Part 3 Device Class Subsystem Design Requirements

Contents

Chapter 6 Buses and Interfaces

IMPORTANT: The requirements in this guide provide instructions for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows Millennium Edition or Windows 2000 Professional or later operating systems. These design requirements are not the basic system requirements for running any version of Windows operating systems.

USB

This section presents the requirements for Universal Serial Bus (USB).

Required on all PC 2001 systems, USB provides an expandable, hot-pluggable Plug and Play serial interface that ensures a standard, low-cost socket for adding external peripheral devices ranging from interactive HID devices such as joysticks and pointing devices to isochronous devices such as telephony, audio, and imaging devices. USB allows integration of cascading hubs into desktop devices such as monitors and keyboards.

Any device that plugs into or is connected to a USB port is considered a USB device and must comply with the requirements defined in these requirements. If the device provides the capabilities of one or more functions or it provides a hub to the host, it must comply with the requirements in this chapter.

Unless this chapter defines a specific requirement or exception, all requirements for buses and interfaces apply as presented in Chapter 3, “PC System,” Chapter 4, “Workstation,” and Chapter 5, “Mobile.”

For information about USB BIOS requirements, see “PC 2001 BIOS Requirements” in Chapter 3, “PC System.”

USB Core Requirements

This section covers requirements for the USB 1.1 and 2.0 specifications on PC 2001 systems.

USB–0081. USB system hardware and devices comply with USB specifications

USB system hardware and devices, including hubs, must comply with the *Universal Serial Bus Specification, Revision 1.1*. If a USB hub or device supports USB 2.0, it must comply with the *Universal Serial Bus Specification, Revision 2.0*.

When a system has more than one host controller, each host controller must provide full bandwidth and isochronous support. Host controllers must be located on the PCI bus (or equivalent) to meet this requirement. The host controller providing USB 1.1 functionality must comply with the specifications for either *OpenHCI: Open Host Controller Interface Specification for USB*, published by Compaq, Microsoft, and National Semiconductor, or *Universal Host Controller Interface (UHCI) Design Guide, Revision 1.1*, published by Intel. Information on OHCI and UHCI is listed in "Buses and Interfaces References." Host controllers providing USB 2.0 functionality must comply with the *Enhanced Host Controller Interface Specification for Universal Serial Bus* 2.0.

USB–0084. USB devices and drivers support maximum flexibility of hardware interface options

Device and driver designs must provide maximum flexibility for interface options so that the operating system or other vendor-supplied resource management tool can coordinate user preferences, allowing multiple devices and applications simultaneously. Minimum requirements consist of the following.

- **USB–0084.1. Devices and drivers provide multiple alternate settings.** Devices and drivers must provide multiple alternate settings for each interface where any alternate setting consumes isochronous bandwidth.
- **USB–0084.2. Devices and drivers must not use isochronous bandwidth for alternate setting 0.** Devices must consume bandwidth only when they are in use.

USB–0085. USB host controller and devices can wake the system

The USB host controller must support wakeup capabilities from S1, S2, and S3 states. If the system contains multiple USB host controllers, all host controllers integrated on the system board (that is, not add-on cards) are required to support wakeup from S1, S2, and S3.

USB devices and USB client software and drivers must support multiple system suspend and resume cycles into and out of S3.

USB–0086. USB hubs are self-powered

This requirement does not apply for hubs integrated into USB keyboards or into mobile systems. To minimize USB power consumption requirements, bus-powered hubs must provide ports that can be individually power switched.

USB–0087. USB bus, controllers, and devices comply with USB power management requirements

Devices must comply with the power management requirements in the *Universal Serial Bus Specification, Revision 1.1*. In addition, devices must comply with the Interface Power Management feature in the *Universal Serial Bus Common Class Specification, Revision 1.0*.

Mobile PC Note

An internal device that connects to a mobile PC using USB must not continually maintain the system when all component parts are on. Such a device will override system power-management settings that control power-saving modes to protect battery life. When any USB device is connected but not active, the driver must allow system power management to suspend the mobile PC.

USB–0088. USB devices and drivers meet requirements in related USB device class specification

A USB device or driver that fits into one of the USB device class definitions must comply with the related USB device class specification.

If a device vendor builds a device in a device class that does not have generic operating system driver support, or if the vendor must exploit additional, unique hardware features in their device, they can create additional WDM minidrivers.

WDM minidrivers are defined in the “Windows 2000 and WDM Drivers” section of the Windows 2000 DDK.

USB–0089. USB devices install without preloading software

A user must not be required to install software before hot-plugging a USB device. Instead, the user must be able to hot-plug the USB device and then load any software in response to operating system detection of the newly attached device.

