C H A P T E R   3

PC 99 Basic Requirements

This chapter summarizes the basic features required for all PC 99 systems, with specific requirements for Consumer, Office, Mobile, Workstation, and Entertainment PC systems.

For definitions of common terms, acronyms, and abbreviations used in this guide, see the Glossary; see also "Conventions Used in This Guide" in "Welcome."

Important: The system requirements defined in this guide provide guidelines for designing PC systems that will result in an optimal user experience with typical Windows-based applications running under either the Microsoft Windows 98 or Windows 2000 Professional operating systems. These design requirements are not the basic system requirements for running Windows operating systems.

Contents

PC 99 General System Requirements

This section presents a summary of the general system requirements and recommendations, including system board, memory, and BIOS requirements.

3.1. System performance meets PC 99 minimum requirements

Consumer	Office	Mobile	Workstation	Entertainment
300 MHz, 32 MB	300 MHz, 64 MB	233 MHz, 32 MB	400 MHz, 128 MB	300 MHz 64 MB

The performance requirements for PC 99 systems are based on the minimum computational capabilities and performance necessary to support the demands of Windows-based applications together with the estimated processing demand and processing capability of the lowest-end processor in mid-1999.

The minimum performance requirement consists of the following:

- **3.1.1 System includes CPU and L2 cache that meets PC 99 minimum requirements.** The minimum microprocessor capability is specified to support the demands of rich media, Internet access, and conferencing. The performance requirement for media enhancement is specified to ensure that the system meets performance targets at minimum platform power.

  This processor requirement does not specify a particular processor form factor or package type.

  - Consumer PC, Office PC, and Entertainment PC: 300 MHz Intel Architecture compatible processor with 128K Level 2 (L2) cache

  - Mobile PC: 233 MHz Intel Architecture compatible processor with 128K L2 cache

  - Workstation PC: 400 MHz or greater Intel Architecture compatible processor with 512K L2 cache

    For multiprocessor workstations, a minimum 512K cache is required per processor.

    PC 99A correction for workstations: The minimum required L2 cache is 256K per processor.

  Recommended: Processor supports multimedia extensions.

  This processor requirement does not specify a particular processor form factor or package type. DEC Alpha implementations that meet or exceed these performance requirements are also acceptable for systems that run Windows 2000.

- **3.1.2 System memory meets PC 99 minimum requirements.**
  - Consumer PC and Mobile PC: 32 MB required; 64 MB recommended
  - Office PC and Entertainment PC: 64 MB
  - Workstation PC: 128 MB RAM

  For all systems, a minimum of 28 MB of memory must be available for the system to use at boot time. These minimum RAM requirements do not preclude applications that use dynamically allocated memory for audio or video playback or other temporary uses.

- **3.1.3 Multiprocessor support is MPS and ACPI compliant.** If multi-
  processor support is provided in any system using Intel Architecture, such
  support must comply with *MultiProcessor Specification, Version 1.4* or later,
  and the Advanced Programmable Interrupt Controller (APIC) extension to the
  Advanced Configuration and Power Interface Specification (ACPI)*, Revision
  1.0* or later specification.

Support for both MPS 1.4 and ACPI 1.0 helps customers through the transition
from Windows NT 4.0 to Windows 2000; however, Windows 2000 uses only
ACPI methods. A DEC Alpha system meets the requirements for
multiprocessor support.

PC 99A clarifications for multiprocessor systems:

1. PCI IRQ Routing on Multiprocessors. For information about the
requirements for PCI IRQ routing on a multiprocessor Advanced
Configuration and Power Interface (ACPI) system, see PCI IRQ Routing on a
Multiprocessor ACPI System at http://www.microsoft.com/hwdev/onnow/acpi-
mp.htm.

2. Multiprocessor Wakeup. A problem has been uncovered with certain
multiprocessor systems that will prevent them from properly waking up from a
Sleep state under Windows 2000. This pertains to dual-processor or multi-
processor systems that transition all processors from an active state to a
STPCLK state, and more specifically to systems where all processors receive
their STPCLK# request from one source.

Prior to transitioning from a STPCLK state to a Sleep state or lower power
state, all processors must generate a Stop Grant Bus cycle. It is essential that
all processors have transitioned into the STPGNT state before it is safe to: 1)
transition to a lower power state such as Sleep, or 2) externally shut off the
processor clocks to allow for flushing buffers, cache maintenance, and other
internal activities.

For dual-processor and multiprocessor systems using a single STPCLK to all
processors and a single SLP pin to all processors, the transition to the Sleep
state should not be used. Behavior of the system during removal of the
processor clock—such as transitions from STPCLK to Sleep state—cannot be
guaranteed unless all STPGNT bus cycles are received.

For example, *Intel® Xeon™ II Specification*, "Section 4.2.5 Sleep State-State
5," specifies that for a multiprocessor system, all processors are required to
complete the Stop Grant bus cycle before the subsequent 100 BCLK waiting
period and before the assertion of SLP# can occur. When multiple processors
are serviced by a single STPCLK request to all processors and a single SLP,
there is no provision to guarantee that all Stop Grant bus cycles are received
before the assertion of SLP.

As another example, in 450NX-based platforms from Intel, the STPCLK#
from PIIX4E is connected to all processors, and SLP# from PIIX4E is
connected to all processors. The following sequence occurs:

t0. Operating system writes PMCNTRL register.
t1. PIIX4E asserts STPCLK#, then waits for Stop Grant acknowledgment.
t3. The processor acknowledges with Stop Grant ACK cycle.
t4. PIIX4E asserts SLP# after receiving this.

This sequence works for uniprocessor systems (which is what the PIIX4E was originally designed for). However, in multiprocessor systems, SLP# might be asserted to a processor that is not in Processor Sleep State 3 (that is, not yet acknowledged). This premature SLP# assertion might result in a wakeup problem.

Intel provides additional information about this issue through the Intel Technical Support Hotline at 1-800-628-8686 (outside North America at 1-916-377-7000).

For more information, see http://www.microsoft.com/hwdev/winlogo/99logo.htm.

Note: All requirements in this guide for DEC Alpha PCs are for the Windows 2000 operating system only. There are no plans to enable Windows to run on DEC Alpha PCs.

Mobile PC Note   For complete performance guidelines and exceptions for workstation and mobile PCs, see Chapter 4, "Workstation PC 99," and Chapter 6, "Mobile PC 99."

3.2. System design meets ACPI 1.0 specification and PC 99 requirements
Required for all system types, with exceptions for mobile PCs

The system board must support *Advanced Configuration and Power Interface Specification, Revision 1.0* or later. This requirement ensures that the system correctly supports Plug and Play and power management.

PC 99A note: *ACPI Specification, Revision 1.1* has been published on the ACPI web site at http://www.teleport.com/~acpi/. The draft process for Revision 2.0 is underway, as of Q1 1999.

ACPI support must include the following:

- **3.2.1 System includes power management timer, button, and alarm.**
  The system must include a power-management timer and Power button in compliance with the ACPI 1.0 specification. This should be implemented as described in requirement 3.3, "Hardware design supports OnNow and Instantly Available PC initiatives." A separate reset switch is an acceptable alternative to the ACPI-specified override mechanism.

