C H A P T E R   1 8

Storage and Related Peripherals

This section presents the requirements for storage and related peripherals, including DVD devices. Specific requirements for SCSI, ATA, and ATAPI peripherals are defined in the related chapters in Part 3 of this guide.

For specific information about implementation details related to storage devices under the Windows 98 and Windows 2000 Professional operating systems, see the articles at http://www.microsoft.com/hwdev/storage/.

Contents

Storage Controller and Peripherals Basic Features

This section summarizes the hardware requirements for storage peripherals. For related acoustical requirements for storage devices, see requirement 3.7, "Audible noise meets PC 99 requirements."

18.1. Storage controller and hard disk devices support bus master capabilities

Required

PC 99A correction: ATA and ATAPI devices must meet the following support requirements and recommendations for Ultra DMA and IDE Bus Master DMA.

Support for Ultra DMA:

- Required for ATA controllers and ATA devices
- Recommended for ATAPI peripherals

  However, ATAPI devices might be connected to the ATA bus (which is required to support UDMA). Therefore, to ensure that ATAPI devices will tolerate Ultra DMA, ATAPI devices must support the termination scheme as defined in ATA/ATAPI-4 or SFF 8038i.

Support for IDE Bus Master DMA:

- Required for ATA controllers
- Required for ATA devices and ATAPI peripherals, including CD and DVD devices
- Recommended for ATA/ATAPI tape drives
- Recommended for ATAPI removable media drives

The host controller and hard disk devices must support bus mastering, and bus mastering must be enabled by default. When correctly implemented, bus master support ensures improved performance and Windows-compatible device driver support.

Bus master capabilities must meet the related specification for the particular controller. For example, the programming register set for PCI IDE bus master DMA is defined in the *ATA/ATAPI-4 Revision 17* or later standard and also in Small Form Factor (SFF) 8038i.

Note: This requirement does not apply to legacy floppy disk controllers (FDCs) and will not become a requirement for legacy FDCs.

18.2. Removable media devices support media status notification
Required

The following list shows the required specifications for implementing media status notification, depending on device type.

Device type	Media status notification implementation
CD and DVD devices	Required. Comply with A*NSI NCITS T10 Multi-Media Command Set-2 (MMC-2)* standard for Media Status Event Notification.
ATAPI floppy/optical direct access drives	Required. Comply with either MMC-2 standard or SFF 8070i Version 1.1.
IEEE 1394 storage devices	Required. Comply with *NCITS Reduced Block Commands* (RBC; T10/97-260r0) standard.
ATA and non-ATAPI storage devices	Required. Comply with *Media Status Notification Support, Version 1.03*.

Other ATA/ATAPI devices, including tape drives	Recommended. If implemented, comply with *Media Status Notification Support Specification, Version 1.03,* or SFF 8070i.
Other types of SCSI removable devices	Recommended. If implemented, support based on *NCITS Reduced Block Commands* standard is recommended.

PC 99A correction: The intent of this requirement is for devices to support the commands of the implemented bus interface so the operating system can detect when a media event has taken place. The requirements for removable storage devices are as follows; they apply either to single LUN devices or to devices that are part of a Multiple LUN device:

Device type	Media status notification implementation
All CD or DVD devices (independent of interconnect)	Required. Comply with *ANSI NCITS T10 Multi-Media Command Set-2 (MMC-2)* standard for Media Status Event Notification.
ATAPI floppy/optical direct access drives (PD, MO, removable magnetic floppy or rigid based, and so on.)	Required. Comply with either MMC-2 standard or SFF 8070i Version 1.1. See Chapter 18 section 24.
IEEE 1394 storage devices (non-CD / DVD)	Required. Comply with *NCITS Reduced Block Commands* (RBC; T10/97-260r0) standard.
ATA and non-ATAPI (IDE interconnect) storage devices	Required. Comply with *Media Status Notification Support, Version 1.03*.
Other ATA/ATAPI devices, including tape drives	Recommended. If implemented, comply with *Media Status Notification Support Specification, Version 1.03,* or SFF 8070i.
Other types of SCSI removable devices	Recommended. If implemented, support based on *NCITS Reduced Block Commands* standard is recommended.