IEEE 1394

The following requirements expressly require interconnectivity for IEEE 1394-1995 and IEEE 1394a-2000 devices. However, these requirements do not preclude implementations of IEEE P1394b, which has advantages for power management, performance, and integration into low-power systems.

Basic Requirements for IEEE 1394

This section defines the basic PC 2001 requirements for implementing IEEE 1394.

Note: An implementation of IEEE P1394b can meet these requirements.

1394–0090. System implementing IEEE 1394 supports mandatory features in IEEE 1394 standards

Systems that support IEEE 1394 features and interconnectivity that interface to the IEEE 1394 bus must support the industry standards and its amendments as they apply to internal and external devices. Minimum requirements consist of the following.

- **1394–0090.1. System provides IEEE 1394-1995/1394a interconnectivity**

  All systems must support the following industry standards and their amendments:

  - IEEE 1394a-2000 amendment to IEEE 1394-1995
  - *IEEE 1394-1995 Standard for a High Performance Serial Bus*
  - IEEE 1212-2000
  - *Serial Bus Protocol 2 (SBP-2)*
  - *1394 Trade Association Power Specification* (all components)
  - *Plug and Play Design Specification for IEEE 1394, Version 1.0c*

- **1394–0090.2. Systems implementing IEEE 1394 internal devices support mandatory features in the IEEE 1394a-2000 or IEEE P1394b amendments to IEEE 1394-1995**

  A system designer may incorporate one or more internal IEEE 1394 devices, one or more externally accessible IEEE 1394 sockets, or any combination thereof. For example, a system could provide an internal IEEE 1394 DVD device without providing any external interconnect to IEEE 1394. If, however, that same system provides externally accessible IEEE 1394 sockets, support must be provided for connecting an IEEE 1394-1995/1394a device to that socket.

1394–0091. Host controller supports mandatory components of 1394 OHCI 1.1

Host controllers must implement the mandatory features of *1394 Open Host Controller Interface Specification, Revision 1.1*, including host notification of a PHY LinkOn event, Dual Buffer Mode enhancements, ack_tardy processing, SCLK failure detection, Skip Processing enhancements, and Block Read Request handling.

PCI Bus Power Management Interface Specification, Revision 1.1, is an implementation option for OHCI 1.1, however, IEEE 1394 host controllers used on PC 2001 systems must provide support for PCI 1.1 Power Management, including power states D0, D1, D2, and $D3_{cold}$.

1394–0092. Host controller supports minimum peak data rates specified in IEEE 1394 standards

Host controllers must support the highest data rate of the PHY to which they connect.

The host controller's PHY must support data rates of S100 megabits per second (Mbps), S200 Mbps, and S400 Mbps as specified in IEEE 1394-1995 and IEEE 1394a-2000.

1394–0093. If the IEEE 1394 implementation provides external connectivity, system must use only sockets specified by IEEE 1394-1995 and its amendments

A system that implements externally accessible sockets must provide a method for connecting to devices that only support IEEE 1394-1995 or its amendment, IEEE 1394a-2000.

The connector described in the *Device Bay Specification, Version 1.0*, is for use inside the PC 2001 system and is not an externally available socket.

Any externally accessible socket must meet all interface specifications of IEEE 1394-1995, 1394a-2000 or IEEE P1394b, as appropriate. This requirement includes, but is not limited to: a) input impedance from the perspective of the pins on the socket looking back into the system, as specified by the IEEE standards, b) signal amplitude, c) sensitivity, and d) jitter.

Minimum acceptable performance of IEEE 1394-1995 and 1394a-2000 sockets can be validated by following the recommendations, test sequences, and test procedures of ANSI/EIA 364-B-90, as specified in the IEEE standards, and comparing results against the electrical and performance requirements contained within the IEEE 1394-1995 and 1394a-2000 standards.

Minimum acceptable performance implementations of non-optical IEEE P1394b sockets can be validated by following the recommendations, test sequences, and

test procedures of ANSI/EIA 364-C-94, as specified in the IEEE P1394b standard, and comparing results against the electrical and performance requirements contained within the IEEE P1394b standard.

Requirements for IEEE 1394 Devices

This section summarizes additional requirements for IEEE 1394 peripherals.

1394–0094. Device command protocols conform to standard device class interfaces

Drivers for devices using the SBP-2 protocol must conform to the requirements set in "SBP-2 Support and Windows 2000," listed in "Buses and Interfaces References."

1394–0095. Peak data rates for internal and external devices meet IEEE 1394 requirements

System designers may incorporate IEEE 1394 devices as external, internal, or both. Minimum requirements consist of the following.

