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Macintosh: Connecting SCSI Devices (4/96)

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TOPIC -----

SCSI (pronounced SKUH-zee) stands for Small Computer System Interface. It is a standard method for connecting computers and peripheral devices like hard disk drives, CD-ROM drives, printers, and scanners. SCSI ports, cables, and terminators are usually labeled with the SCSI icon which looks like a diamond-shaped G.

This article covers the following topics:

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DISCUSSION -----

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OVERVIEW
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The Connection
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Most storage devices, such as hard drives, CD-ROM drives, Bernoulli and SyQuest drives, rewriteable optical drives, and tape drives, are connected to the Macintosh using SCSI. Other SCSI peripherals include scanners and some printers. The 25-pin port is located on the back of your desktop Macintosh. You can recognize the SCSI port by the diamond-shaped SCSI icon above it. (On PowerBook models the port is a 30-pin square connector.) Peripheral devices typically have a 50-pin Centronics connector on them (it is longer and wider than the SCSI port on your Macintosh).

Your Macintosh can have a total of seven SCSI devices connected to it (the Workgroup Server 95 can have up to 20 devices). If you have System 7.5 and use the SCSI Manager 4.3, you can have up to 14 SCSI devices, 7 per bus on the Quadra 900 and 950 and the Power Macintosh 8100/8150/9150. Internal hard drives, internal CD-ROM drives, and other internal storage devices are included in this limit of seven devices. This does not include floppy drives, which are not SCSI devices.

Basic Vocabulary =====

Terms You Need to Know:

SCSI bus -----

The electronic path on which data travels.

SCSI device -----

A computer or peripheral that can communicate on a SCSI bus. A SCSI device can be internal (such as an internal hard drive) or external (such as an external hard drive, printer, CD-ROM drive, or scanner).

SCSI chain -----

A series of SCSI devices connected by SCSI cables. A SCSI chain can have up to seven SCSI devices.

SCSI ID number -----

A number from 0-7 used by the computer to identify and distinguish between SCSI devices. The SCSI ID identifies each device no matter where it is physically connected in the SCSI chain. The SCSI ID number also determines which one goes first when devices compete for the use of the SCSI bus. The higher the number, the higher the priority on the SCSI bus. Though since the Macintosh is the only device "competing" for the bus, the ID number as a priority is basically irrelevant.

SCSI terminator -----

A piece of hardware that acts as a resistor to reduce interference along the SCSI bus. SCSI devices chained together form an electronic signal path. At the

end of the path, signals tend to "bounce" back up the SCSI path and cause interference. This interference can cause problems with your Macintosh and/or one or more of your SCSI devices.

SCSI Termination =====

The most important thing to understand about using SCSI devices is proper termination. SCSI devices chained together form an electronic signal path. At the end of the path, signals tend to bounce back up the SCSI path and cause interference. This interference can cause problems with your Macintosh and/or one or more of your SCSI devices.

Terminating a SCSI bus preserves high transmission speeds, and if the terminator is properly placed, cleans up the signal along the entire length of the line. Terminators also provide a reasonable degree of electrical noise immunity. The most important reason to terminate a SCSI bus is that termination is required for the bus to work! A bad signal anywhere on the chain can cause all of the SCSI devices, in some cases the Macintosh itself, not to function properly.

Terminator Types =====

Physically, terminators generally take three forms. Electrically, these types of terminators are equivalent and vary only in where and how they are installed.

On-Device Terminators -----

These are known as resistor packs (or sips or dips). You only remove them to add a second drive or to add a drive to a system where the mother board is terminated. They reside on the SCSI device itself and are almost always removable. Always note the orientation of the resistor packs before attempting to remove them! They are polarized and must not be inserted backwards. Some newer drives have resistors permanently mounted on the drive. On these drives, there is a jumper to enable or disable termination.

External Terminator Blocks or Plugs -----

These are short plug-like devices and are inserted between an external hard drive's SCSI connector and the SCSI cable, or on the second connector if one exists. Don't confuse these with the ON-DRIVE terminators. ON-DRIVE literally means on the drive mechanism -- not on the external connector. Never use the external terminator when the drive inside a cabinet has terminators installed on it.

Main logic board terminators -----

These may look like a SIMM or a narrow plug. They are used only when there is no internal hard drive in the Macintosh. Main logic board terminators are inserted into the 50 pin SCSI connector on the Macintosh main logic board where the cable for an internal drive would normally connect. These main logic board terminators

are keyed (a polarity notch) and must never be inserted backwards!