18.3. Device meets PC 99 general device requirements

Required

These include the requirements for Plug and Play device IDs, automated software-only settings for device configuration, device drivers and Windows-based installation, and icons for external connectors. For more information, see "PC 99 General Device Requirements" in Chapter 3, "PC 99 Basic Requirements."

18.4. Device meets PC 99 requirements for ports or buses

Required

The device must meet all requirements for the port or bus to which it is attached. A drive that uses the parallel port must meet all the requirements defined for legacy Plug and Play parallel peripherals, including requirements for ECP mode, as defined in "Parallel Port Requirements" in Chapter 13, "I/O Ports and

Devices." If the device uses a USB, IEEE 1394, PCI, ATA, or SCSI connection, the device must meet the related requirements defined in Part 3 of this guide.

18.5. Device Bay storage device meets PC 99 requirements

Required

Device Bay is not required for PC 99 systems.

All Device Bay controllers and devices included with a PC 99 system or provided as retail devices must meet the requirements defined in *Device Bay Interface Specification, Version 1.0.* Any storage device designed as a Device Bay peripheral must also interface with either USB, IEEE 1394, or both. If it interfaces with USB, the device must support the *Universal Serial Bus Device Class Definition for Mass Storage Devices, Version 1.0* or later.

18.6. ATA controllers and devices support Ultra DMA

Required

PC 99A correction: See correction for item PC 99 3.47.

All ATA devices and controllers must support Ultra DMA at transfer rates up to 33 MB per second as defined in the ATA/ATAPI-4 or SFF 8038i standard, and as described in requirement 10.7, "Controller and peripherals support Ultra DMA."

PC 99A clarification: Under requirements for ATA controllers and devices to support Ultra DMA, implementations based on ATA/66 are compliant with this requirement.

Performance capabilities defined for CD and DVD devices in *PC 99 System Design Guide* are no longer based on the traditional marketing performance criteria such as 8X, 24X, and so on. Performance specifications are now based on the minimum sustained transfer rate that occurs anywhere on the disk; this allows a realistic evaluation of the actual performance of the device.

A peripheral that does not support the Ultra DMA transfer protocol must, at a minimum, implement the termination scheme required by this protocol in order to be tolerant of Ultra DMA.

Mobile PC Note

PC 99A clarification: This feature is *recommended* for controllers in docking stations. Controllers in mobile PC units are *required* to support Ultra DMA.

This is only a recommendation for controllers in docking stations because of a lack of controllers that support Ultra DMA and provide fully-relocatable resources. Under Windows 2000, controllers that do not have fully-relocatable resources will not function in a docking station.

18.7. USB-based mass storage device meets PC 99 requirements for USB

Required

If a USB-based mass-storage device, which could be a tape drive, UHD floppy drive, or CD drive, is implemented in a PC 99 system, it must meet the

requirements defined in Chapter 7, "USB." It must also meet the requirements defined in *Universal Serial Bus Device Class Definition for Mass Storage Devices, Version 1.0* or later.

18.8. System BIOS or option ROM supports El Torito No Emulation mode

Required

For PC systems that include CD or DVD drives, the system BIOS or option ROM must support the No Emulation mode defined in the specification *El Torito— Bootable CD-ROM Format Specification, Version 1.0,* published by IBM and Phoenix.

A removable USB mass storage device must not be the primary boot device.

18.9. System BIOS or option ROM supports bootable ARMD

Recommended

For PC systems that include ATAPI floppy drives, the system BIOS or option ROM should support the *ATAPI Removable Media Device (ARMD) Specification, Version 1.0* or later.

18.10. Host controller for secondary storage uses IEEE 1394

Recommended

The IEEE 1394 bus is recommended as the connection for the host controller for secondary storage. Any IEEE 1394 implementation must meet all requirements defined in Chapter 8, "IEEE 1394," including the requirement that controllers comply with *1394 Open Host Controller Interface Specification, Revision 1.0* (OpenHCI).

A removable IEEE 1394 mass storage device must not be the primary boot device.

Floppy Disk Controller and Drive

This section describes the specific requirements for any FDC provided with a PC 99 system. The device must also meet the general requirements defined in "Storage Controller and Peripherals Basic Features" and "PC 99 Design for Storage Components" in this chapter.