- **1394–0095.1. Internal devices support the standard IEEE 1394a-2000 Amendment data rates.** Internal devices support S400-Mbps minimum. A CD-ROM or DVD drive mounted in an externally accessible bay is an example of an internal device.
- **1394–0095.2. External devices support IEEE 1394a-2000 data transfer rates.** External devices that interoperate with a PC and have more than one socket must support S100 Mbps, S200 Mbps, and S400 Mbps data transfer rates. Devices with a single socket may support only S100- or S200-Mbps data transfer rate. An externally mounted CD-ROM or DVD drive is an example of an external device.

Plug and Play for IEEE 1394

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

1394–0096. IEEE 1394 Plug and Play devices demonstrate interoperability with other devices

All devices must support Plug and Play for intended use in both a minimal and an extended bus configuration. A minimal configuration is the minimum number of devices necessary to demonstrate the primary use of the device. An extended configuration has at least two devices added to the minimal configuration. The added devices can be extraneous to the use.

1394–0097. IEEE 1394 devices that initiate peer-to-peer communications provide a remote control interface

All devices capable of initiating peer-to-peer communications that have been designed for use with a PC must provide a remote interface enabling remote control for PC applications that allows a third device, such as a PC or some other device controller, to initiate data transmission between two devices.

For example, two devices communicating on IEEE 1394 use a basic protocol to carry command/status information and the actual data, such as a device driver to handle this communication, with SBP-2 and International Electrotechnical Commission (IEC-61883) as example protocols.

Plug and Play for CSR Space

This section defines the Plug and Play requirements related to Configuration Status Register space.

1394–0098. IEEE 1394 CSR provides unique device identification

The device control and status register (CSR) space must provide configuration information as specified in the IEEE 1212r-2000 standard and applicable IEEE 1394 standards, thus providing Plug and Play device control.

1394–0099. IEEE 1394 device CSR space implements IEEE 1212-2000 format

The CSR space format is specified in the applicable IEEE 1394 standards and the IEEE 1212-2000 standard. The general CSR format is an extensible tree structure enabling a managed environment by providing node-specific and unit-specific information as required for Plug and Play, power management, and isochronous data transfers. The general CSR format also provides for definition of multifunction device units. The bus information block and root directory of the general CSR format are required as specified in CSR table of IEEE 1212-2000.

1394–0100. IEEE 1394 CSR includes a unit directory for each independent device function

A unit directory is required for independent function and control of each device unit. A valid pointer to a unit directory must be provided in the root directory.

1394–0101. Vendor and model leafs support textual descriptor leaf format

Textual descriptors are required for Vendor_ID and Model_ID entries in the CSR space in order to display this information to the user. Each textual descriptor points to a leaf that contains a single character string.

Examples of valid textual descriptors are found in the IEEE 1394 Plug and Play specification.

Power Management for IEEE 1394 Devices

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

1394–0102. Power Manager notified of device power state changes

The host controller and all devices that provide or consume cable power must conform to all components of the *1394 Trade Association Power Specification*.

1394–0103. Devices and controllers comply with all components of the 1394 Trade Association Power Specification

The *1394 Trade Association Power Specification* provides requirements for implementation of devices that propagate, source, or sink cable power. In addition, mechanisms are defined by which devices consuming cable power may be enabled as well as placed into a variety of power-consuming states.

SCSI

This section presents requirements for the small computer system interface (SCSI), a flexible I/O bus that is used in the design of a wide variety of peripherals, including disk drives, CD drives, tape drives, scanners, and magneto-optical drives. The SCSI host adapter provides circuitry that serves as an interface between the system and one or more SCSI peripherals. A host adapter can be a card that plugs into the system's expansion bus, such as a PCI card, or it can be designed directly into the system board.

See also "SCSI Storage" in Chapter 12, "Storage."

SCSI Host Adapter Requirements

This section summarizes class specifications and standards for SCSI host adapters.

SCSI–0104. SCSI controller complies with SPI-3

All SCSI controllers must meet the hardware and software design requirements in the *SCSI Parallel Interface-3 (SPI-3)* standard, listed in "Buses and Interfaces References."

SCSI–0105. PCI-based SCSI host controller supports bus mastering and virtual DMA services

The host controller must support PCI bus mastering. PCI bus mastering must be enabled by default and virtual direct access memory (DMA) services must be supported in the host-adapter option ROM.

SCSI–0106. Bootable SCSI controller supports El Torito No Emulation mode and Int 13h Extensions

SCSI host adapters with boot ROMs must support the current No Emulation mode of the "*El Torito"–Bootable CD-ROM Format Specification, Version 1.0* and the *BIOS Boot Specification, Version 1.01*.

The Int 13h Extensions ensure correct support for high-capacity drives, and consistent drive-letter mapping between real mode and protected mode. Support for the fixed-disk access subset of Int 13h Extensions must be provided in the system BIOS and in any option ROMs for storage devices that include BIOS support.

