C H A P T E R 7

# IEEE 1394

This chapter presents the requirements and recommendations for IEEE 1394 under the Microsoft Windows family of operating systems.

Version 1.1
Includes changes to items 2, 3, 6, 6a, 8, 9, References for IEEE 1394, Checklist for IEEE 1394, as previously published in the PC 97 FAQ on http://www.microsoft.com/hwdev/pc97.htm and the PC 97 OnNow Requirements on http://www.microsoft.com/hwdev/desguid/onnowpc97.htm

**Contents**

# Overview for IEEE 1394

This section summarizes the basic design requirements for the approved IEEE 1394−1995 standard. The IEEE 1394 high-speed serial bus provides enhanced PC connectivity for a wide range of devices, from consumer audio/video (A/V) components to traditional PC storage devices including PCs and hand held devices.

IEEE 1394 has been widely adopted by the consumer electronics industry and provides a low cost, Plug and Play-compatible expansion interface for the PC. Although the 400 megabit per second (Mb/s) transfer rate for IEEE 1394 is well suited to multi-streaming I/O demands, a proposal for 800 Mb/s is in development.

The following summarizes the IEEE 1394 design issues related to Windows, as addressed in this chapter.

- Compliance with approved IEEE 1394−1995 standards.
- Plug and Play support for device configuration, device Command and Status Registers (CSRs), connectors and cabling, and connection fault handling.
- Cable power distribution, including requirements for source devices and sink devices, self-powered devices, plus configuration ROM entries and CSRs.
- Device power management, including CSRs and soft power protocols.
- Device command protocols for Audio, Imaging, and Storage device classes.
- Support for the Open Host Controller Interface (OpenHCI) for IEEE 1394. This provides a common device programming model with a script-based control interface and low interrupt count.

# IEEE 1394 Basic Requirements

This section summarizes the basic design requirements for IEEE 1394, including specifications and standards.

### 1. Devices and controllers support IEEE 1394 standards

*Required*

Designs that interface to the IEEE 1394 high-speed bus must support the following industry standards and supplemental specifications:

- IEEE 1394–1995

All devices must comply with the bus architecture and hardware interface specifications specified by the defining standard for the IEEE 1394 high-speed serial bus.

- IEEE 1212–1991 Control Status Register Format (ISO/IEC 13213: 1994)

To ensure interoperability, all devices must comply with IEEE 1212 memory-mapped control and status register specifications as supplemented by the "1394 Plug and Play Design Reference" (described later in this chapter).

### 2. Controllers comply with OpenHCI for IEEE 1394

*Required*

*Version 1.1 Change:*
*Recommended*

The Open Host Controller Interface (OpenHCI) for IEEE 1394 specifies the programming interface for host connection hardware, ensuring base silicon and software driver support required for add-on devices and PC system board integration. OpenHCI for IEEE 1394 specifies basic capabilities required for the PC that uses IEEE 1394.

**Version 1.1 Change:**

Because the dates for completion of specifications and operating system support do not allow for timely implementation of support by vendors, this item is recommended rather than required.

Compliance testing is expected to begin either July 1, 1998 or January 1, 1999 for this requirement. For information about compliance dates for this IEEE 1394 requirement, see the PC 98 FAQ on http://www.microsoft.com/hwdev/pc98.htm. (Change date: June 3, 1997; June 12, 1997; September 11, 1997)

### 3. Devices comply with IEEE 1394 electrical isolation requirements

*Required*

*Version 1.1 Change:*
*Recommended*

Self-powered devices with their own AC power supply must provide electrical isolation between the local device ground reference (green wire) and the bus cable

power signals as specified in Annex A of IEEE 1394−1995. This isolation is required to avoid excessive currents resulting from ground fault potential between one or more devices, particularly for buses configured in a local area network.

Isolation is typically provided in the device power supply or by AC coupling of the PHY and Link interface, Annex J of IEEE 1394−1995. Isolation is not required for devices that do not supply their own local ground reference (green wire).