The Quadra 800/900/950 have a terminator on the internal drive cable itself. This means that internal SCSI devices should not be terminated.

Switched Termination

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Some SCSI peripheral vendors also use switched termination. This means they have a type of switch that controls whether or not the device is terminated. The terminator is actually one of the first two types mentioned, but is controlled electronically via a switch.

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THE SCSI CHAIN

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Making the SCSI Chain Work

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There are several key points you need to keep in mind to make sure that all of your SCSI devices work correctly:

Keep connected SCSI devices powered while your Macintosh is on

Even if you do not plan to use a device, you still must power it on. This ensures a proper SCSI signal path. It is okay to power the devices on at the same time as your Macintosh, but some devices need to be powered on before your Macintosh, consult the manual that came with your SCSI device.

Only terminate the first and the last device

In most cases, only the first and last SCSI device should be terminated. If the Macintosh has no internal hard disk drive (or other SCSI device) installed, then a main logic board terminator should be installed. Macintosh computers sold without internal hard drives include this terminator, and many third party hard drive vendors sell them if you need one. If there is not an internal SCSI device, and if there is not an internal terminator present, then the first external device should be terminated.

There are a few exceptions. If the bus is short (generally 18 inches or less) then it is best to terminate just one end. Also, if the total cable length between all devices is greater than 10 feet, the cable might need to be terminated at the 10 foot point in addition to each end. When daisy chaining three or more SCSI devices, the total bus length often exceeds the 10 foot specification and may require three terminators in the chain to work properly. Do not add the third terminator unless you are having problems and you've checked all other possible causes.

Never terminate the same device twice

Some devices which supply termination power (TERMPWR) to the SCSI bus can cause problems if they are used on the internal bus of the Power Macintosh 8100/8150/9150. Any drives attached to this bus should be configured with TERMPWR disabled, regardless of whether they are terminated or not.

Only use a black terminator where specified

The black terminator should only be used when a Macintosh IIcx is the host Macintosh and for connecting hard drives to the LaserWriter IIx/IIg and the LaserWriter Pro 630. This black terminator differs (electrically) only slightly from the gray terminator; it does not differ physically other than color. Its purpose is to compensate for some changes in the SCSI chip used in these devices.

Always use high quality cables

Use cables that are double-shielded (foil and braid), such as Apple SCSI cables. Never use simple printer type RS232 cables, which are commonly used with DOS/Windows printers. Make sure the connector hoods (or shrouds) are each connected to the shield braid. Poor quality cables are often the cause of seemingly mysterious SCSI problems.

Keep total length of all cables used under 20 feet

A longer SCSI chain is susceptible to interference and possible data loss or corruption. Keeping the length under 20 feet maximizes signal integrity.

Keep cables between devices as short as possible

Generally 18 to 24 inches is best, but never exceed 6 feet or you will most likely have problems. PowerBook computers, some scanners, and possibly other devices refuse to work with cables over 24 inches in length.

Avoid mixing brands, types, or styles of cables

Each cable has a different type of construction, impedance, and wire placement, which can result in bus reflections. In mixed cable configurations some devices may simply not work even if all other guidelines are followed.

Check all SCSI devices have a unique SCSI ID number

A number from 0-6 is used by the Macintosh to identify and distinguish between SCSI devices. The number 7 is always reserved for the Macintosh itself. Other devices include a factory set default, as this table indicates:

Begin_Table

ID	DEVICE
0	Commonly used for an internal hard drive, if present
3	External Apple CD-ROM drives
3	Internal Apple CD-ROM drives
5	Apple scanners

8 & 9 Always invalid number selections but may appear as options on some third party devices

End_Table

If two devices have the same ID number, one or both may not start up, or they may damage files if they try to send data at the same time. Device manufacturers use many ways to set the SCSI ID number, including thimble, push switch, DIP switches, jumpers, and software. Check each device's documentation to see how to set its ID.

Power off all devices prior to changing SCSI chain configuration

Always turn off the Macintosh and all peripherals before attaching or detaching any cables or devices or changing SCSI ID numbers. Doing otherwise could cause permanent physical damage to your computer or SCSI devices as well as the loss of important data. Attach the proper cables to their devices. Use the thumbscrews and metal clamps on the cables to maintain a tight, reliable connection. Do not over-tighten.