The Int 13h Extensions are defined in the "Layered Block Device Drivers" section of the Windows 98 DDK.

SCSI–0108. Bus type is clearly indicated on connectors for all adapters, peripherals, cables, and terminators

Connectors must comply with the requirements defined in the SCSI-2 standard. The SCSI bus cable must be plugged into shrouded and keyed connectors on the host adapter and devices. For internal configurations, Pin 1 orientation must be designated on one edge of the ribbon cable and also on the keyed connector of the SCSI peripheral device.

Although an external connector is optional, an external connector must be a high-density connector as defined in the SCSI-2 standard.

Clearly label connectors for each SCSI adapter, peripheral, cable, and terminator to indicate the bus type. All external SCSI connectors must display the appropriate SCSI icon defined in the SCSI Parallel Interface (SPI) standard, Annex H, and must display any clarifying abbreviations or acronyms. The following are applicable acronyms and their definitions:

- **DIFF (differential).** A signaling method that employs differential drivers and receivers to improve signal-to-noise ratios and increase maximum cable lengths. This method includes both low voltage differential (LVD) and high voltage differential (HVD) types.
- **SE (single-ended).** A signaling method that employs drivers and receivers to increase circuit density.
- **LVD (low voltage differential).** A signaling method with low signaling voltages supporting higher transfer rates.
- **HVD (high voltage differential).** A signaling method with high signaling voltages.

SCSI–0109. Differential devices support DIFFSENS as defined in the SPI-3 Standard

Without DIFFSENS, the differential bus drivers, a single-ended device, or both could be damaged if a single-ended device is connected to a differential bus.

The standard for DIFFSENS is defined in the SPI-3 standards document.

SCSI–0110. Automatic termination circuit and SCSI terminators meet SPI-3 standard

SCSI add-on adapters and on-board controllers must use automatic termination, which allows a user to add external devices without removing the PC case. Terminators used in the SCSI host adapter must be regulated terminators, also known as active, SCSI-2 alternative-2, or Boulay terminators. SCSI termination built onto internal cables must meet SCSI-3 standard.

SCSI–0111. TERMPWR is supplied to the SCSI bus with overcurrent protection

This requirement includes the following two components.

- **SCSI–0111.1. Host adapter supplies TERMPWR.** The base requirement for system-board implementations using PCI or another expansion bus is that the host adapter must supply terminator power (TERMPWR) to the SCSI bus. All terminators on the host adapter, as well as those on the internal and external SCSI bus, must be powered from the TERMPWR lines on the SCSI bus.
- **SCSI–0111.2. The circuit that supplies TERMPWR has built-in overcurrent protection.** Devices that provide TERMPWR must also provide some means of limiting the current through use of a self-resetting device. For example, a positive-temperature coefficient device or circuit breaker can be designed into the circuit. These devices open during an overcurrent condition and close after the end of the overcurrent condition.

Mobile PC Note This feature is not required for battery-powered systems that implement the SCSI host adapter as a PC Card device because of battery consumption issues.

Plug and Play for SCSI Host Adapters

This subsection summarizes the Plug and Play requirements for SCSI controllers.

SCSI–0113. SCAM support is disabled by default

If support is present, it must be disabled by default. SCSI Configured AutoMagically (SCAM) is not supported by the Windows family of operating systems; enabling SCAM can cause the system to become unstable or inoperable.

SCSI–0114. SCSI controllers provide multi-initiator support

Multi-initiator support allows two SCSI controllers—each installed in a separate computer system—to coexist on a shared SCSI bus with a set of shared devices. If this capability is supported, the SCSI IDs must be changeable from the default SCSI controller ID of 7, and the boot-time SCSI bus reset operation must be able to be disabled on each controller attached to a shared bus.

ATA and ATAPI

This section presents the requirements for Windows-compatible ATA and ATAPI controllers and peripherals.

The use of ATA in a PC 2001 system is optional. If a system uses ATA, however, all components must comply with the requirements defined in this section.

ATA–0115. ATA/ATAPI controllers comply with ATA/ATAPI-5 standards

All ATA/ATAPI controllers must meet the hardware and software design requirements listed in the *AT Attachment with Packet Interface – 5 (ATA/ATAPI-5)* standard.

ATA–0116. Bootable ATA controller supports El Torito No Emulation mode

Details are defined in requirement BIOS–0005, “BIOS includes local boot support,” in Chapter 3.

ATA–0117. ATA controller supports Int 13h Extensions and Logical Block Addressing

Int 13h Extensions are detailed in SCSI–0106, “Bootable SCSI controller supports El Torito No Emulation mode and Int 13h Extensions.”