  The real-time clock alarm must support wake-up due to a scheduled time and day of the month. Notice that the day-of-month feature is a requirement, although it is an optional feature in the ACPI 1.0 specification.

  The system must also provide a system control interrupt and Status and Enable (STS/EN) bits for the power-management timer, power button, and real-time clock.

- **3.2.2 System supports S5 state.** The system must support the S5 (soft-off) state, as required in the ACPI 1.0 specification, plus either the S1, S2, or S3 sleep state. Support of S4 or S4BIOS is optional. It is recommended that the S3 sleep state, meaning Suspend To RAM, is supported to provide the optimal user experience and power savings.

  Recommended: The system supports one sleep state that reduces overall system power consumption in accordance with the EPA ENERGY STAR guidelines for computers.

  Note: It is likely that support for the S3 state will be required in future design guides.

- **3.2.3 System includes a description table for system-board devices and ACPI control methods for configuring buses and devices.** The description table for system-board devices (including host PCI bridges) defines the complete hierarchy, including all non-Plug and Play devices to be enumerated and all other devices for which power management or removal capabilities have been added in the system-board design.

  The system must include ACPI control methods necessary for configuring each bus and device enumerated using ACPI, as described in requirement 3.12, "Each bus and device meets Plug and Play specifications."

- **3.2.4 USB controller can wake the system from at least one supported sleep state.** The Universal Serial Bus (USB) host controller must support wake-up capabilities in one of the following system states: S1 or S2. Supporting wake-up from the S3 state is recommended.

  Notice that if wake-up from the S2 or S3 state is supported, wake-up must be supported for all higher power sleep states. For example, if the controller supports wake-up from the S2 state, it must also support wake-up from the S1 state.

  Supporting wake-up from the S3 state is expected to become a requirement in future versions of these guidelines.

- **3.2.5 System provides no user-accessible method for disabling ACPI in the BIOS.** If the system includes a BIOS setting that the manufacturer can use to switch between ACPI and APM modes, this setting must not be exposed to the end user in CMOS setting or other means once a Microsoft ACPI-enabled operating system has been installed. Disabling ACPI will cause boot failures, because Windows 2000 relies on it for identification and initialization of system devices. Not having an option to "disable" ACPI support does not impact the ability to properly load an operating system that is not ACPI compatible.

The following power management features are recommended for all PC 99 systems:

- **System should implement ACPI thermal model and fan control.** It is recommended to implement a thermal model and fan control as defined in Section 12 of the ACPI 1.0 specification as a means of running the PC quietly while it is working and turning the fan off while it is sleeping.

  Notice that a hardware-based, open-loop thermal control is an acceptable implementation for system cooling if it meets requirement 3.7, "Audible noise meets PC 99 requirements." However, the recommended implementation is a closed-loop control using the PC's processor, an embedded controller, or both. If a closed-loop implementation is used, it must comply with the ACPI 1.0 specification.

- **BIOS should support standard options for automatic restart in the event of system power loss.** It is recommended to have a BIOS setup option that allows users to select the desired restart behavior of the PC after a system power loss. Systems should provide three standard restart options:

  1) Always restart
  2) Remain off
  3) Return to the same state (either off or on) as before power loss

  The third option (return to last state) should be set as the system default.

  If this restart selection feature is supported, it must be implemented as an OEM extension using ACPI control methods to facilitate future standardization and enhanced support in Windows operating systems such as a standard application programming interface (API).

  Also, in addition to any user interface provided by a BIOS setup program, a user interface to select the restart option must be implemented as a property page extension to the Windows Power Management control panel.

Note: Any other system-board power management or Plug and Play features must be implemented in compliance with the ACPI 1.0 specification, even if a particular feature is not a specific requirement or recommendation.

3.3. Hardware design supports OnNow and Instantly Available PC initiatives
Required for all system types, with exceptions for mobile PCs

Elements of the OnNow design initiative ensure that the operating system and device drivers control the state of individual devices and the system board. The Instantly Available PC initiative is fully consistent with the OnNow design initiative and provides guidelines for hardware design to ensure efficient power management on the desktop.

These initiatives are based on these goals for the user experience:

- The user experiences the PC as off when it is in a sleep state

- The user can easily see whether the PC is working or sleeping

- The user can easily control power through switches and software

Based on these goals, the following is required to support the OnNow and Instantly Available PC initiatives:

- **3.3.1 System and devices appear as off in the sleep state.** At a minimum, all media drives, display, sound, input devices, and fans must be perceived as off while the system is in a sleep state, for example, no noise or lights other than the status indicator.

- **3.3.2 System provides one or more indicators to show whether the system is in the working or sleep state.**

  Recommended: A non-flashing, light-emitting diode (LED) sleep indicator that is a different color than the wake indicator. A slowly blinking LED indicator (less than 1 Hz) is also an acceptable implementation. This applies for S1, S2, and S3 system states.

  The nonvolatile sleep state, S4 or S4BIOS, should appear to the user as the off state (S5); therefore, all of these states should have the same indicator.

  If telephone answering machine capabilities are built into the system, then a Message Waiting indicator should be included on desktop systems.

- **3.3.3 System provides software-controlled, ACPI-based power switch.** The system must provide an easily accessible power switch that can be controlled by software and that supports the functionality required in Section 4.7.2.2.1 of the ACPI 1.0 specification.

  This requirement for an easily accessible power switch does not preclude power-control capabilities, such as closing the lid on a mobile PC.

  The following provides implementation guidelines for the power switch:

  - The power switch can be implemented as either a power button or a sleep button. It is recommended to implement both buttons for desktop and mobile PCs. If both buttons are implemented, the sleep button should be the user's primary switch interface and must be easily distinguishable from the power button. The preferred implementation is to hide the power button.

  - The function of these buttons is determined by the operating system. The default action for the sleep button is to cause the machine to enter a sleep state. The default action for the power button is to shut down the operating system and power off the machine.

    In a single-button configuration, the button can be used for either sleep/wake transitions (G0<−>G1/S1-S4) or off/on transitions (G0<−>G2/S5), depending on user preference and the policy set in the operating system.

    In a two-button configuration that includes separate power and sleep buttons, the user interface provided by the operating system will allow only the default actions.

- In case of a hardware or software failure that prevents normal operation of the software-controlled buttons, the switch capabilities must include an override mechanism for turning off the PC.

  A 4-second override mechanism is recommended in Section 4.7.2.2.1 of the ACPI 1.0 specification. The override can be on either the power button or the sleep button in a two-button configuration, but it is recommended that the override be associated with the sleep button in order to establish an industry-standard implementation.

  An acceptable but not recommended alternative to the 4-second override is a separate hidden or recessed switch that cannot be mistaken for either the power button or the sleep button.

  Notice that the override mechanism is not an alternative way for the user to turn off the PC in normal operation; it is only a fail-safe function for fault conditions.

- If the power switch is provided on the keyboard, the key must be clearly labeled and must consist of a single keystroke for turning on the PC, to ensure accessibility for persons with disabilities. (Two keystrokes can be used to turn off the PC.) For information about scan codes for keyboard power switches, see the information available on the web site at http://www.microsoft.com/hwdev/desinit/scancode.htm.