**Version 1.1 Change:**
This is no longer a requirement because this reference has been targeted for removal from the IEEE standard. The related design problem can be solved by building isolation into the power supply if needed. In most cases, even with a greenwire power plug, isolation is unnecessary. (Change date: October 15, 1996)

**4. Devices and PCs requiring high-bandwidth support use IEEE 1394**
*Recommended*

For devices that need support for high-speed, high-bandwidth data transfers and enhanced Plug and Play connectivity, the recommended bus is IEEE 1394. Such devices include the following:

Component audio
Digital camcorder
Digital still cameras
Digital VCR
Digital TV
PC docking stations
PC system boards
PCI add-on cards
Hard disk drives
DVD
Set-top controllers for TV
Video conferencing cameras
High-resolution scanners and printers

**5. Support peak data rate of 400 megabits per second, minimum**
*Recommended*

Although 400 Mb/s is significantly higher than current PC storage I/O data rates (IDE at 132.8 Mb/s; fast SCSI at 160 Mb/s), today's magnetic disk media rates of 80 Mb/s are forecasted to double every three years. By 1998, 200 Mb/s of the IEEE 1394 bus bandwidth must be available for PC system disk I/O and asynchronous device control. Thus, 400 Mb/s bus bandwidth is required to effectively support multistreaming audio/video applications such as MPEG-2 at 6 Mb/s and DVC Standard Definition at 3.5 Mb/s concurrent with PC storage I/O.

Further, a 200-Mb/s device with a 160-Mb/s data stream will require 80 percent bus utilization, effectively lowering overall bus bandwidth to 200 Mb/s for 80 percent of the time. Therefore, low bus utilization is required for 100- and 200-Mb/s devices to effectively coexist with 400-Mb/s PC peripheral devices. For example, three devices performing at 200-Mb/s with 30-percent bus utilization will saturate the bus. recommended design targets for devices with less than 400-Mb/s bandwidth is to limit peak bus utilization to less than 30 percent.

Also, application bandwidth can be limited by speed traps (a slow device separating two faster devices), imposing speed-dependent cabling considerations for the end user. For these reasons, 400-Mb/s devices are strongly recommended for IEEE 1394 PC applications.

**Version 1.1 Change:**

Because the dates for completion of specifications and operating system support do not allow for timely implementation of support by vendors, this item is recommended rather than required.

Compliance testing is expected to begin either July 1, 1998 or January 1, 1999 for this requirement. For information about compliance dates for this IEEE 1394 requirement, see the PC 98 FAQ on http://www.microsoft.com/hwdev/pc98.htm. (Change date: June 3, 1997; June 12, 1997; September 11, 1997)

### 6. PHY supports Fast Incremental Reset

*Required*

*Version 1.1 Change:*
*Recommended*

The IEEE 1394.1 project is chartered to define a PHY layer protocol to reduce bus off-time following a bus reset condition. All Windows-compatible devices are required to support this protocol to minimize interruption of isochronous A/V streams.

**Version 1.1 Change:**

Because the dates for completion of specifications and operating system support do not allow for timely implementation of support by vendors, this item is recommended rather than required.

Compliance testing is expected to begin either July 1, 1998 or January 1, 1999 for this requirement. For information about compliance dates for this IEEE 1394 requirement, see the PC 98 FAQ on http://www.microsoft.com/hwdev/pc98.htm. (Change date: June 3, 1997; June 12, 1997; September 11, 1997)

**Version 1.1 Addition:**

### 6a. IEEE 1394 connectors use IEEE 1394 icon

*Required*

Because the location and number of ports for IEEE 1394 can be variable, the need for appropriate icons on both ports and cables will be important ease-of-use factors for these new external expansion connections. For PC 97, therefore, icons for USB are required for the following:

- External devices
- Connecting cables
- Connection port

Compliance testing for this requirement began **October 1, 1997.** (Change date: April 7, 1997)

# Plug and Play for IEEE 1394 Devices

This section summarizes the Plug and Play requirements for IEEE 1394 peripheral devices and PC host controllers.

**7. Devices and controllers comply with "1394 Plug and Play Design Reference"**

*Required*

This specification outlines device requirements necessary to ensure dynamic configuration while eliminating fault conditions associated with unsupervised connection of devices to the IEEE 1394 bus. It provides details about the Device Configuration ROM, Global Unique identifier (GUID) for device detection and driver loading, and configuration of power-independent connectors and cabling.

# Power Specifications for IEEE 1394 Devices

All devices on the IEEE 1394 bus must comply with the power management requirements outlined in this section.

**8. Devices and controllers comply with Specification for Cable Power Distribution, from IEEE 1394 Trade Association**

*Required*

*Version 1.1 Change:*
*Recommended*

The Cable Power Distribution model for IEEE 1394 makes it easy to implement devices that serve as the source or consume cable power by defining specific requirements for power source, power sink and self-powered devices. This model reduces cabling constraints for end users while helping to ensure power availability for both managed and unmanaged IEEE 1394 environments. The power distribution model makes it easy to use cable power by reducing the likelihood of power-fault conditions while ensuring device interoperability and power-independent cabling.