The system BIOS must support the use of logical block addressing (LBA) for drives with LBA addressable area greater than 16,515,072 sectors, and the system BIOS must use LBA for all read and write operations to the device. The ATA 1226 technical report defines the proper implementation of LBA. Support for drives with capacities greater than 8.4 GB must be provided through the extended services (functions 4xh and greater) of the Int 13h Extensions as defined in *Enhanced BIOS Services for Disk Drives [T13-1226DT], Revision 7.*

ATA–0118. If implemented, dual ATA adapters use single FIFO with asynchronous access or dual FIFOs and channels

Although the use of an ATA adapter with more than one channel is optional, if included, dual ATA adapters must be designed so that either channel might be used at any time; the operating system does not have to serialize access between the primary and secondary channel. This requirement means either that the two

channels are totally independent or that anything shared. For example, a programmed I/O (PIO) read prefetch buffer is protected by a hardware arbitrator.

Section 5.0 of the *BIOS Boot Specification, Version 1.01* defines an implementation for dual asynchronous channels.

A design implementing a single first in/first out (FIFO) that uses a hardware solution to synchronize access to both channels meets this requirement. A request on one channel need not be completed before another request to the other channel can start. A software-based solution is not acceptable.

ATA–0119. Controller supports Ultra DMA (ATA/33)

The programming register set for PCI Integrated Device Electronics (IDE) bus master DMA is defined in ATA/ATAPI-5. ATA drives must comply with ATA-5 to ensure fully featured hardware and Windows-compatible device driver support.

All controllers and ATA hard drive peripherals must support Ultra DMA at transfer rates of 33 MB per second or higher as defined in ATA/ATAPI-5. In addition to improved transfer rates, Ultra DMA also provides error checking for improved robustness over previous ATA implementations. PCI chip sets must implement DMA as defined in ATA-5.

Definitions for the ACPI control methods can be found in Section 10.8 of ACPI 1.0b.

ATA–0120. ATA controller and peripheral connections include Pin 1 cable designation with keyed and shrouded connectors

One edge of the keyed ribbon cable and the keyed connector of the ATA or ATAPI controller and peripheral device must indicate the Pin 1 cable orientation. Designation of the keyed connector must be clearly indicated on or near the connector.

ATA–0121. ATA bus complies with device class power management reference specification

The ATA bus must comply with the *Storage Device Class Power Management Reference Specification, Version 1.0a*.

ATA–0122. Discrete PCI ATA controllers in mobile docking stations implement in PCI Native-Mode ATA

Discrete ATA and ATAPI controllers that are implemented in mobile docking stations must comply with the *PCI IDE Controller Specification, Revision 1.0*, for native mode support. This requirement does not apply to controllers that are a part of the mobile PC’s chip set architecture.

PCI

This section presents the PC 2001 requirements for Peripheral Component Interconnect (PCI) host controllers and peripherals.

The PCI architecture has become the most common method used to extend PCs for add-on adapters. Windows Me and Windows 2000 use the basic PCI infrastructure to gain information about devices attached to the PCI bus. The ability of PCI to supply such information makes it an integral part of the Plug and Play architecture in Windows.

PCI Core Requirements

This section summarizes the basic design requirements for PCI.

PCI–0123. All PCI components comply with PCI 2.2

All system-board bus hardware and add-on devices that use PCI must comply with the *PCI Local Bus Specification, Revision 2.2* (PCI 2.2).

Bus designs must fully implement all bus requirements on every expansion card connector.

PCI–0057. 66-MHz and 64-bit PCI buses comply with PCI 2.2 requirements

If either 66-MHz or 64-bit PCI buses are implemented in a system, all devices connected to these buses must meet the requirements defined in PCI 2.2.

PCI–0124. PCI-to-PCI bridges comply with the PCI-to-PCI bridge specification

In particular, nonsubtractive decode PCI bridges must implement the standard method to close base address register (BAR) windows as defined in the *PCI to PCI Bridge Architecture Specification Rev. 1.1*. Setting the BAR to its maximum value and the limit register to zeros effectively closes the I/O or memory window references in that bridge BAR.

PCI–0125. All PCI devices complete memory write transaction (as a target) within specified times

All devices must comply with the Maximum Completion Time requirements in PCI 2.2. Complying with this requirement ensures shorter transaction latencies on PCI, allowing more robust handling of isochronous streams in the system.

Plug and Play for PCI Controllers and Peripherals

This section lists the Plug and Play requirements for PCI devices.

PCI–0126. PCI device IDs include Subsystem IDs

The Subsystem ID (SID) and SVID fields must comply with the SID requirement in PCI 2.2. For more information, see the white paper, "PCI Device Subsystem IDs and Windows," listed in "Buses and Interfaces References." Appropriate values for the SID and SVID fields are described below.