A PC 99 system is not required to include an FDC of any type. Although most systems include some form of floppy disk drive, some Office PC systems might not need one.

18.11. Floppy disk capabilities, if implemented, do not use legacy FDC

Recommended for all system types

To support migration away from legacy devices, it is recommended that support for floppy disk drives be provided by using a solution other than a legacy FDC. Solutions could include an MMC-2-compliant ATAPI floppy drive, USB, PC Card, SCSI, or ATA expansion card.

Any floppy disk implementation or legacy FDC that is included on a PC 99 system must meet the requirements specified in this chapter. Requirements for ATAPI peripherals are defined in Chapter 10, "ATA and ATAPI." See also the related recommendation for BIOS or option ROM boot support in requirement 3.5, "BIOS meets PC 99 requirements for boot support," plus requirement 18.9, "System BIOS or option ROM supports bootable ARMD."

18.12. Legacy FDC device meets resource configuration requirements, if present
Required

A legacy FDC is optional for PC 99 systems. If implemented, the following resource requirements must be met for each legacy FDC device on the system:

- Use static I/O addresses 3F2h, 3F4h, and 3F5h. Additional addresses can be provided in the event of conflict
- Use IRQ 6
- Use DMA Channel 2 if FDC supports block data transfers to memory using DMA controllers

These resources cannot be shared among devices of the same type.

18.13. System supports dynamic configuration of legacy FDC
Required

If a legacy FDC is included in the system, the FDC must be capable of being configured, relocated, and disabled. For example, if the legacy FDC is located on the system board and an adapter that includes an FDC is added to the system, the system-board FDC must be capable of being disabled to prevent conflicts with the new adapter.

If the legacy FDC is located on an expansion card, the expansion card must allow independent dynamic disabling of the FDC and the hard disk controller. In this case, the adapter will continue to function if the FDC is disabled because of conflicts.

Hard Disk Drives

This section summarizes specific requirements for hard disk drives. The device must also meet the general requirements defined in "Storage Controller and Peripherals Basic Features" and "PC 99 Design for Storage Components" in this chapter.

Note: BIOS support is required for LBA for all read and write operations to ATA disk drives that have capacities greater than 528 MB. For more information, see requirement 10.5, "System BIOS and devices support LBA."

18.14. Operating system recognizes the boot drive in a multiple-drive system
Required

The implementation of boot-drive determination in multiple-drive systems is defined in Section 5.0 of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*. This is the format that both Windows 98 and Windows 2000 operating systems use for determining the boot drive when new bootable devices are introduced to a PC. The system designer can use an equivalent method for boot-drive determination but the method must ensure that the Windows 98 and Windows 2000 operating systems recognize the boot drive.

18.15. Hard drive is SMART-compliant and uses SMART IOCTL API
Optional

The Self-Monitoring, Analysis, and Reporting Technology system (SMART) is an industry term used to describe technology that monitors and predicts device performance.

The *SMART IOCTL API Specification, Version 1.1* or later, published by Compaq Computer Corporation and Microsoft Corporation, describes the API used by an application to issue SMART commands to a hard drive under Microsoft Windows operating systems. If SMART compliance is implemented, the driver must support the SMART IOCTLs.

CD Devices

This section summarizes the requirements for CD peripherals. The device must also meet the general requirements defined in "Storage Controllers and Peripherals Basic Features" and "PC 99 Design for Storage Components" in this chapter, including requirement 18.1, "Storage controller and devices support bus master capabilities."

18.16. CD device provides 8x minimum transfer rate or better performance
Required

The minimum CD device media transfer rate for read operations must be no less than 1200 KB per second when running in the fully on power state.

18.17. CD drive is CD-Enhanced compatible
Required

The CD drive must be able to mount multisession CD-ROM discs, even if track 1 is Red Book audio. Microsoft recommends use of the Sony ReadTOC method for SCSI-2 multisession support as defined in the MMC-2 standard or SFF 8020i, Version 2.5 or later.