Use the same driver software for all storage devices

If you have several storage devices from different vendors, you may encounter driver-level conflicts. Since device drivers load into memory when the Macintosh is turned on, they can generate conflicts similar to INIT or extension conflicts. To eliminate these conflicts, you should reformat all of your SCSI storage devices with the same formatting software. Apple's formatting software, Apple HD SC Setup, only works with devices sold by Apple, so this isn't usually an option. However, there are several third parties that make "universal" formatters (such as Drive 7, Hard Disk Tool Kit, and Silverlining) that format most of the storage devices available for the Macintosh.

SCSI Manager 4.3

SCSI Manager 4.3 adds several new features to the SCSI architecture of the Macintosh. These features include SCSI 2 compliance, concurrent asynchronous I/O, and disconnect and reconnect. These new features can improve the performance of the SCSI bus. SCSI Manager 4.3 is supported on all Power Macintosh, and 68040 Macintosh computers, except for the Macintosh 630 family and 68040 PowerBook.

SCSI Manager 4.3 is part of the ROM in all Power Macintosh and Quadra AV computers. Other 68040 Macintosh computers require the SCSI Manager 4.3 system extension.

Make a bootable floppy for testing

Since System file corruption and extension conflicts can cloud the troubleshooting process, it is a good idea to make a bootable floppy to test SCSI problems. Configure the start-up disk with minimal drivers and extensions.

Check the drive with a utility

Use Apple's Disk First Aid or another utility to verify the integrity of a SCSI storage device. You will likely have to start your Macintosh from a different drive than the one you are checking to repair it if problems are found. The Disk Tools or Utilities floppy disk or startup CD that you received with your Macintosh can be used.

When troubleshooting, isolate devices

If you have followed all the rules without success, start to isolate devices. See if each one individually works correctly. If it does, then start to build the SCSI chain one device at a time. There may be a specific bad device, cable, terminator, connector, or software driver causing the problem.

Reformat the storage device

Corrupt drivers cannot usually be detected by diagnostic utilities. If you are unable to get a particular device to work by itself, reinstalling the driver (Update in Apple HD SC Setup) will often help. In rare cases you may wish to consider reformatting to be sure the driver is good.

Setting up a SCSI Chain

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Setting up a chain of SCSI devices consists of:

- Setting SCSI ID numbers (also called SCSI addresses).
- Connecting SCSI cables.
- Terminating the SCSI chain.

Setting SCSI ID Numbers

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This takes three steps:

Step 1

Make sure your Macintosh and all SCSI devices are powered OFF. SCSI IDs should never be changed with the devices on.

Step 2

Check all SCSI devices on the SCSI chain to make sure that each has a unique SCSI ID number. (The Macintosh is always 7, so that it has the highest priority; an internal hard drive, if present, is usually 0.) Do not set duplicate numbers. If two devices have the same ID number, one or both may not start up, or they may damage files if they try to send data at the same time.

Step 3

Reset the SCSI ID numbers if necessary. There are four methods that device manufacturers use to set the SCSI ID number: thumb wheel, switch, DIP switches, or software.

Connecting SCSI Cables =====

There are three types of SCSI cables:

- System cable (Macintosh to SCSI device)
- Peripheral interface cable (SCSI device to SCSI device)
- Cable extender (extends the SCSI cable length)

Follow these steps to connect your SCSI cables:

Step 1

Identify your cables before beginning.

Step 2

Turn off the computer and all peripherals before attaching cables and/or devices.

Step 3

Attach the proper cables to their devices. Use no more than 20 feet of cable; otherwise, SCSI signals deteriorate, causing unreliable operation. Use the metal clamps and thumbscrews on the cables to maintain a tight, reliable connection. Do not over tighten.

Terminating the SCSI Chain =====

Improper termination can cause damage to SCSI circuits inside your Macintosh, corrupt files, keep your Macintosh from starting up, and/or cause intermittent failures.

Choose the correct terminator type

Terminators are of two colors: gray and black. Use the gray one when any Macintosh except the Macintosh IIx is used. Use the black one when a Macintosh IIx is used.

The black terminator is also used when connecting a hard drive to some Apple LaserWriter printers. Consult your printer manual to verify which terminator you should use. Currently only the LaserWriter IIx/IIg and the LaserWriter Pro 630 require the black terminator.

Turn off the computer and all peripherals before changing terminators

The risk of damaging either the peripheral or the host computer is quite high if termination is changed while either device is powered on.

The Macintosh has an internal hard drive

If the Macintosh in the SCSI chain DOES have an internal hard drive, terminate only the other end of the SCSI chain. (All Apple internal SCSI hard drives have built-in terminators).

