data
 - One wire is for the data and one for the inverse of the data
 - By taking the difference of the two signals, the device could reject common mode noise, allowing for a SCSI chain of up to 25 meters
 - Under no circumstances should a SE and HVD device be connected on the same SCSI chain – unless you like smoke!

SCSI-3

- **SCSI-3 devices have many names and technologies, such as Ultra 2 or Wide Ultra**
 - Interfaces for various types of serial SCSI, including **Firewire**
 - Wide SCSI can control up to 16 devices on one chain
 - Hot swap capabilities

SCSI-3: Narrow & Wide Speeds

Narrow SCSI-3 vs. Wide SCSI-3			
SCSI Type	Bus Speed	8-Bit (Narrow)	16-Bit (Wide)
Ultra SCSI (Fast-20)	20 MHz	20 MBps	40 MBps
Ultra2 SCSI (Fast-40)	40 MHz	40 MBps	80 MBps
Ultra3 SCSI (Fast-80)	80 MHz	80 MBps	160 MBps

Termination types

- **Termination can be of four types depending upon the type of SCSI chain**
 - **Passive**
 - Uses resistors
 - Used on older 8-bit SCSI devices
 - **Active**
 - Uses voltage regulators in order to have a tighter tolerance on voltage and impedance
 - Used on fast/wide SCSI devices
 - **Forced Perfect Termination (FPT)**
 - Uses diodes to have an even finer control over voltage
 - **LVD termination**
 - Uses a special type of active terminators

Serial SCSI

- **Serial SCSI** means transferring SCSI commands over a single wire (SCSI is generally a parallel interface)
 - IEEE 1394
 - Serial storage architecture (SSA)
 - Fiber channel
 - Long cable runs, hot swapping, and a relatively low cost

Serial SCSI Cabling Standards

Current Parallel SCSI Picture (Courtesy of the SCSI Trade Association—//www.scsta.org)

SCSI Trade Association Terms	Bus Speed (Mbps)	Bus Width (bits)	Maximum Bus Lengths, Meters ¹			Maximum Device Support
			SE	LVD ²	HVD ³	
SCSI-1 ⁴	5	8	6	*	25	8
Fast SCSI ⁵	10	8	3	*	25	8
Fast Wide SCSI	20	16	3	*	25	16
Ultra SCSI ⁶	20	8	1.5	*	25	8
Ultra SCSI ⁷	20	8	3	—	—	4
Wide Ultra SCSI	40	16	—	*	25	16
Wide Ultra SCSI	40	16	1.5	—	—	8
Wide Ultra SCSI	40	16	3	—	—	4
Ultra2 SCSI ⁸	40	8	*	12	25	8
Wide Ultra2 SCSI ⁹	80	16	*	12	25	16
Ultra3 SCSI or Ultra160 ¹⁰	160	16	*	12	5	16
Ultra320 ¹¹	320	16	*	12	5	16

¹ The listed maximum bus lengths may be exceeded in Point-to-Point and engineered applications.
² Use of the word "narrow" preceding SCSI, Ultra SCSI, or Ultra2 SCSI is optional.
³ LVD was not defined in the original SCSI standards for this speed. If all devices on the bus support LVD, 12 meter operation is possible at this speed. However, if any device on the bus is single-ended only, the entire bus switches to single-ended mode and the distances in the single-ended column apply.
⁴ Single-ended is not defined for speeds beyond Ultra.
⁵ HVD (Differential) is not defined for speeds beyond Ultra2.
⁶ After Ultra2 all new speeds are wide only.

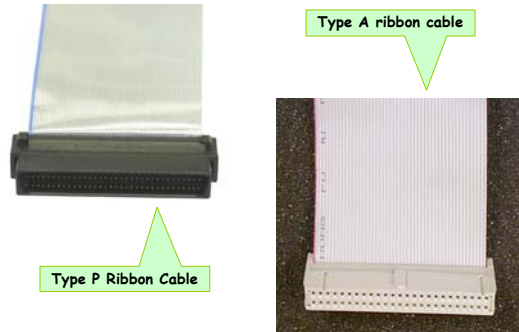
Bus Mastering

- A SCSI tape drive and SCSI hard drive connected to the same host adapter can use bus mastering to communicate with each other directly
 - The host adapter remains in the circuit only long enough to arbitrate the connection between the drives
 - Once the connection is made, the two devices are not consuming any system resources