- **3.3.4 Each device supports the power management specifications for its class.** All devices and drivers must support the D0 and D3 power states consistent with the definitions in the relevant device class power management reference specification and the *Default Device Class Power Management Specification, Version 1.0* or later. Support of D1 and D2 states is optional unless stated as required in the relevant device class specification.

  This means that each device can successfully survive a system sleep/wake transition (where the device transitions from D0 to D3 to D0) without losing functionality and without requiring user intervention to restore functionality. This applies whether or not system power is removed while the device is in the D3 power state.

  There is no power consumption requirement for devices in the D3 power state. It is recommended, however, that devices implement the D3 power state such that device power consumption is reduced to near zero. This recognizes that there is no requirement to retain any device context because it will be preserved or restored by the driver when returning to the D0 power state.

  PCI, USB, IEEE 1394, and PC Card buses must support power management requirements as defined in their related bus standards. For information, see the respective chapters in Part 3 of this guide.

- **3.3.5 System power supply provides "standby" power for system wake-up events.** A minimum of 720mA of "standby" power is required to support wake-up devices on PCI or USB when the system is in the ACPI S3, S4, or S5 state. For more information, see the Instantly Available PC System Power

Delivery Requirements and Recommendations available from the web site at http://developer.intel.com/design/power/supply98.htm.

Mobile PC Note   This requirement for the system power supply does not apply to mobile PCs.

3.4. BIOS meets PC 99 requirements for OnNow support

Required for all system types

This requirement does not apply for DEC Alpha PCs, except for the requirement for fast power-on self test (POST).

The intention of this requirement is to ensure that the end user is not presented with confusing information and unnecessary visual display, and to ensure that access to error information remains available using a hot key.

The following BIOS capabilities are required for OnNow support:

- **3.4.1 BIOS supports Fast POST.** The system must be available to the user as quickly as possible. Although a specific time limit is not established, the basic recommendation is that power on to the bootstrap loader should occur within 5 seconds, plus hard disk ready time, option ROMs, and time required for error correction code (ECC) scrubbing.

  Future design guidelines are likely to require a specific time limit for boot speed. In the meantime, the following are recommended ways to reduce processing overhead to make system boot time as fast as possible:

  - No video memory test and limited test DRAM size.

  - No tests for serial or parallel ports.

  - No floppy disk test or media check (the system boots from a hard disk or network).

  - No tests for the hard disk controller or drive type (if the system does not include swappable drives).

  - Test execution is controlled using Windows-based control panel or application that can be scheduled to run periodically at off-hours.

  - Fast POST mode for BIOS (the mode can be disabled by the user for troubleshooting).

  - Compliance with the *Simple Boot Flag Specification, Version 1.0* or later. This enables the BIOS to boot quickly when the last boot was successful and to perform diagnostics only if a problem occurred on the previous boot. Enabling and disabling this feature can be provided in the BIOS configuration program for compatibility with operating systems that do not support the Simple Boot Flag.

- **3.4.2 Resume from sleep state (S1–S4) to operating system handoff occurs within 500 ms.** This requirement does not apply for the S4BIOS state. For all other sleep states, the time to operating system handoff is measured from when the processor starts running (first instruction) until the BIOS jumps to the

Waking Vector in the ACPI firmware control structure table, as described in Section 5.2.6 in the ACPI 1.0 specification.

- **3.4.3 System presents minimal start-up display.** System start-up must only draw the end user's attention in case of errors or when there is a need for user action. By default, the system must be configured so the screen display does not display memory counts, device status, and so on, but presents a "clean" BIOS start-up.

  The default configuration must allow a beep during the boot process only in case of an error. The only screen display allowed is the OEM splash screen, which can include information such as copyright notices.

  However, the system start-up process can include the following:

  - Manufacturer branding messages.

  - A blank start-up screen.

  - A hot-key override to display screen messages for troubleshooting or to display user-definable CMOS settings.

  - Text-based messages related to end-user action. Examples are: messages to display the setup hot key, the system help hot key, password entry, network log on for remote booting, and so on.

  - A CMOS option to turn the clean start-up screen off and on.

3.5. BIOS meets PC 99 requirements for boot support
Required for all systems, with exceptions for mobile PCs
This requirement does not apply for DEC Alpha PCs.

ACPI BIOS entries, as defined in Section 1.6 of the ACPI 1.0 specification, should be the same for supporting either Windows 98 or Windows 2000. In general, the run-time services portion of the Plug and Play BIOS is replaced by ACPI and therefore is not required. The Extended System Configuration Data (ESCD) calling interface is not supported by Windows 98 or Windows 2000.

The BIOS boot support requirements include the following:

- **3.5.1 BIOS supports preboot execution environment, with unique system ID provided in print.** For Office PC 99, the system's execution environment must conform to the description given in "Attachment B: Preboot Execution Environment" of *Network PC System Design Guidelines.*

  For Consumer PC 99 and Entertainment PC 99, this means providing a unique PXENV system identifier (ID) structure in the system BIOS or CMOS, as defined in "Attachment B: Preboot Execution Environment" of *Network PC System Design Guidelines.*

  PC 99A clarification: PXENV specifications. The specification cited for a unique PXENV system identifier is *Network PC System Design Guidelines, Version 1.0b*, plus the additional information in the related FAQ at

http://www.microsoft.com/hwdev/netpc.htm. This is the specification upon which the Windows 2000 implementation was based; it is not the later information defined in *Wired for Management, Version 2.0* or later. As indicated in *PC 99 System Design Guide*, one possible implementation for remote boot is defined in *Wired for Management, Version 1.1a*.

In addition, for Office PC and Workstation PC systems, the unique system ID must be provided to the user in printed form, for assistance in environments where it might be used as part of pre-staging systems. This mechanism is left up to the system manufacturer, but suggested means include posting the unique system ID on the system chassis or case, or printed on the shipping carton. The printed form will likely become a requirement for Consumer PC and Entertainment PC systems in future versions of these design guidelines.

PC 99 A clarification: Mobile PC Note Only mobile PCs that ship with an integrated network adapter are required to provide the unique system ID in printed form. The initial use of the unique system ID will be for creating a Machine Account Object for the remote installation service. Currently, no Microsoft operating system supports remote installation using a PC Card network adapter.

- **3.5.2 BIOS supports booting the system from a CD or DVD device.** For any system that includes a CD or DVD drive, the system BIOS or option ROM must support the No Emulation mode in *El Torito—Bootable CD-ROM Format Specification, Version 1.0,* by IBM and Phoenix Technologies, Limited, or an equivalent method that supports the process for installing Windows from compact disc.

- **3.5.3 BIOS supports booting the system from the network.** For any system that includes a network adapter, the system BIOS must comply with the requirements defined in Sections 3 and 4, as they apply to Plug and Play devices, of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*, which describes the requirements for Initial Program Load (IPL) devices.

The system must also allow all boot devices to be configured as to order of precedence for boot. This mechanism must clearly show how the system will order boot devices when end users are making configuration choices. For example, in a system that permits booting from floppy drive, hard drive, CD or DVD drive, and network adapter, it must be clear to the end user how to set a boot order that favors a specific device such as the network adapter.