The power distribution model also helps to provide a Plug and Play-compatible cabling environment for both managed and unmanaged power environments. Requirements in this specification enable unmanaged default configurations to function. Alternately, these requirements enable managed environments with an active PC bus manager to provide an enhanced Plug and Play experience.

**Version 1.1 Change:**

Because the dates for completion of specifications and operating system support do not allow for timely implementation of support by vendors, this item is recommended rather than required.

Compliance testing is expected to begin either July 1, 1998 or January 1, 1999 for this requirement. For information about compliance dates for this IEEE 1394

requirement, see the PC 98 FAQ on http://www.microsoft.com/hwdev/pc98.htm. (Change date: June 3, 1997; June 12, 1997; September 11, 1997)

### 9. Devices and controllers comply with "1394 Power Specification" from Microsoft

*Required*

*Version 1.1 Change:*
*Recommended*

This specification addresses both cable (bus) powered and self-powered (AC powered) devices. The device power management architecture defines a standard Command and Status Register (CSR) protocol and IEEE 1394 device power states necessary for an intelligent bus manager to effectively manage device power consumption. Benefits include consistent device behavior, power conservation and instant ("OnNow") availability for end-user applications.

The IEEE 1394 power management architecture defines a framework for Soft Power_On, Soft Power_Shutdown, and Remote Wakeup. The architecture applies a number of key features defined in the IEEE 1394 standard to implement device power management including four standard device power states (D0−D3), power status CSRs, and device wakeup signaling. Together, these capabilities enable power conservation while providing for OnNow-compatible device environments.

**Version 1.1 Change:**

Because the dates for completion of specifications and operating system support do not allow for timely implementation of support by vendors, this item is recommended rather than required.

Compliance testing is expected to begin either July 1, 1998 or January 1, 1999 for this requirement. For information about compliance dates for this IEEE 1394 requirement, see the PC 98 FAQ on http://www.microsoft.com/hwdev/pc98.htm. (Change date: June 3, 1997; June 12, 1997; September 11, 1997)

The power management requirements are available on http://www.microsoft.com/hwdev/onnow.htm. These specifications have been submitted for adoption by the 1394 Trade Association.

It is important to note that an IEEE 1394 host controller is a device, and therefore as of **July 1, 1997,** it must comply with the *Default Device Class Power Management Specification* as described in the clarifications to item 5 of the "Basic PC 97" chapter, as well as with the *1394 Power Management Specification.* Compliance testing of systems and devices for IEEE 1394 power management will begin as of **July 1, 1998.**

# Device Command Protocol for IEEE 1394 Devices

This section summarizes command protocol requirements for integration and interoperability of the IEEE 1394 bus with IEEE 1394 peripherals such as consumer electronics devices.

### 10. Device command protocols conform to Win32 Device Class Interfaces

*Required*

Support in the Windows operating systems for new device classes (for example, Digital VCR) will leverage the Win32 Driver Model (WDM) so that a single device class driver binary will support the same devices on both Windows and Windows NT.

New Win32 device driver interfaces are based on available industry standards. Areas of standardization include generic command and protocol standards for Audio, Imaging, and Storage class interfaces, spanning multiple device types in each category. Win32 class drivers provide hardware-independent, class-specific interfaces that can be extended by hardware-specific device minidrivers.

Devices that comply with interface standards such as HCI for IEEE 1394 eliminate the need for developing and testing third-party device drivers. Other devices will require implementation of a simple minidriver to extend Microsoft-supplied generic class interfaces to support a specific device. In limited, but special cases, it might be necessary for a third party to implement both a class and a minidriver to support a new device.

### 11. Consumer A/V device interfaces comply with industry standards

*Required*

These standards include Digital Interface for Consumer Electronic Audio/Video Equipment (Draft 2.1 or later) by Philips Electronics N.V., Matsushita Electric Ind. Co., Ltd, Thomson Multimedia, Sony Corporation, October, 1995 (also available from IEEE 1394 Trade Association).

This specification outlines implementation requirements for interoperability of consumer audio/video equipment over IEEE 1394. It includes a clarifying sample of a device configuration ROM and CSRs. Specific areas for compliance are summarized here:

- Isochronous IEEE 1394 devices support Common Isochronous Packet (CIP) Header.