- The PCI Special Interest Group assigns valid, nonzero Vendor ID values to member companies. This Vendor ID value must be used to populate the SVID register.
- The vendor assigns values for the SID register. To be valid, these values must be nonzero and unique to a subsystem configuration.

Note: For subsystems on system boards that contain a PCI device, the SVID and SID registers must also be loaded with valid nonzero values before the operating system accesses the device. The exception to this requirement is core chip sets.

PCI–0127. PCI interrupt routing is supported using ACPI

The system must provide interrupt routing information using a _PRT object, as defined in Section 6.2.3 of the ACPI 1.0b specification.

Power Management for PCI Controllers and Peripherals

This section lists the specific PCI power management requirements.

PCI–0130. All PCI components comply with PCI Bus Power Management Interface specification

PCI Bus Power Management Interface Specification, Revision 1.1, is the only industry specification that ensures compatibility with the power management capabilities of Windows 2000, which uses PME# as the wakeup signal.

The primary PCI bus controller, PCI-to-PCI bridges, and all PCI add-on devices that implement PME# must comply with the *PCI Bus Power Management Interface Specification, Revision 1.1*. PCI add-on devices that do not implement PME# must comply with *PCI Bus Power Management Interface Specification, Revision 1.0*. Minimum requirements consist of the following.

PCI-CardBus Bridges are required to comply with the *PC Card Standard, Release 7*.

- **PCI–0130.1. All components correctly implement configuration space registers used for power management.** This requirement includes correct implementation of the PCI Configuration Space registers used by power management operations, and the appropriate device state definitions.

  A PCI function is a set of logic represented by a single Configuration Space. Some examples include PCI-to-PCI bridges, USB host controllers, and IDE controllers. If a function is integrated as part of the core chip set, and thus is not an add-on capable device, it can use ACPI rather than PCI Power Management registers for its power management interface.

- **PCI–0130.2. PCI add-on cards using $3.3V_{aux}$ operate correctly.** PCI add-on cards that use $3.3V_{aux}$ must operate correctly. This applies when the system supports $3.3V_{aux}$ to the PCI connectors.

  PC add-on cards designed and built exclusively for installation in systems—and which are never sold through retail distribution channels—are not required to supply the static field effect transistor (FET) switches described in section 7.4.4 of *PCI Bus Power Management Interface Specification*.

  A method that PCI add-on cards can use to meet this requirement is described in Section 7.4.4 of *PCI Bus Power Management Interface Specification, Revision 1.0*.

PCI–0131. System provides support for $3.3V_{aux}$

System support for delivery of $3.3V_{aux}$ to the PCI bus must be capable of powering a single PCI slot with 375 mA at 3.3V and it must also be capable of powering each of the other PCI slots on the segment with 20 mA at 3.3V whenever the PCI bus is in the B3 state. See also SYS–0002.1, “System supports S3, S4, and S5 states,” in Chapter 3.

Systems must be capable of delivering 375 mA at 3.3V to all PCI slots whenever the PCI bus is in any bus-powered state: B0, B1, or B2.

Mobile PC Note

For mobile PCs, the requirement for delivery of $3.3V_{aux}$ is 10 mA at 3.3V because mobile platforms often need to support Small PCI or Mini PCI add-in cards while the bus is in the B3 state.

PCI–0132. PCI-based modem and network adapters support wakeup

PCI-based modem and network adapters must support wakeup as defined in Chapter 13, “Modems,” and Chapter 14, “Network Communications.”

Note: CardBus-based modem cards are not required to support wakeup.

Bluetooth

Bluetooth technology is designed to be used as a wireless local bus to connect mobile devices over a personal and private connection (in essence, to replace the cables carried by many mobile travelers). Three types of Bluetooth devices are:

- Host controllers, used to enable PC communication with other devices using Bluetooth wireless technology
- PC peripherals using Bluetooth wireless technology for communication to the PC
- Independent devices, such as personal data assistants, which are not within the scope of this design guide

Bluetooth Host Controllers

The following requirements apply to host controllers that are used connect a PC to other Bluetooth devices.

BTH–0396. All Bluetooth Host controllers meet current Bluetooth specifications

Bluetooth Host controllers must meet HCI functional specifications stated in “Part H:1 Bluetooth Host Controller Interface Functional Specification.” HCI in the defined transport classes also must meet the corresponding specifications:

- USB must meet “Part H:2 USB Transport Layer.”
- RS232 must meet “Part H:3 HCI RS232 Transport Layer.”
- Universal Asynchronous Receiver/Transmitters (UARTs) must meet “Part H:4 HCI UART Transport Layer.”