CD-Enhanced support must be Blue Book compliant, as defined in *Enhanced Music CD Specification, Version 1.0.*

18.18. CD drive supports specified logical and physical CD formats
Required

At a minimum, the CD drive must be compatible with the following formats to ensure cross-media compatibility, based on compliance with the *Optical Storage Technology Association (OSTA) MultiRead Specification for CD-ROM, CD-R, CD-R/RW, and DVD-ROM Devices, Version 1.11*:

- Logical formats: CD Red Book (CD-Audio), Yellow Book (CD-ROM), Orange Book parts II and III (packet writing if recordable),White Book, Blue Book, and UDF versions 1.5 and 2.0.
- Physical formats: ROM (stamped), and Orange Book part II (CD-R) and part III (CD-RW).

Note: Any ATAPI CD drive designed to play back CD-I content must return a minimum of two track entries for the READ_TOC (0x43) command. These two track entries must be a track 01 entry and a track 0xAA entry for the lead-out address. Drives that do not comply with this minimum requirement cannot play back CD-I movies.

18.19. ATA/ATAPI CD drive complies with SFF 8020i v. 2.6
Required

CD drives attached to the system using the ATA interface must support the hardware and protocols documented in *ATA Packet Interface for CD-ROMs,* SFF 8020i, Version 2.6 or later.

Note: Support for the READ CD-DA command as defined in the MMC-2 standard is recommended. This might become a requirement in future versions of these guidelines.

For DVD drives, see requirement 18.28, "DVD device complies with the MMC-2 standard," later in this chapter.

18.20. CD drive supports multisession and compatibility forms of the READ_TOC command
Required

Both multisession forms (01b and 10b) and the compatibility form (00b) of the READ_TOC command must be implemented. This ensures complete support for CD-ROM multisession capabilities.

For information about ATAPI peripheral support for CD-I content, see requirement 18.18, "CD drive supports specified logical and physical CD formats."

18.21. ATA/ATAPI CD changer complies with the MMC-2 standard
Required

If an ATAPI-compatible CD changer with a capacity for seven or fewer discs is present, the changer must comply with the MMC-2 standard or with SFF 8070i.

18.22. CD device supports digital audio detection
Required

CD drives must support the bit "CD Capabilities and Mechanical Status Page" (2Ah), as defined in the MMC-2 standard. The bit "CD-DA Commands Supported" must be set if the drive can provide digital audio streams. This bit must be unset if the drive is not capable of digital audio.

PC 99A correction: CD and DVD drives must implement "CD Capabilities and Mechanical Status Page" (2Ah), as defined in the MMC-2 standard. The bit "CD-DA Commands Supported" must be set and the functionality must be implemented.

The bit "CD-DA Stream is Accurate" of "CD Capabilities and Mechanical Status Page" can be set only if either the READ_CD command or READ_RAW command provides sector-accurate reads, as defined in MMC-2. Data alignment accuracy should be equivalent to that of data reads. Because of the lack of ECC bytes used for data tracks, the data itself may contain inaccuracies due to physical defects of the media. This bit must be unset if the conditions are not met.

PC 99A correction: CD and DVD drives must also implement and set the bit "CD-DA Stream is Accurate" of "CD Capabilities and Mechanical Status Page." The READ_CD command and READ_RAW commands must provide sector-accurate reads, as defined in MMC-2. Data alignment accuracy must be equivalent to that of data reads. Because of the lack of error correction code (ECC) bytes used for data tracks, the data itself may contain inaccuracies due to physical defects of the media.

18.23. CD device uses push-to-close design
Recommended

A motorized design is not required, but if it is implemented, the device must be designed so the user has three options for closing the device when inserting a disc:

- Physically pushing on the bay
- Physically pushing the close button on the bay housing
- Selecting a software-supported option to close the device

Rewritable Optical ATAPI Devices

This section summarizes specific requirements for rewritable optical storage devices. The device must also meet the general requirements defined in "Storage

Controller and Peripherals Basic Features" and "PC 99 Design for Storage Components" in this chapter.

18.24. Block rewritable optical ATAPI device complies with SFF 8070i
Required

SFF 8070i defines the requirements for block rewritable ATAPI devices, including specifications for logical unit number (LUN) implementation, media status notification, and device write protection. This also includes required support for the Read Format Capacities command.

DVD Devices

This section summarizes specific requirements for DVD devices. The device also must meet the general requirements defined in "Storage Controller and Peripherals Basic Features" and "PC 99 Design for Storage Components" in this chapter.