In addition, for any system that includes a network adapter, a key sequence must be provided to invoke a pop-up screen that allows the user to force a system boot initiated from the network adapter. This key sequence must be enabled by default. Configuration of this feature can be provided through a CMOS configuration setting. When this feature is enabled, the boot display must indicate the key sequence that will invoke the pop-up screen that would allow a network boot. This display must appear for a duration sufficient to be read by users, but must not lengthen the overall time needed to boot the machine.

This feature must be implemented in accordance with Appendix C of the *Compaq, Intel, Phoenix BIOS Boot Specification, Version 1.01*. Notice that this feature is a PC 99 requirement, although it is optional in the *BIOS Boot Specification*.

For a consistent user experience across all system brands and types, it is suggested that system and BIOS manufacturers standardize on the F12 key to perform this action. It is expected that F12 or another standard key sequence will become a requirement in future versions of the design guidelines.

- **3.5.4 BIOS properly accommodates all dates.** Dates, including the year 2000 and beyond, correctly supported in BIOS and CMOS.

- **3.5.5 BIOS on Office PC supports security.** Office PC systems must provide some mechanism for security, such as a pre-boot password, to protect enable/disable capabilities for hardware components before the operating system boots.

  This capability is also recommended for other system types. The purpose of this feature is to prevent end users from accidentally or purposefully circumventing operating system–level security and control as applied by an administrator.

- **3.5.6 BIOS on Office PC supports BIOS updates and revisions.** BIOS updates must be implemented in order for BIOS ROMs to be upgraded to a new image through OEM-provided programs. The following methods can be used to meet this requirement:

  - Through a remote new system setup mechanism downloaded and executed at boot time as described in Chapter 20, "Network Communications"

  - Through a normal file access and execution methods when the system is fully booted into the normal operating system environment

  If option ROMs are provided, they must also be capable of being upgraded.

  Recommended: Implement a mechanism to authenticate the requester of the update programming. Implement a mechanism to validate that the program arrived intact after download.

- **3.5.7 BIOS provides boot support for USB keyboards and hubs.** For systems based on Intel Architecture compatible processors, the system BIOS must provide boot support for USB keyboards and hubs as defined in *Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9* or later. This support must provide the ability for the user to enter the system's BIOS setup program and provide enough functionality to get a USB-aware operating system installed and booted.

Mobile PC Note   Mobile PCs, which have built-in keyboards, are exempt from this requirement for BIOS support of USB keyboards.

- **3.5.8 System BIOS supports console redirection of a serial port.**
  This capability provides support during system startup for debugging and troubleshooting activities. If a legacy serial port is implemented, the BIOS

must provide an option to configure at least one legacy serial port to use either 2F8h or 3F8h. This allows the port to be treated as a boot device by the BIOS and is required to be usable by components as a diagnostic port in the event that system debugging is required by either the BIOS or the operating system.

Recommended: System BIOS or option ROM provides boot support for primary ATAPI bootable floppy disk drive in compliance with *ATAPI Removable Media BIOS Specification (ARMD), Version 1.0* or later. Complying with this specification provides Int 13h and Int 40h support for bootable floppy drives as the primary or secondary floppy device.

PC 99 Physical Design Requirements

This section summarizes physical design requirements and recommendations for PC 99 systems. These requirements are in addition to those related to the OnNow initiative for power-state indicators and easily accessible power switches.

3.6. All expansion slots in the system are accessible for users to insert cards
Required for all system types, with extra guidelines for mobile
The internal expansion slots cannot be physically blocked by components or devices provided with the system. This requirement does not exclude configurations that allow space only for half-height cards for some slots, for passive back planes for connectors, and so on.

PC 99A clarification for AGP and requirement for expansion slots to be accessible to end users: For designs implementing the proposed AGP Pro specification, the two PCI slots adjacent to the component side of the AGP Pro slot may be blocked and used by an AGP Pro Adapter. When the AGP Pro connector is used by a "standard" AGP board, the PCI connectors must be accessible and available for use with PCI cards.

Mobile PC Note   For mobile guidelines and exceptions, see Chapter 6, "Mobile PC 99."

3.7. Audible noise meets PC 99 requirements
Required for all system types
A PC 99 system must be "silent" in any sleep state. That is, it must be perceived as not significantly noisier than the off state to typical users, relevant to an operating position appropriate to the PC's form factor (such as desktop, minitower, or laptop) and the ambient noise level of its normal usage environment (such as corporate office, home office, family room, and so on). This requirement applies primarily to fan noise, as all other devices will not be active in the sleep state.

It is hoped that this definition will become more objective over time through standardization of acoustic noise measurement and reporting procedures for PCs. Intel and Microsoft are working on proposals for acoustic noise measurement and

reporting. The goal is to achieve common PC acoustic noise measurement methods based on established international standards. With such methods in place, end users will be able to receive reliable acoustic noise specifications about PCs similar to those available for other product categories such as automobiles and appliances.

Although this requirement does not specify noise limits for PCs in idle and working states, manufacturers are encouraged to design systems that operate as quietly as possible, especially PCs designed for use in the home family room.

3.8. System and component design practices follow accessibility guidelines
Recommended for all system types

Accessibility design guidelines are provided in Appendix C, "Accessibility." These guidelines were developed in consultation with the Trace Research and Development Center at the University of Wisconsin at Madison, see the web site at http://trace.wisc.edu. In particular, the following guidelines are recommended for implementation on all system types:

- All modifier keys should be capable of being read and operated by software, including F*n* and similar OEM-specific keys. This capability allows users to access these keys and the functions that rely on them through operating system features such as StickyKeys and SerialKeys and through third-party software such as voice recognition and on-screen keyboard utilities.
- Computers should have sound systems that are sufficient to run high-end voice-recognition software utilities that support large vocabularies with continuous speech.

This recommendation for following accessibility guidelines will not become a requirement in future versions of this design guide. For extensive references and resources, see Appendix C, "Accessibility."

3.9. Internal system modification capabilities are not accessible to end users
Recommended for all system types

This recommendation is based on goals to reduce total cost of ownership (TCO) by ensuring that end users are prevented from accidentally or purposefully altering the predefined software and hardware configurations. This recommendation can encompass a lockable or sealed-case design, where internal expansion capabilities are not end-user accessible.

3.10. System design provides physical security
Recommended for all system types

To prevent unauthorized hardware access, the following security features are recommended for PC 99 systems:

- External drive devices should have locking capabilities. Each removable media device should be capable of being locked to prevent unauthorized data access.

This means that the device is rendered inoperable, either electronically or mechanically, when locked.

- PC case and switches should have locking capabilities to prevent unauthorized internal access. An OEM-specific method can be implemented, either electronically or mechanically.

PC 99 General Device Requirements

The requirements in this section apply for every device, whether present on the system board or as an expansion device provided by the OEM in a default system configuration. Most general device requirements are related to Plug and Play capabilities.

3.11. Each device and driver meets PC 99 device requirements
Required for all system types

Each device must comply with all requirements defined in this guide for the related device class, whether the device is provided in the PC system as an expansion card or as an external device.

Drivers must be provided for both Windows 98 and Windows 2000 operating systems. The manufacturer does not need to supply a driver for a device if the device passes PC 99 compliance testing using a driver provided with the operating system.

In addition to the device requirements in this section, see also the specific requirements for each device class in Part 4 of this guide.