BTH–0397. All Bluetooth Host controllers provide Plug and Play and revision information

To minimize the need for new drivers, Bluetooth HCI must do both of the following:

- Conform to the Plug and Play specifications for the applicable bus, such as USB, PCI, CardBus
- Support Part H:1 requirements for reporting the revision of the supported HCI specification

Bluetooth PC Peripherals

The following requirements apply to the devices themselves.

BTH–0398. Peripherals equipped with Bluetooth wireless technology provide Plug and Play information

The Bluetooth system defines a Service Discovery Protocol (SDP). Bluetooth PC peripherals must support SDP and support the *Bluetooth Specification 1.0*.

BTH-0399. Bluetooth peripherals support Windows class driver requirements

Bluetooth peripherals must meet other requirements stated in this guide for the corresponding device types. For example, Bluetooth HID devices, modems, printers, or cameras must meet any applicable corresponding requirements in Chapters 7, 13, 15, or 16 of this design guide respectively.

Buses and Interfaces References

Following are the references, services, and tools cited in this chapter that are available to help build hardware that works optimally with Windows operating systems.

1394 Open Host Controller Interface Specification, Revision 1.1

http://www.microsoft.com/hwdev/1394/
http://developer.intel.com/technology/1394/download/ohci_11.htm

1394 Trade Association

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

1394 Trade Association Power Specification Part 1: Cable Power Distribution
1394 Trade Association Power Specification, Part 3: Power State Management

ftp://ftp.p1394pm.org/pub/p1394pm/

Advanced Configuration and Power Interface Specification, Revision 1.0b (ACPI 1.0b)

http://www.teleport.com/~acpi/

AT Attachment with Packet Interface – 5 (ATA/ATAPI-5)

ftp://fission.dt.wdc.com/pub/standards/x3t13/project/d1321r3.pdf

Other ATA standards
Global Engineering Documents
http://global.ihs.com

BIOS Boot Specification, Version 1.01

http://www.ptltd.com/techs/specs.html

Bluetooth Special Interest Group (SIG): See *Specification of the Bluetooth System*

Device Bay Specification, Version 1.0

http://www.device-bay.org

EIA standards

Global Engineering Documents
http://global.ihs.com/

"El Torito" Bootable CD-ROM Format Specification, Version 1.0

http://www.ptltd.com/techs/specs.html

Enhanced BIOS Services for Disk Drives [T13-1226DT], Revision 7

http://global.ihs.com

Enhanced Host Controller Interface Specification for Universal Serial Bus 2.0

To be published on http://www.usb.org/ when available

IEEE 1212-2000
IEEE 1394a-2000 amendment to IEEE 1394-1995
IEEE 1394-1995 Standard for a High Performance Serial Bus
IEEE P1394b

http://standards.ieee.org/reading/ieee/std/busarch/1394-1995.pdf
http://standards.ieee.org/catalog/ordering.html
http://global.ihs.com

OpenHCI: Open Host Controller Interface Specification for USB, Release 1.0a

http://www.microsoft.com/hwdev/respec/busspecs.htm
Specification drafts:
http://www.microsoft.com/hwdev/1394/

PC Card Standard, Release 7

http://www.pcmcia.org/bookstore.htm

"PCI Device Subsystem IDs and Windows"

http://www.microsoft.com/hwdev/devdes/pciids.htm

PCI Bus Power Management Interface Specification, Revision 1.1

PCI SIG
Phone: (800) 433-5177
http://www.pcisig.com/developers/specification/

PCI IDE Controller Specification, Revision 1.0

http://www.pcisig.com/developers/docs/

PCI Local Bus Specification, Revision 2.2 (PCI 2.2)
PCI to PCI Bridge Architecture Specification Rev. 1.1

PCI SIG
Phone: (800) 433-5177
For ordering information and document descriptions, see
http://www.pcisig.com/developers/specification/

Plug and Play Design Specification for IEEE 1394, Version 1.0c
http://www.microsoft.com/hwdev/respec/pnpspecs.htm

SBP-2: See *Serial Bus Protocol 2.*

SBP-2 Support and Windows 2000
http://www.microsoft.com/hwdev/print/sbp2_w2000.htm

SCSI Parallel Interface-3 (SPI-3)
ftp://ftp.t10.org/t10/drafts/spi3/spi3r14.pdf

Serial Bus Protocol 2 (SBP-2)
ANSI NCITS 325-1998
http://web.ansi.org/public/std_info.html

Specification of the Bluetooth System, Volume 1: Core, Version 1.0 B
Specification of the Bluetooth System, Volume 2: Profiles, Version 1.0 B
http://www.bluetooth.com

Storage Device Class Power Management Reference Specification, Version 1.0a
Other device class power management reference specifications
http://www.microsoft.com/hwdev/specs/PMref/PMstore.htm