For information about the requirements for DVD-Video and MPEG-2 playback performance, see Chapter 15, "Video and Broadcast Components." For more information about DVD support under Windows 98 and Windows 2000 operating systems, see the articles at http://www.microsoft.com/hwdev/devdes/dvdwp.htm.

18.25. DVD device provides 2 MB per second minimum transfer rate or better performance anywhere on the disc
Required

PC 99A clarification: This requirement has been changed to read "DVD device provides 2 MB per second minimum transfer rate or better performance." The supporting text for the requirement remains the same.

The minimum sustained DVD device media transfer rate must be at least 2 MB per second for read operations from the DVD disc.

Recommended: A 4X DVD-ROM at 4 MB per second sustained from the DVD disc.

18.26. DVD drive and controller support bus master DMA transfers
Required

The drive and controller must support byte-aligned, multisegment, bus master DMA transfers. DMA must be enabled by default.

If attached by way of an ATA interface, ATAPI DVD drives and ATA system-board implementations must support DMA as specified in the ATA/ATAPI-4 standard or SFF 8090.

18.27. DVD drive meets minimum compatibility requirements
Required

DVD drives must support all the functionality of CD drives as outlined in "CD Devices" earlier in this chapter. Specifically, the DVD device must be compatible with the following formats to ensure that the DVD device can read earlier media:

- Logical formats: CD Red Book (CD-Audio), Yellow Book (CD-ROM), White Book, Orange Book parts II and III (packet writing), Blue Book, UDF versions 1.5 and 2.0, and DVD video if applicable.

- Physical formats: ROM (stamped), Orange Book part II (CD-R) and part III (CD-RW), and ECMA-267 and ECMA-268 (DVD-ROM).

Recommended: Support for ECMA-274 (PC+RW) and ECMA-272, 273 (DVD-RAM 1.0 and DVD-R).

PC 99A correction: Recommended: Support for ECMA-274 (+RW) and ECMA-272, 273 (DVD-RAM) and DVD-R.

Conforming to *OSTA MultiRead Specification, Version 1.11* indicates compliance with all of these compatibility requirements.

18.28. DVD device complies with the MMC-2 standard
Required

A DVD device must comply with the MMC-2 standard, which defines the implementation requirements that the Windows operating system supports. The drive must support the following commands:

Beh	Read CD	08h	Device reset
B9h	Read CD MSF	A0h	Packet
4Bh	Pause/resume	A1h	Identify packet device
E5h	Check power mode	Efh	Set features
90h	Execute device diagnostic	E6h	Sleep
E1h	Idle Immediately	E0h	Standby immediate
00h	NOP		

DVD devices must also support the following:

- Timeout model as designed and documented in MMC-2.

- Get Event Status command (Media Event Status class) and all related commands, including Persistent Prevent/Allow, as defined in MMC-2.

- Get Configuration command for Morphing class devices (Class 2), as defined in MMC-2. Windows 98 uses the Get Configuration command to determine whether media event status is supported correctly.

18.29. DVD device uses push-to-close design

Recommended

A motorized tray design is not required, but if it is implemented, the device must be designed so the user has three options for closing the device when inserting a disc:

- Physically pushing on the bay
- Physically pushing the close button on the bay housing
- Selecting a software-supported option to close the device

18.30. DVD device supports defect management

Required

DVD drives must support defect management that is transparent to the operating system, according to industry standards. Defect management for DVD-RAM media is defined in *DVD Specifications for Rewritable Disc, Part 1: Physical Specifications,* published by Toshiba Corporation. Defect management for DVD+RW is defined in ECMA-274.

PC 99A correction: Defect management for +RW media is defined in ECMA-274.

18.31. DVD device supports copyright protection

Required

The drive must support a licensed implementation of the CSS copyright-protection scheme and support CSS-protected discs to ensure proper protection for prerecorded video content as defined in the DVD specification.

Software is provided as part of the Windows 98 and Windows 2000 operating system support for DVD in order to facilitate the authentication process required by this scheme. This allows a DVD drive to authenticate and transfer keys with a CSS content decrypter. Windows 98 and Windows 2000 operating system software will act as the agent to allow either hardware or software decrypters to be authenticated.