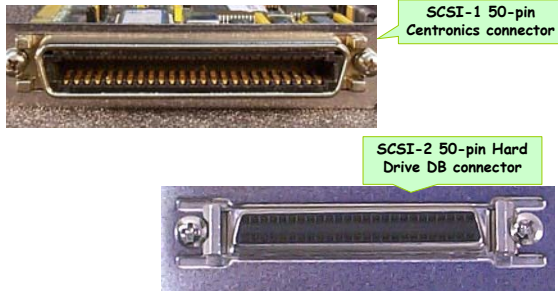
SCSI Cables and Connectors

- **Type A SCSI cable**
 - 50-wires
 - Eight-bit data transfers
 - SCSI-1, SCSI-2, 8-bit fast SCSI-2
- **Type B cable**
 - 68 wires
 - Used in parallel with the A cable in the early days of SCSI-2 (requiring two cables)
- **P type cable**
 - 68 wires
- **D type cable**
 - 80 wires
 - Hot swapping

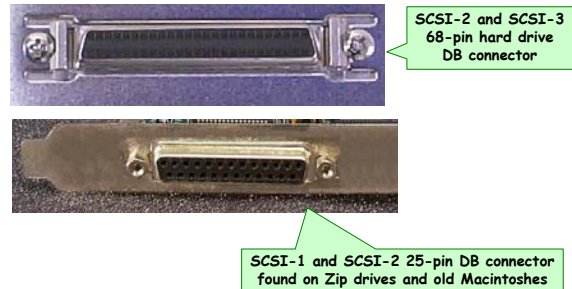
Internal Connections



External Connectors



External Connectors



ASPI

- **BIOS (Basic Input/Output Services) is software that allows the CPU to talk to the hardware**
 - Can be hard-wired into the motherboard (system BIOS)
 - Hard-wired into the device (ROM chip)
 - Device driver
- **The ROM chip on a SCSI host adapter only knows how to talk to hard drives**
- **Advanced SCSI Programmer Interface (ASPI)** mandates a standard way to write BIOS device drivers for other SCSI devices
 - Standardized set of device drivers for all SCSI devices

SCSI Performance

- **SCSI is a bus-mastering device**
- **A PCI SCSI host adapter supports transfer speeds up to 132 Mbps**
 - An IDE SCSI card doesn't speed things up much

Compatibility

- **Devices communicating using LVD (Low Voltage Differential) and SE (Single Ended) can be mixed on a SCSI chain, but it lowers performance**
- **IDE and SCSI drives can be mixed in a single system**
 - IDE drives get logical drive letters first unless you can change it in the BIOS

Troubleshooting SCSI

Power and Connectivity

- **As the host adapter initializes a list of all the SCSI devices will be shown**
 - If a device is not on the list, suspect a power or connectivity issue
 - Power is required so check the power cords whether internal or external
 - Connectivity issues include proper termination, proper cabling, and unique SCSI IDs

Boot Firmware and Memory Chips

- **Boot Firmware**
 - Check the settings in CMOS or the SCSI ROM BIOS if you do not see a SCSI scan during booting
- **Memory chips**
 - Usually more than SCSI devices will be affected

Storage, I/O, & Device Drivers

- **Storage**
 - Same issues as IDE such as partitioning, formatting, defragmentation
- **I/O**
 - Many adapters store resource settings (IRQs...) on an onboard chip, so a power surge could set them back to defaults
- **Device drivers**
 - Some do not work well together

Cost and Benefits of SCSI

Cost and Benefits

- **SCSI is ideal for the following:**
 - File servers
 - Workstations
 - Multitasking systems
 - Any system moving large amounts of data among peripheral devices
 - Any system with a large number of peripherals
 - Any system requiring fault tolerance

Cost and Benefits

- **As the initial cost of SCSI is higher, and the devices expensive, the following questions should be answered to determine the need for SCSI:**
 - Is this a graphics/CAD workstation?
 - Is this a network file server?
 - Is this a stand-alone machine frequently running multitasking applications?

SCSI vs. EIDE

- **Data throughput for EIDE has increased to as fast as 133 MBps**
- **SCSI-3 supports a data transfer rate of 360 MBps**
- **SCSI's bus mastering capability makes it ideal for data intensive operations**
- **SCSI remains the high performance interface choice for external devices that are not hard drives**

SCSI vs. EIDE

- **Higher end parallel SCSI supports up to 15 devices on a single controller**
- **Serial SCSI standards support more**
- **SCSI is the best option for servers that require a huge data storage capacity**

New Development

- **Serial-Attached SCSI (SAS)**
 - Point-to-point interface
 - Smaller cable
 - Reduced power consumption
 - Enterprise-level storage solution
 - 1.5 GBps
- **For more information about SCSI**
 - SCSI Trade Association: www.scsita.org
 - T-10: www.t10.org
 - Paralan Corporation: www.paralan.com
 - [Good SCSI glossary](#)