  Devices capable of isochronous data handling must support the CIP format to ensure interoperability of isochronous data between consumer A/V nodes on an IEEE 1394 bus.

- Isochronous IEEE 1394 devices support Connection Management Protocol (CMP).

  CMP is Required to enable management of isochronous connections including swift allocation and deallocation of channels following a bus reset. Plug Control Registers (PCRs) are Required to facilitate CMP necessary for isochronous data flow management.

- Consumer A/V devices support the Function Control Protocol (FCP).

  FCP is Required for compatibility with Microsoft-supplied consumer-A/V class device drivers. (for example, digital cameras and camcorders).

  Part 1 defines command packet formats for the simple command-response FCP protocol for asynchronous control of digital A/V devices. Parts 2 and 3 specify packet format and transmission timing for Standard Definition (SD) and High Definition (HD) digital VCR data respectively.

### 12. Imaging devices support interface standards

*Recommended*

The Win32 Imaging Class drivers (for cameras, camcorders, printers, scanners, and so on) will be based on one or more of the following standards:

- AVC command set (available from the IEEE 1394 Trade Association)
- Specifications for consumer-use digital VCRs using 6.3mm magnetic tape (Blue Book)
- Digital Interface for Consumer Electronic Audio/Video Equipment (draft 2.1 or later)

For more information, see the Microsoft Win32 Driver Model DDK.

### 13. Audio devices support interface standards

*Recommended*

The Win32 Audio Class driver (for component audio, musical instruments, and so on) will be implemented based on one or more of the following:

- Human Input Device Class (http://www.teleport.com/~usb)
- USB Audio Class (http://www.teleport.com/~usb)
- Digital Interface for Consumer Electronic Audio/Video Equipment (draft 2.1 or later)
- AVC Command set (available from the IEEE 1394 Trade Association)
- Digital Audio and Performance Data Transmission Protocol and Connection Management for Electronic Musical Environment—Yamaha Corporation

For more information, see the Microsoft Win32 Driver Model DDK.

### 14. Support for SCSI-3 protocol

*Recommended*

Where feasible, designs should leverage common command protocols defined for SCSI-3. Storage devices in particular can take advantage of common commands and protocols based on Command Descriptor Blocks (CDBs):

- SCSI-3 Serial Bus Protocol (Working Draft of X3T10 Tech. Subcommittee)

  SCSI-3 SBP specifies a command delivery protocol developed to extend existing parallel SCSI protocol to support new features (for example, isochronous data streaming) provided by the IEEE 1394 bus. The SCSI-3 SBP is intended for use with SCSI-3 primary commands for block I/O and multimedia devices.
- SCSI-3 Multimedia Command Set (MMC) X3T10/1048D

## IEEE 1394 Controller Requirements

This section summarizes class specifications and standards for IEEE 1394 controllers. These requirements are in addition to those defined in “IEEE 1394 Basic Requirements” earlier in this chapter.

### 15. IEEE 1394 host controllers are bus-manager capable

*Required*

IEEE 1394 host controllers must be bus-manager capable as specified in clause 8.3.1.6 of the IEEE 1394−1995 standard. This functionality is necessary for intelligent PC bus managers to provide a managed environment for Plug and Play and for power and isochronous data, including cycle master and isochronous resource manager.

The host controller must be capable of asserting the force root node assignment protocol necessary for an IEEE 1394-capable PC to be assigned the role of active bus manager.

Other bus management capabilities include the following:

- Managing TOPOLOGY_MAP and SPEED_MAP registers.
- Managing BANDWIDTH_AVAILABLE and CHANNELS_AVAILABLE registers.
- Configuring the arbitration gap count for optimum bus performance.
- Enabling Isochronous by ensuring that the root node is cycle-master capable.
- Managing cable power distribution.
- Managing device power consumption.

**16. Host controller provides system memory protection and security**
*Required*

Host controllers must restrict access to host memory from unqualified IEEE 1394 devices. The default after a bus reset is no access to host memory for add-on IEEE 1394 devices.

Host controllers must not provide the capability to spoof either their Node ID or the Global Unique ID using any software-accessible control.

It is acceptable if the Global Unique ID is only non-spoofable for quadlet reads from IEEE 1394 devices. Those who want to read non-spoofable Global Unique IDs should use quadlet reads, not block reads.