The Macintosh does not have an internal hard drive

If a Macintosh in the SCSI chain DOES NOT have an internal hard drive and DOES NOT have a terminator on the internal ribbon cable or on the logic board, terminate both ends of the SCSI chain.

Peripheral SCSI Chain Needs Its Own Termination

If you have a hard drive connected to a printer (to store fonts for example) which is connected to your Macintosh computer through LocalTalk or some other network connection, that hard drive is on a separate chain from the SCSI port on your Macintosh computer. Therefore, the hard drive connected to your printer must have its own termination. The terminator on your Macintosh computer's SCSI chain will not terminate this completely separate chain.

The Macintosh has a third party SCSI device

If you have a third-party (non-Apple) SCSI device, check the manual to find out if it is internally terminated. If the device is not internally terminated, follow the directions in the 2nd, 3rd, and 4th items directly above under the section "Terminating the SCSI Chain."

If the SCSI device is internally terminated, you have two choices:

- Put the device at the end of the SCSI chain
- Remove the termination from the device

(Check the device's manual to find out if termination can be removed, and, if so, how it is done.)

Hints and Help

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Set Higher Priorities to Startup Devices

In general, assign the higher priorities to startup devices. For example, an external hard drive that is used as the startup disk should be set to number 6 or 5.

Set Lower Priorities to Seldom Used Devices

After assigning priorities to startup devices, set other ID numbers according to

how often they are used. For example, a tape backup that is only used occasionally should be set to a lower numbers, such as 2 or 1.

Use Factory Settings as a Guideline

Use the factory settings as a guideline for setting SCSI ID number priorities. For example, if you have a SCSI device that has an ID number of 1, but you already have a device using this number, set it to another low number, such as 2 or 3.

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POWERBOOK REQUIREMENTS

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All the preceding rules apply to PowerBook computers. In addition, some PowerBook computers may require special attention. Consider these points:

PowerBook computers do not supply termination power

Using a terminator may keep the PowerBook from either booting, or seeing the external SCSI device. Depending on the device, you may or may not need a terminator. This depends on whether the device supplies termination power. If you use a terminator, be sure you place it at the very end of the SCSI chain.

Termination is supplied by the internal hard drive

PowerBook computers depend on the internal hard drive to supply termination so that they are properly terminated when placed in SCSI disk mode. In SCSI disk mode the PowerBook is just another hard drive in the SCSI chain because all other subsystems have been shut down. Therefore, when a PowerBook is in SCSI disk mode, it should be the last device in the SCSI chain.

Only one PowerBook can be in SCSI disk mode on a SCSI bus

If you have two PowerBook computers and other devices on the chain, one PowerBook must be the very last device in the SCSI chain (in SCSI disk mode) and the second PowerBook must be at the beginning of the chain. In this situation, one PowerBook is the CPU and the other is in SCSI disk mode.

PowerBook SCSI cables are different

Note the difference between the disk adapter cable (used only for SCSI disk mode) and the system cable (used to connect external devices to the PowerBook). The only true difference between these two cables is an extra pin in the adapter cable, which triggers SCSI disk mode in the machine.

Not all PowerBook computers support SCSI disk mode

Consult your owners manual to determine if yours does. As of this writing, all PowerBook computers except the 140, 145, 145B, 150, and 170 support SCSI Disk Mode.

APPLE CABLE PART NUMBERS

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SCSI System Cable, M0206

HDI-30 SCSI System Cable, M2538LL/A

HDI-30 SCSI Disk Adaptor Cable, M2539LL/A

SCSI Peripheral Interface Cable, M0207

SCSI Cable Extender, M0208LL/B

SCSI Cable Terminator, M3503LL/A

SCSI Cable Terminator II (black), M5871G/A

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WHERE TO GET MORE INFORMATION

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Macintosh Reference

(System 6.0.x) by Apple Computer, Inc. (030-4015-A)

Macintosh Reference

(System 7.0) by Apple Computer, Inc. (030-3934-A)

Macintosh Technical Note #273

SCSI Termination Available on AppleLink via this path: Developer Services:
Developer Tech Support: Developer Essentials: Technical Documentation: Macintosh
Technical Notes

Macintosh Technical Note #271

Macintosh IIfx: The Inside Story Available on AppleLink via this path:
Developer Services: Developer Tech Support: Developer Essentials: Technical
Documentation: Macintosh Technical Notes

"Understanding SCSI"

Macintosh Service Course Prerequisite Manual-Vol. 2 by Apple Computer, Inc.
Available through the Macintosh Service Course

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