PC 99 Design for Storage Components

This section summarizes requirements related to Plug and Play and other bus-related and resource-related design issues for storage devices.

Plug and Play and Bus Design for Storage Components

The items in this section are requirements for Plug and Play capabilities.

18.32. Each device has a Plug and Play device ID

Required

For each system-board device, there must be a device-specific ID.

Each device must provide Plug and Play device IDs in the manner required for the bus it uses as defined in Part 3 of this guide. For example, a PCI add-on device must comply with PCI 2.1 requirements and also must provide a Subsystem ID and Subsystem Vendor ID, as defined in Chapter 9, "PCI."

18.33. Dynamic resource configuration is supported for all devices

Required

To ensure conflict resolution for resource allocation, the device must conform to the Plug and Play specifications for the bus it uses, as described in Part 3 of this guide. The system must be able to automatically configure, relocate, or disable the resources used by the device if conflicts occur when an expansion card is added to the system.

Devices must be capable of being disabled with software settings only. Configuring or adding a device must not require rebooting or jumper setting changes. Disabling the device must result in freeing all its resources for use by other devices. DIP switches on boot devices can be used for an initial power-on default state or for non-Plug and Play system compatibility, but must be able to be overridden by software configuration after system power up.

The primary hard disk controller is not required to support dynamic disable capabilities.

Note: This requirement does not apply to jumper settings used by the OEM to make basic system-related settings in the factory. This requirement applies only to settings that the end user must make to configure the hardware.

18.34. 3F7h and 377h are unclaimed by devices

Required

To avoid having two devices in the system claim 3F7h and 377h, these addresses must not be claimed for device registers by ATA devices.

It is recognized that some FDC devices claim this range. Such devices can be implemented in a PC 99 system; however, the system manufacturer must ensure that only a single device in the system claims this range.

18.35. Physical security is provided for storage devices

Recommended

External drive devices should have locking capabilities. Each removable media device should be capable of being locked to prevent unauthorized access to data. This means that the device is rendered useless, either electronically or mechanically.

18.36. Option ROMs support Int 13h Extensions

Required

PC 99A clarification: This requirement also applies for RAID controllers implemented on client systems such as workstations.

The Int 13h Extensions ensure correct support for high-capacity drives, consistent drive-letter mapping between real and protected modes, and other capabilities for both Windows 98 and Windows 2000 operating systems. 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 and in the Windows 2000 DDK.

PC 99A clarification: The Int 13h Extensions are defined in "Chapter 14: Int 13 Extension APIs" in the "Storage Technology Reference" in the "Windows 95 Documentation" in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/storage_60q9.htm).

In addition, it is recommended that BIOS interrupt services should provide a protocol-independent method using the Int 40h extension to support ATAPI floppy drives as specified in the ARMD Specification, Version 1.0.

Power Management for Storage Components

This section summarizes specific power management requirements for storage devices.

18.37. Device and controller comply with device class power management reference specification

Required

The *Storage Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions of the OnNow device power states (D0–D3) for these devices. The specification also covers device functionality expected in each power state and possible wake-up event definitions for the class. Support is required for power states D0, D1, and D3 for hard disks, CD and DVD drives, and other mass storage devices. Support for the D1 state is not required for floppy disk devices.

Mobile PC Note   For mobile hard drives, it is recommended that a Read operation typically be completed within 5 seconds of applying power or leaving the D1 state and transitioning to D3. For desktop systems, the recommendation is 10 seconds.

The drive spinup time recommendation is not expected to become a requirement in future versions of this guide.

18.38. Device supports wake-up events

Optional

The ability to cause a wake-up event as defined in the *Storage Device Class Power Management Reference Specification, Version 1.0* or later, is an optional feature.

Device Drivers and Installation for Storage

This section summarizes the basic requirements for device drivers and installation procedures for storage devices.

18.39. Device drivers and installation meet PC 99 requirements

Required

The manufacturer does not need to supply a driver if a PC 99-compliant driver provided with the operating system can be used. If the manufacturer supplies a driver, it must comply with requirement 3.16, "Device driver and installation meet PC 99 requirements." The basic requirements include driver support for unattended installation and Help file support if special driver parameters are used.