A host controller can spoof Node IDs only if that controller provides a hardware jumper to enable the feature (for example, for debug purposes). The state of the jumper must be detectable from software and must be disabled by default.

All IEEE 1394 devices, including host controllers, must check the source ID as well as the transaction label before accepting a response packet to satisfy an outstanding request.

# References for IEEE 1394

This section lists some of the publications, services, and tools available to help build hardware that works with Windows operating systems.

IEEE 1394 Standards
ASK*IEEE
Telephone: (800) 949-4333
Fax: (415) 259-5045
Released Standards: Global Engineering, (800) 854-7179

Open Host Controller Interface Specification
Fast Incremental Reset Protocol (IEEE 1394.1 project)
http://www.skipstone.com (IEEE 1394 Trade Association web site)
Trade Association Internet reflector: IEEE 1394-sig@apple.com

"1394 Plug and Play Design Reference" from Microsoft
"1394 Power Specification" from Microsoft
http://www.microsoft.com/hwdev/respec/

Win32 Driver Model DDK for IEEE 1394, Windows 95 DDK, Windows NT DDK, and Win32 SDK
Microsoft Developer Network (MSDN) Professional membership

Digital Interface for Consumer Electronic Audio/Video Equipment (Draft 2.1 or later)
Philips Electronics N.V., Matsushita Electric Ind. Co., Ltd,
Thomson Multimedia, Sony Corporation, October, 1995

Other IEEE 1394 information can be obtained from these Internet sites:
http://www.sel.sony.com/sel/consumer/camcorder/dv.html
http://firewire.org
http://www.ti.com/sc/ieee1394

**Version 1.1 References Update:**
*1394 Specification for Power Management*
ftp://ftp.p1394pm.org/pub/p1394pm/
http://www.microsoft.com/hwdev/onnow.htm

1394 Trade Association
E-mail: 1394-sig@1394ta.org
http://www.1394ta.org

*1394 Trade Association Power Specification Part 1: Cable Power Distribution*
ftp:// ftp.p1394pm.org/pub/p1394pm/

*IEC 1883 Digital Interface for Consumer Electronic Audio/Video Equipment*
http://www.iec.ch

IEEE 1394 Standards
ASK*IEEE
Telephone: (800) 949-4333

Fax: (212) 310-4091
E-mail: askieee@ieee.org

Global Engineering Documents
Phone: (800) 854-7179 (US)
(613) 237-4250 (Canada)
(303) 792-2181 (Outside North America)
Fax: (303) 397-2740
ftp://ftp.symbios.com/pub/standards/io/

Information about IEEE 1394 implementations
http://developer.intel.com
http://www.microsoft.com/hwdev/busbios/

*Open Host Controller Interface Specification*
ftp://www.austin.ibm.com/pub/chrptech/1394ohci/

Windows NT DDK
MSDN Professional membership

# Checklist for IEEE 1394

## IEEE 1394 Basic Requirements

*1. Devices and controllers support IEEE 1394 standards*
*Required*

*2. Controllers comply with OpenHCI for IEEE 1394*
*Recommended*

*3. Devices comply with IEEE 1394 electrical isolation requirements*
*Recommended*

*4. Devices and PCs requiring high-bandwidth support use IEEE 1394*
*Recommended*

*5. Support peak data rate of 400 megabits per second, minimum*
*Recommended*

*6. PHY supports Fast Incremental Reset*
*Recommended*

*6a. IEEE 1394 connectors use IEEE 1394 icon*
*Required*

## Plug and Play for IEEE 1394 Devices

*7. Devices and controllers comply with "1394 Plug and Play Design Reference"*
*Required*

## Power Specifications for IEEE 1394 Devices

*8. Devices and controllers comply with Specification for Cable Power Distribution, from IEEE 1394 Trade Association*
*Recommended*

*9. Devices and controllers comply with "1394 Power Specification" from Microsoft*
*Recommended*

## Device Command Protocol for IEEE 1394 Devices

*10. Device command protocols conform to Win32 Device Class Interfaces*
*Required*

*11. Consumer A/V device interfaces comply with industry standards*
*Required*

*12. Imaging devices support interface standards*
*Recommended*

*13. Audio devices support interface standards*
*Recommended*

*14. Support for SCSI-3 protocol*
*Recommended*

## IEEE 1394 Controller Requirements

*15. IEEE 1394 host controllers are bus-manager capable*
*Required*

*16. Host controller provides system memory protection and security*
*Required*