3.12. Each bus and device meets Plug and Play specifications
Required for all system types

Each bus and device provided in a PC 99 system must meet the current Plug and Play specifications related to its class, including requirements defined in Section 6 of the ACPI 1.0 specification and clarifications published for some Plug and Play specifications. This includes requirements for automatic device configuration, resource allocation, and dynamic disable capabilities.

For information about Plug and Play support under Windows 2000, see the Windows 2000 Device Driver Kit (DDK).

The following shows current version numbers for all Plug and Play specifications:

- *PCI Local Bus Specification, Revision 2.1*
- *Plug and Play External COM Device Specification, Version 1.0*
- *Plug and Play Industry Standard Architecture (ISA) Specification, Version 1.0a,* and *Clarification to Plug and Play ISA Specification, Version 1.0a*
- *Plug and Play Parallel Port Device Specification, Version 1.0b*

- *Plug and Play Small Computer System Interface Specification, Version 1.0*
- *Universal Serial Bus Specification, Version 1.0*

Plug and Play specifications for IEEE 1394 are defined in this guide. For information, see Chapter 8, "IEEE 1394."

Note: Standard system devices are excluded from this requirement. The system can reserve static resources for devices such as programmable interrupt controllers (PICs) 1 and 2, 8254-2 timer, 8042 keyboard controller, real-time clock, direct memory access (DMA) page registers, DMA controllers 1 and 2, and math coprocessor. For systems based on Intel Architecture compatible processors, these fixed resources are located at I/O addresses under 100h and can also include a Nonmaskable Interrupt (NMI).

All system-board devices must use ISA-compatible addresses. This includes devices with I/O port addresses within the reserved range 0h–0xFFh. For information about legacy system I/O addresses, see Appendix D, "Legacy Support."

In addition, systems designed to run only on Windows 2000 are not required to meet requirements for legacy Plug and Play support. If the system is designed to run both Windows 98 and Windows 2000, it must meet all requirements for legacy Plug and Play support.

3.13. Unique Plug and Play device ID provided for each system device and add-on device

Required for all system types

Each device connected to an expansion bus must be able to supply its own unique ID. The following are the specific requirements for Plug and Play device IDs:

- Each separate function or device on the system board must be separately enumerated; therefore, each must provide a device ID in the manner required in the current Plug and Play specification for the bus it uses.
- If a device on an expansion card is enumerated by the BIOS, it must have a unique ID and its own resources according to the current device ID requirements for the bus to which the card is connected. This includes devices that are separately enumerated on multifunction cards or multifunction chips.

  Multifunction CardBus devices must meet the requirements defined in Chapter 12, "PC Card."

In addition, for Office PCs, if an OEM uses a proprietary mechanism to assign asset or serial numbers to hardware, this information must be available to the operating system using Windows hardware instrumentation technology, as defined in the *Network PC System Design Guidelines, Version 1.0b.*

The following are exceptions to the requirement for a unique Plug and Play ID:

- Legacy devices attached to the ISA bus on the system board do not have unique Plug and Play IDs—for example, serial ports, parallel ports, or Personal System/2 (PS/2) compatible port devices. The method for device identification is defined in the *Plug and Play ISA Specification, Version 1.0a,* and the ACPI 1.0 specification.

- Some multifunction devices, such as Super I/O, might include devices that do not have unique Plug and Play IDs or unique PCI subsystem IDs, but that are supported by drivers provided with the Windows operating system.

- A device such as a multifunction PCI device that supports a number of functions but uses only a single set of relocatable resources does not have to provide separate IDs for each function included on the device.

3.14. Option ROMs meet Plug and Play requirements
Required for all system types

This requirement applies only for devices that might use option ROM on systems based on Intel Architecture compatible processors, whether the device is present on the system board or provided through an expansion card.

Option ROMs are usually located on cards used as system boot devices. During the boot process, option ROMs initialize the boot devices, which provide the primary input, primary output, and IPL device to boot the system. However, Plug and Play option ROMs can be used to supply the Plug and Play expansion header to devices other than boot devices, enabling them to initialize both devices when the system boots.

Option ROM requirements for specific devices are defined in Chapter 10, "ATA and ATAPI," Chapter 11, "SCSI," Chapter 14, "Graphics Adapters," and Chapter 18, "Storage and Related Peripherals."

Note: Systems designed to run only on Windows 2000 are not required to meet these requirements for legacy Plug and Play support.

3.15. "PNP" vendor code used only to define a legacy device's Compatible ID
Required for all system types

All legacy devices not enumerated by the system-board interface must not use the acronym for Plug and Play, "PNP" in their vendor and device codes. The PNP vendor code is reserved for Microsoft and for vendors whose hardware is specifically assigned a particular ID. Other hardware can use a PNP code only when defining a device's Compatible ID and only after first indicating the device's Hardware ID in the Plug and Play header.

Use of Compatible IDs are recommended for devices that use device drivers provided with the Windows operating system, such as a Standard PC COM Port (PNP0500).

For information about using PNP Compatible IDs, see Appendix B, "Device Identifiers." To obtain a unique PNP vendor ID, please send a request by e-mail to pnpid@microsoft.com.

3.16. Device driver and installation meet PC 99 requirements

Required for all system types

Each device must have drivers for both Windows 98 and Windows 2000 operating systems to ensure correct support under both operating systems. For some device classes, this support can be provided using a Windows Driver Model (WDM) driver, as defined in the related device requirements in Part 4 of this guide.

The manufacturer does not need to supply a driver for a device if the device passes PC 99 compliance testing using a driver provided with the operating system. If the manufacturer does supply a driver, the requirements for device drivers and installation include the following:

- **3.16.1 All devices and drivers must pass PC 99 compliance testing.** Each device included in a system must comply with the requirements defined in these guidelines and must have supporting 32-bit device drivers for the CPU platform and operating system.

  Each device must have a driver for both Windows 98 and Windows 2000. A device is not required to have a driver for both CPU platforms, but a system must include the correct device drivers for the platform.

  The installation and loading of a driver must not reduce or eliminate functionality of other devices installed on the system.

  For systems that come with Windows 2000 pre-installed, only 32-bit protected-mode components must be installed. No real-mode or 16-bit protected-mode components can be provided in order to operate under Windows 2000.

  Under Windows 98, the graphics adapter driver is a Win16 module. All other components must be 32-bit protected-mode components.

- **3.16.2 Devices with WDM support in Windows include WDM-based drivers.** For any device for which WDM-based support is provided in the operating system, the driver supplied by the manufacturer must be a WDM minidriver. This applies whether the system comes pre-installed with Windows 98 or Windows 2000.

- **3.16.3 Driver supports Plug and Play and power management IRPs.** Every driver (or minidriver) must support Plug and Play and power management I/O request packets (IRPs). This applies whether the system comes pre-installed with Windows 98 or Windows 2000.

  For VxD drivers for Windows 98, the following requirements apply:

  - Every VxD must support Plug and Play and power management messages.

  - The driver must provide power management support as required by any device class power management reference specification.

- **3.16.4 All configuration settings are stored in the registry.** The driver must not use initialization files (INI) for configuration settings.

  The driver must also include correct provider, version, and copyright entries. This information is displayed in the user interface, such as Device Manager in Windows.