Ease-of-use requirements for installation and configuration are defined for SCSI peripherals and for ATA and ATAPI devices in Part 3 of this guide. For information about WDM support for devices that use the USB or IEEE 1394 bus, see the Windows 2000 DDK. See also the related articles on the web site at http://www.microsoft.com/hwdev/wdm/.

PC 99A clarification: For information about storage device driver support under Windows 2000, see "Part 3: Storage Drivers" in the "Kernel-Mode Drivers Reference" in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/k301_2ur6.htm).

For information about storage device driver support under Windows 98, see "Storage Technology Reference" in the Windows 95 DDK (included with the Windows 98 DDK and available online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/storage_5ku1.htm).

For information about WDM support for devices that use the USB or IEEE 1394 bus, see "Part 5: USB Drivers" and "Part 6: IEEE 1394 Drivers" in the "Kernel-Mode Drivers Reference" in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/usbirp_85rm.htm).

18.40. Device driver runs in protected mode following installation

Required

The device driver must be running in 32-bit protected mode, not compatibility mode, immediately following installation.

Note: Although it is preferred that a system reboot not be required as part of device installation, it is recognized that installation of boot devices presents a

special situation. It is acceptable that installation of a boot device includes restarting the system.

18.41. Applications provided with the device meet Win32 requirements

Required

Any Windows-based applications provided with the device must meet requirements for software compatibility as defined in the Microsoft Platform SDK. However, any software applications included with the device can be installed using an alternate Windows-based installation method as defined in the Microsoft Platform SDK.

18.42. Device driver for partitioned media supports all Windows 98 and Windows 2000 partition types

Required

Device drivers that support partitioned media must support all Windows 98 and Windows 2000 partition types, which include but are not limited to FAT16, FAT32, and NTFS, plus UDF 1.5 and 2.0 for CD and DVD.

18.43. Device driver for block-mode device supports extended BPBs

Required

Storage subsystems that include an MS-DOS–based block-mode device driver, for example, Aspidisk.sys, must support Extended BIOS Parameter Blocks (BPBs) in the Build BPB device driver function call, and must support category=48 in the generic IOCTL device driver interface calls, as specified in the 1996 update to the Windows 95 DDK.

PC 99A clarification: For information, see "Chapter 1: Layered Block Device Drivers" in the "Storage Technology Reference" in the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/storage_5kvk.htm).

Storage References and Resources

This section lists resources for building storage hardware that works with the Windows 98 and Windows 2000 operating systems.

1394 Open Host Controller Interface Specification, Revision 1.0
     ftp://ftp.austin.ibm.com/pub/chrptech/1394ohci/

ATA/ATAPI-4 Revision 17 Working Draft Standard (ATA/ATAPI-4)

ATA Packet Interface for CD-ROMs (SFF 8020*I*)

Other ATA and SCSI standards

   Global Engineering Documents

   Fax: (303) 397-2740

   Phone: (800) 854-7179 (U.S.)

            (613) 237-4250 (Canada)

            (303) 792-2181 (Outside North America)

   ATA and ATAPI draft standards and other working documents are available at ftp://fission.dt.wdc.com/pub/standards/ and ftp://ftp.symbios.com/pub/standards/io/

Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01

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

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

Device Bay Interface Specification, Version 1.0

   http://www.device-bay.org

Device driver support for storage devices and DVD white papers

   http://www.microsoft.com/hwdev/storage/

ECMA Standards ECMA-267 (DVD-ROM), ECMA-274 (DVD+RW)

     and ECMA-272, 273 (DVD-RAM)

   http://www.ecma.ch

FAT32 partition device driver support

   http://www.microsoft.com/hwdev/storage/

Media Status Notification Support Specification, Version 1.03

Plug and Play specifications

SMART IOCTL API Specification, Version 1.1

   http://msdn.microsoft.com/library/

Microsoft Windows 95 DDK, Windows 98 DDK, Windows 2000 DDK,

     and Microsoft Platform SDK

   MSDN Professional subscription

MMC-2 Multi-Media Command Set-2

   ftp://ftp.symbios.com/pub/standards/io/t10/drafts/mmc2/

Multisession Compact Disc Specification Enhanced Music CD Specification,

     Version 1.0

   Philips Consumer Electronics B.V.