Universal Host Controller Interface (UHCI) Design Guide, Revision 1.1
http://www2.fm.intel.com/pcd_ae/public/general/specs_ind/USB/uhci_1_1.pdf

Universal Serial Bus Common Class Specification, Revision 1.0
Universal Serial Bus Specification, Revision 1.1
Universal Serial Bus Specification, Revision 2.0
http://www.usb.org/developers/docs.html

Windows Me DDK and Windows 2000 DDK
http://www.microsoft.com/ddk/

Checklist for Buses and Interfaces

USB–0081. USB system hardware and devices comply with USB specifications

USB–0084. USB devices and drivers support maximum flexibility of hardware interface options

USB–0085. USB host controller and devices can wake the system

USB–0086. USB hubs are self-powered

USB–0087. USB bus, controllers, and devices comply with USB power management requirements

USB–0088. USB devices and drivers meet requirements in related USB device class specification

USB–0089. USB devices install without preloading software

1394–0090. System implementing IEEE 1394 supports mandatory features in IEEE 1394 standards

1394–0091. Host controller supports mandatory components of 1394 OHCI 1.1

1394–0092. Host controller supports minimum peak data rates specified in IEEE 1394 standards

1394–0093. If the IEEE 1394 implementation provides external connectivity, system must use only sockets specified by IEEE 1394-1995 and its amendments

1394–0094. Device command protocols conform to standard device class interfaces

1394–0095. Peak data rates for internal and external devices meet IEEE 1394 requirements

1394–0096. IEEE 1394 Plug and Play devices demonstrate interoperability with other devices

1394–0097. IEEE 1394 devices that initiate peer-to-peer communications provide a remote control interface

1394–0098. IEEE 1394 CSR provides unique device identification

1394–0099. IEEE 1394 device CSR space implements IEEE 1212-2000 format

1394–0100. IEEE 1394 CSR includes a unit directory for each independent device function

A unit directory is required for independent function and control of each device unit. A valid pointer to a unit directory must be provided in the root directory.

1394–0101. Vendor and model leafs support textual descriptor leaf format

1394–0102. Power Manager notified of device power state changes

1394–0103. Devices and controllers comply with all components of the 1394 Trade Association Power Specification

SCSI–0104. SCSI controller complies with SPI-3

SCSI–0105. PCI-based SCSI host controller supports bus mastering and virtual DMA services

SCSI–0106. Bootable SCSI controller supports El Torito No Emulation mode and Int 13h Extensions

SCSI–0108. Bus type is clearly indicated on connectors for all adapters, peripherals, cables, and terminators

SCSI–0109. Differential devices support DIFFSENS as defined in the SPI-3 Standard

SCSI–0110. Automatic termination circuit and SCSI terminators meet SPI-3 standard

SCSI–0111. TERMPWR is supplied to the SCSI bus with overcurrent protection

SCSI–0113. SCAM support is disabled by default

SCSI–0114. SCSI controllers provide multi-initiator support

ATA–0115. ATA/ATAPI controllers comply with ATA/ATAPI-5 standards

ATA–0116. Bootable ATA controller supports El Torito No Emulation mode

ATA–0117. ATA controller supports Int 13h Extensions and Logical Block Addressing

ATA–0118. If implemented, dual ATA adapters use single FIFO with asynchronous access or dual FIFOs and channels

ATA–0119. Controller supports Ultra DMA (ATA/33)

ATA–0120. ATA controller and peripheral connections include Pin 1 cable designation with keyed and shrouded connectors

ATA–0121. ATA bus complies with device class power management reference specification

ATA–0122. Discrete PCI ATA controllers in mobile docking stations implement in PCI Native-Mode ATA

PCI–0123. All PCI components comply with PCI 2.2

PCI–0057. 66-MHz and 64-bit PCI buses comply with PCI 2.2 requirements

PCI–0124. PCI-to-PCI bridges comply with the PCI-to-PCI bridge specification

PCI–0125. All PCI devices complete memory write transaction (as a target) within specified times

PCI–0126. PCI device IDs include Subsystem IDs

PCI–0127. PCI interrupt routing is supported using ACPI

PCI–0130. All PCI components comply with PCI Bus Power Management Interface specification

PCI–0131. System provides support for 3.3Vaux

PCI–0132. PCI-based modem and network adapters support wakeup

BTH–0396. All Bluetooth Host controllers meet current Bluetooth specifications

BTH–0397. All Bluetooth Host controllers provide Plug and Play and revision information

BTH–0398. Peripherals equipped with Bluetooth wireless technology provide Plug and Play information

BTH-0399. Bluetooth peripherals support Windows class driver requirements