- **3.16.5 All INF and other file information is correct.** The correct minidriver, virtual device drivers (VxDs), or any other manufacturer-supplied files specified in the device's information file (INF) must be installed in the correct location.

  For manufacturer-provided files, the vendor must *not* be identified as Microsoft and all other copyright and version information must be correct for the manufacturer.

  Files provided by the vendor must not use the same file names as used by files included in Microsoft operating systems and provided as either retail or OEM products, unless specifically agreed upon with Microsoft.

- **3.16.6 Installation uses methods defined in the DDK.** Driver installation and removal must use Windows-based methods as defined in the Windows 98 and Windows 2000 DDKs.

  The device driver must be able to be removed using Windows-based software, which can be managed using either the Windows Control Panel option for removing devices or its own remove utility. For information, see the driver installation information in the \SRC\General directory in the Windows 2000 DDK; see also "Windows 95 Class Installers and Network Driver Installers" in the Windows 95 DDK.

  However, any software applications included with the device can be installed using an alternate Windows-based installation method as defined in the Microsoft Platform Software Developers Kit (SDK).

  Also, any software components and registry entries installed during driver installation must be removed during driver uninstallation.

  Any real-mode components provided for backward compatibility under Windows 98 should use separate installation procedures. Although installation of Windows-based components must not make entries in Autoexec.bat or Config.sys, the separate real-mode installation program can make such entries but must not modify the registry, Win.ini, or System.ini.

- **3.16.7 Driver supports unattended installation.** It must be possible for the device's driver to be installed using a mechanism such as a script or special software for supplying required parameters without the user being present.

- **3.16.8 Driver includes Help file if special parameters are used.** To ensure that the user can correctly change settings, a Windows Help file must be provided if special driver parameters are used. The device's installation routine must install the Help file as part of the setup program. The user interface for the device's dialog boxes must display the correct Help file, and the Help file

must contain relevant information to assist the user. The guidelines for implementing a Help file are defined in the Windows 2000 DDK.

3.17. Minimal user interaction needed to install and configure devices

Required for all system types

After physically installing the device, the user must not be required to perform any action other than to insert the disks that contain drivers and other files. The user should have to restart the system only for devices that do not support hot plugging.

As specified in requirement 3.19, "Hot-plugging capabilities for buses and devices meet PC 99 requirements," devices that use USB, IEEE 1394, or PC Card must support hot-plugging. For devices that use other buses, detection occurs when the system is powered on after the device is inserted.

The following requirements must be met:

- **3.17.1 The device is immediately functional without restarting the system.** It is acceptable to require rebooting for primary system devices such as the primary graphics adapter and the primary hard disk controller; furthermore, ATA drives are not required to implemented Cable Select (CS) settings. In all cases, however, changing configuration settings must not require the end user to make jumper changes.

- **3.17.2 Software settings are available for configuring all resources.** All buses and devices on both the system board and all expansion cards must be capable of being configured by the operating system and by software, such as the Device Manager in Windows, so that the user does not need to open the PC case to change the configuration. DIP switches on boot devices can be used for an initial power-on default state or for non-Plug and Play system compatibility, but such settings must be capable of being overridden by software configuration after power on occurs under Plug and Play operating systems.

  Note: This requirement does not apply for jumper settings used by the OEM to set CPU speed, select a keyboard, or make other basic system-related settings in the factory. This requirement applies only for settings that the end user must make to configure the hardware.

- **3.17.3 Dynamic disable capabilities are supported for all devices.** All devices must be capable of being automatically disabled by the system. Also, disabling the device must result in the freeing of all its resources for use by other devices.

  The following devices are exempt from this requirement: all legacy devices using the I/O range under 100h, keyboard controller, floppy disk controller (FDC), hard disk controller, VGA memory and I/O addresses, and any BIOS memory ranges required for legacy boot support.

3.18. Connections use icons, plus keyed or shrouded connectors, with color coding

Required for all system types, with exceptions for mobile PCs

This requirement helps ensure that the end user can correctly make the physical connections required for adding a device to a system. This requirement includes the following:

- **3.18.1 Connector's physical design ensures that the user cannot insert it into the wrong port.** Wherever possible, keyed or shrouded connectors or other configurations should be used to prevent misconnection. For specific requirements related to keyed connectors and cables for I/O controllers and peripherals, see Chapter 10, "ATA and ATAPI," and Chapter 11, "SCSI."

- **3.18.2 Icons are provided for all external connectors.** The icons can be molded, printed, or affixed as permanent stickers, which can include text. Icons can be based on existing vendor designs or on the examples listed in Appendix A, "Icons."

Mobile PC Note   For mobile PC designs, connector icons might not fit on the back of the case. In such designs, it is acceptable to wrap the icons to the bottom of the unit or place them on the inside of an access door.

- **3.18.3 Systems use a color-coding scheme for connectors and ports.** All PC 99 systems must implement a color-coding scheme for their ports and device connectors.

PC 99A clarification to color coding requirements: Color coding is required for PC systems, but the color codes listed in *PC 99 System Design Guide* are only recommended. The intent is to standardize the industry on a single color-coding scheme, so these specific colors will become a requirement for systems in future versions of the design guidelines.

For retail peripherals, color-coding is *not* required. However, if color codes are implemented on peripheral devices, the scheme *must* follow the color codes listed in *PC 99 System Design Guide*. See the color coding FAQ at http://www.pcdesguide.com/documents/pc99icons.htm. For questions and issues about color coding, send e-mail to **comments@pcdesguide.com**.

The following list shows the PC 99 recommendation for color codes. The selection of these specific colors was done using criteria established by Human Factors and Industrial Design professionals from multiple companies who are involved in the design of computer hardware.

Recommended Color Codes for Connectors

Connector	Recommended color	Pantone
Analog VGA	Blue	661C
Audio line in	Light blue	284C
Audio line out	Lime	577C
Digital monitor/flat panel	White	
IEEE 1394	Grey	424C
Microphone	Pink	701C
MIDI/game	Gold	131C
Parallel	Burgundy	235C
PS/2-compatible keyboard	Purple	2715C
PS/2-compatible mouse	Green	3395C
Serial	Teal or Turquoise	322C
Speaker out/subwoofer	Orange	157C
Right-to-left speaker	Brown	4645C
USB	Black	426C
Video out	Yellow	123C
SCSI, network, telephone, modem, and so on	None	—

It is recommended that retail peripherals also implement color coding, and those that do are required to use the colors noted earlier in order to correspond with PC 99 systems that adopt this scheme.

It is expected that system and peripheral color coding in accordance with this scheme will become a requirement in future design guides.

Mobile PC Note   Mobile PCs are not required to comply with the requirement for color coding.

Note: It is recognized that the physical design will not change for legacy ports such as the PS/2-compatible mouse and keyboard ports, analog audio and video jacks, and the microphone and speaker jacks. Therefore, they cannot fully meet this requirement. However, icons and labels must be provided and color-coding applied wherever possible to help the user make the correct connections.

3.19. Hot-plugging capabilities for buses and devices meet PC 99 requirements
Required for all system types
Recommended: A locking mechanism to ensure that devices are removed only under operating system control or during sleep or off states.