   Coordination Office Optical–Magnetic Media Systems

   Building SWA-109, PO Box 80002

   5600 JB Eindhoven, The Netherlands

   Fax: (31) (40) 732113

National Committee for Information Technology Standards (NCITS) Reduced

     Block Commands (RBC) T10/97-260r0

   ftp://ftp.symbios.com/pub/standards/io/t10/drafts/rbc/

OSTA MultiRead Specification for CD-ROM, CD-R, CD-R/RW, and DVD-ROM Devices, Version 1.11
Universal Disk Format Specification, Version 1.5 and 2.0
http://www.osta.org

SFF Committee publications
FaxAccess: (408) 741-1600 (fax-back)
Fax: (408) 867-2115

Storage Device Class Power Management Reference Specification, Version 1.0
http://www.microsoft.com/hwdev/specs/PMref/PMstore.htm

Universal Serial Bus Device Class Definition for Mass Storage Devices, Version 1.0
http://www.usb.org/developers/index.html

WDM device driver support white papers
http://www.microsoft.com/hwdev/wdm/

Checklist for Storage and Related Peripherals

If a recommended feature is implemented, it must meet the PC 98 requirements for that feature as defined in this document.

18.1. Storage controller and hard disk devices support bus master capabilities
Required

18.2. Removable media devices support media status notification
Required

18.3. Device meets PC 99 general device requirements
Required

18.4. Device meets PC 99 requirements for ports or buses
Required

18.5. Device Bay storage device meets PC 99 requirements
Required

18.6. ATA controllers and devices support Ultra DMA
Required

18.7. USB-based mass storage device meets PC 99 requirements for USB
Required

18.8. System BIOS or option ROM supports El Torito No Emulation mode
Required

18.9. System BIOS or option ROM supports bootable ARMD
Recommended

18.10. Host controller for secondary storage uses IEEE 1394
Recommended

18.11. Floppy disk capabilities, if implemented, do not use legacy FDC
Recommended for all system types

18.12. Legacy FDC device meets resource configuration requirements, if present
Required

18.13. System supports dynamic configuration of legacy FDC
Required

18.14. Operating system recognizes the boot drive in a multiple-drive system
Required

18.15. Hard drive is SMART-compliant and uses SMART IOCTL API
Optional

18.16. CD device provides 8x minimum transfer rate or better performance
Required

18.17. CD drive is CD-Enhanced compatible
Required

18.18. CD drive supports specified logical and physical CD formats
Required

18.19. ATA/ATAPI CD drive complies with SFF 8020i v. 2.6
Required

18.20. CD drive supports multisession and compatibility forms of the READ_TOC command
Required

18.21. ATA/ATAPI CD changer complies with the MMC-2 standard
Required

18.22. CD device supports digital audio detection
Required

18.23. CD device uses push-to-close design
Recommended

18.24. Block rewritable optical ATAPI device complies with SFF 8070i
Required

18.25. DVD device provides 2 MB per second minimum transfer rate or better performance anywhere on the disc
Required

18.26. DVD drive and controller support bus master DMA transfers
Required

18.27. DVD drive meets minimum compatibility requirements
Required

18.28. DVD device complies with the MMC-2 standard
Required

18.29. DVD device uses push-to-close design
Recommended

18.30. DVD device supports defect management
Required

18.31. DVD device supports copyright protection
Required

18.32. Each device has a Plug and Play device ID
Required

18.33. Dynamic resource configuration is supported for all devices
Required

18.34. 3F7h and 377h are unclaimed by devices
Required

18.35. Physical security is provided for storage devices
Recommended

18.36. Option ROMs support Int 13h Extensions
Required

18.37. Device and controller comply with device class power management reference specification
Required

18.38. Device supports wake-up events
Optional

18.39. Device drivers and installation meet PC 99 requirements
Required

18.40. Device driver runs in protected mode following installation
Required

18.41. Applications provided with the device meet Win32 requirements
Required

18.42. Device driver for partitioned media supports all Windows and Windows NT partition types
Required

18.43. Device driver for block-mode device supports extended BPBs
Required