To ensure reliable support for hot-plugging capabilities, the following requirements must be met:

- **3.19.1 USB, IEEE 1394, and PC Card devices and buses support hot-plugging.** When designed under their respective specifications, USB, IEEE 1394, and PC Card all support hot-plugging. Any device designed to use any of these connections must support being added or removed while the system is fully powered on.

  The exception to this requirement is any device required for booting such as the primary graphics adapter. For information about supporting multiple graphics adapters, see Chapter 14, "Graphics Adapters."

- **3.19.2 Hot-plugging for PCI devices uses ACPI-based methods.** Hot-plugging is not required for PCI devices. Windows 98 and Windows 2000 support dynamic enumeration, installation, and removal of PCI devices only if there is a supported hardware insert/remove notification mechanism. The notification mechanism is defined as part of the bus standard for CardBus bus controllers. For other solutions, such as those required for docking stations or other devices, the hardware insert/remove notification mechanism must be implemented as defined in Section 5.6.3 of the ACPI 1.0 specification.

  In order to properly function with the native support in the operating system, developing industry standards such as those referred to as PCI Hot Plug and Compact PCI must use ACPI-based methods for supporting hardware insertion and removal as defined in the ACPI 1.0 specification.

- **3.19.3 All removable media support media status notification.** Removable media must support the appropriate media status notification method to ensure that no loss of data or system failure results when such media is removed from the system.

  For media status notification requirements for CD and DVD drives, AT-Attachment (ATA), and ATA Packet Interface (ATAPI) removable devices, see requirement 18.2, "Removable media devices support media status notification." Device Bay guidelines are defined in requirement 3.20, "System includes Device Bay 1.0-compatible bay."

Recommended: Ensure that surprise removal of any swappable device does not cause a system failure. A failure related to surprise removal of a swappable device includes any spontaneous reboot, system stall, or blue screen. At a minimum, the device driver should ensure that the PC system does not fail if the user accidentally pulls the device out of its socket. The only absolute way to ensure against system failure is to prevent surprise removals by including a locking mechanism, which is recommended for PC 99 systems.

Another method of protection is to have the driver check whether its device is present when it receives certain interrupts. For example, CardBus cards share the same PCI interrupt as their socket controller, so interrupt handlers for both the card driver and socket driver are chained to the same PCI interrupt request (IRQ). To prevent a system fault after surprise removal of the CardBus card, its driver must check whether its device is still present whenever it reads a value such as

0xFFh in its status register, and then it must be able to recover gracefully when this occurs.

In all cases, for any failure that might occur, the PC system as a whole should be able to recover gracefully and report the condition to the end user. For implementation details and for additional design guidelines, see the article about hot-plugging support at http://www.microsoft.com/hwdev/busbios/rem_devs.htm.

3.20. System includes Device Bay 1.0-compatible bay
Recommended for all system types

If implemented in a PC 99 system, Device Bay capabilities must meet the following requirements:

- The system includes a Device Bay Controller (DBC) compliant with *Device Bay Interface Specification, Version 1.0* or later. If the DBC is implemented as a USB device, it must be compliant with *Universal Serial Bus Device Class Definition for Device Bay Controllers, Version 1.0* or later.
- The system includes one USB port and one IEEE 1394 port for each Device Bay-capable bay in the system.

Any Device Bay peripherals provided with a PC 99 system must meet the following requirements:

- Device complies with *Device Bay Interface Specification*, *Version 1.0* or later.
- Device uses either the USB bus, IEEE 1394 bus, or both.
- If the device uses the USB bus, it must also comply with the relevant USB device class specifications.

3.21. Multifunction add-on devices meet PC 99 device requirements for each device
Required for all system types

Multifunction add-on devices can contain more than one device. They must comply with requirement 3.16, "Device driver and installation meet PC 99 requirements," including the requirements for automated software-only settings for device configuration, device drivers, and Windows-based installation. In addition, the following requirements must be met:

- **3.21.1 Each enumerated device has a unique device ID.** Each function or device on the multifunction add-on device that is individually enumerated by the BIOS must provide a device ID for the bus it uses.
- **3.21.2 System can separately access and configure each logical device.** The system must be able to separately access each logical device that is individually enumerated by the BIOS, configure the device resources independently, and disable individual devices in the event of a conflict.

- **3.21.3 Each enumerated device meets its own resource requirements.** For each individually enumerated device, resource configuration requirements are the same as for an equivalent device on a separate expansion card. This requirement means that registers cannot be shared among individually enumerated devices on a multifunction add-on device, but it does not supersede device requirements among different bus classes.

The exception to this requirement is a device such as a multifunction PCI device that supports several functions but uses only a single set of relocatable resources. When each device is not individually enumerated, there is no requirement to provide separate IDs and resources for each function on the device. However, see also requirement 9.8, "Functions in a multifunction PCI device do not share writeable PCI Configuration Space bits."

PC 99A clarification: The PC 99 exception for multifunction PCI devices that use only a single set of relocatable resources refers solely to multifunction devices *of the same device class*. If different functions within a multiple-function device require separate class drivers—for example, a combination PCI network adapter and modem—then each function must provide a unique PCI SID and SVID that will allow the proper driver to be loaded for each separate function.

Multifunction devices that contain functions from separate classes will not be properly recognized during an operating system upgrade—and therefore drivers will not be properly upgraded—unless unique IDs are provided for each device.

Note that a "supervisory" driver that loads different drivers for the individual functions does not work well with Windows. In particular, driver support is likely to be lost in cases of operating system re-installation or upgrade, or with distribution of new drivers via Windows Update. Therefore, these supervisory drivers should be avoided. Future versions of the Design Guide will require separate drivers for separate functions.

3.22. All devices support correct 16-bit decoding for I/O port addresses
Required for all system types

Each device must support a unique I/O port address in the 16-bit address range. This requirement means that, at a minimum, the upper address lines (A10–A15) can be used as the device enable address, so that the device does not respond to addresses outside of the 10-bit address range. CardBus controllers and cards must meet the requirements defined in Chapter 12, "PC Card."

Devices that use less than 16-bit I/O decode create conflicts that cannot be resolved by a Plug and Play operating system. Phantom (alias) addressing is not supported by the Windows operating system and cannot be used to meet this requirement.

Notice that this requirement does not apply for the three ISA auto-configuration registers used during device enumeration and configuration. The ADDRESS,

WRITE_DATA, and READ_DATA registers will continue to use 12-bit decoding as described in the *ISA Plug and Play Specification, Version 1.0a.*

3.23. All PC 99 input devices support Microsoft DirectInput and work simultaneously

Required for all system types

All input devices implemented in PC 99 systems that do not use drivers provided with the operating system must have drivers that support Microsoft DirectInput. All input devices must also be able to correctly provide simultaneous input. This means that no input device is automatically disabled when another input device is in use—and applies for external PS/2-compatible devices, so that connecting the external device does not disable an internal PS/2-compatible device.

Note: The built-in drivers provided with Windows 98 and Windows 2000 meet this requirement. For information about implementing drivers that support simultaneous use of devices, see the Microsoft DirectX DDK.

PC 99A clarification: The built-in class drivers support simultaneous operating of multiple input devices. For information about implementing support for other drivers, see "Part 4: Drivers for Input Devices" in the "Kernel-Mode Drivers Design Guide" of the Windows 2000 DDK. See also the sample code and documentation in the Windows 98 DDK at %98DDK%src\hid\ and in the Windows 2000 DDK at %NTDDK%\src\wdm\hid\.

PC 99 Buses and Devices

This section defines specific requirements for buses and devices provided in a PC 99 system, in addition to requirement 3.2, "System design meets ACPI 1.0 specification and PC 99 requirements."

PC 99 System Buses

This section defines the general requirements for system buses. Additional requirements for specific buses are defined in Part 3 of this guide.

3.24. Each bus meets written specifications and PC 99 requirements

Required for all system types

In the past, some bus designs did not fully implement all of the bus requirements on every expansion card connector. Each bus and connector used in the system must meet all the requirements for that bus as defined in Part 3 of this guide.

Each bus and device provided in a PC 99 system must also meet the current Plug and Play specifications related to its class, including requirements defined in the ACPI 1.0 specification and the clarifications published for some Plug and Play specifications. This includes requirements for automatic device configuration, resource allocation, and dynamic disable capabilities. See also the related Plug

and Play requirements in "PC 99 General Device Requirements" earlier in this chapter.

3.25. System includes USB with two USB ports, minimum
Required for all system types, with exceptions for mobile PCs

Recommended: System should have at least one USB Human Interface Device (HID), such as a keyboard or pointing device.

USB provides a bi-directional, isochronous, dynamically attachable serial interface for adding peripheral devices. These devices may include single-bus game controllers, communications devices, and input devices.

The USB controller must be capable of waking the system as defined in Section 3.4.4 of the ACPI 1.0 specification. This capability is part of the requirement for ACPI compliance, as defined in requirement 3.2, "System design meets ACPI 1.0 specification and PC 99 requirements."

The USB implementation in the system must also meet the requirements defined in the USB specifications plus any additional requirements defined in Chapter 7, "USB."

Mobile PC Note   Only one port is required for mobile PCs, as defined in Chapter 6, "Mobile PC 99."

3.26. System includes support for IEEE 1394
Recommended for all system types, with 3 ports recommended for Entertainment PCs

It is recommended that all systems have at least one IEEE 1394 port for external expansion devices, such as scanners and external drives. If implemented, the ports must be compliant with IEEE P1394.a and OHCI Version 1.0, as described in Chapter 8, "IEEE 1394."

Note: Implementation of IEEE 1394 is likely to become a requirement for desktop systems in future versions of these design guidelines.

Mobile PC Note   For guidelines to any implementation of IEEE 1394 on mobile PCs, see Chapter 6, "Mobile PC 99."

3.27. If present, PCI bus meets PCI 2.1 or later, plus PC 99 requirements
Required for all system types

If PCI is used in a PC system, the PCI bus must meet the following requirements:

- *PCI Local Bus Specification (PCI 2.1), Revision 2.1* or later.
- *PCI Power Management Specification (PCI-PM), Revision 1.1* or later.
- Additional requirements defined in Chapter 9, "PCI," including:
  - System and devices support all Engineering Change Notices (ECNs) for PCI 2.1 approved by July 1, 1998. In particular, all devices must comply with the Maximum Completion Time ECN.

- Bus master privileges are supported for all connectors.
- Modem PCI-based network and modem adapters support generation of a power management event (PME#) wake signal.
- Systems that support S3 or S4 states must provide both 3.3 V and 3.3 Vaux power on all connections.

Recommended: PCI devices, chip sets, and expansion slots support the requirements defined in the PCI 2.2 specification. For information about PCI specifications, see http://www.pcisig.com.

3.28. System does not include ISA expansion devices or slots
Required for all system types

ISA expansion devices cannot be included in a PC 99 system. This means that ISA implementations of expansion devices such as audio, modems, or network adapters are not acceptable for PC 99 systems, nor can the ATA controller use an ISA bus. This applies whether the devices are implemented as add-on cards or integrated on the system board.

PC 99 systems must not include ISA slots. Instead, provide non-legacy buses and connectors for system expansion, most notably PCI, USB, and IEEE 1394. Because of hardware incompatibilities and configuration limitations inherent in the ISA legacy architecture, ISA expansion devices are a well-documented cause of costly support problems that continue to burden end-users and the PC industry at large. The benefits of designing ISA-free systems include easier and more stable system configuration, lower support cost, and improved performance.

It is acceptable for all PC 99 systems to use ISA protocols and signaling or ISA-like protocols and signaling for implementations of on-board legacy devices. For such implementations, interrupts are supported using the legacy 8259 or APIC (for Windows 2000). It is recommended that APIC be used in all designs. Any on-board legacy implementations, such as BIOS ROM, Super I/O, 8042 controllers, math coprocessors, and so on, are allowed and must meet the requirements defined in Appendix D, "Legacy Support."

These on-board legacy devices should be implemented using alternative bus extensions such as Low Pin Count (LPC) rather than ISA. The LPC Interface allows the legacy I/O on-board components, typically integrated in a Super I/O chip, to migrate from the ISA/X-bus to the LPC Interface while retaining full software compatibility. The *Low Pin Count Interface Specification* is available from the web site at http://developer.intel.com/design/pcisets/lpc/index.htm.

PC 99A Note: Compliance testing for this requirement will begin January 1, 2000.

PC 99 I/O Devices

This section defines the general requirements for I/O devices. Additional requirements are defined in "PC 99 Graphics Adapters, Video, and Broadcast Services" and "PC 99 Storage and Related Peripherals" later in this chapter.

Mobile PC Note   For specific keyboard and pointing device guidelines for mobile systems, see Chapter 6, "Mobile PC 99."

3.29. System includes keyboard connection and keyboard
Required for all system types
Recommended: USB.

The external keyboard connection requirements on any PC can be met by using either USB, a PS/2-style port, or wireless capabilities in the system. A mobile or all-in-one system that has a built-in keyboard must also provide the capability for an external keyboard connection. This connection can be implemented using a port replicator or a single PS/2-style port with special cabling for both an external keyboard and an external mouse. For complete requirements for keyboard ports and peripherals, see Chapter 13, "I/O Ports and Devices."

3.30. System includes pointing-device connection and pointing device
Required for all system types
Recommended: USB or other external bus.

The external pointing-device connection requirements on any PC can be met by using USB, a PS/2-style port, or wireless capabilities in the system. A mobile or all-in-one system that has a built-in pointing device must also provide the capability for an external pointing-device connection. This can be implemented using a port replicator or a single PS/2-style port with special cabling for both an external keyboard and an external pointing device.

A second serial port is not an acceptable external pointing-device connection.

Note: All input devices must have drivers that support Microsoft DirectInput, as defined in requirement 3.23, "All PC 99 input devices support Microsoft DirectInput and work simultaneously."

For requirements for pointing-device ports and peripherals, see Chapter 13, "I/O Ports and Devices."

3.31. System includes connection for external parallel devices
Required for all system types
Recommended: USB or other external bus.

The requirement for an external connection for parallel devices can be met by using USB or another external bus. This capability can also be provided as a parallel port with extended capabilities port (ECP) capabilities, but a legacy

parallel port is not the recommended implementation. For complete parallel port requirements, see Chapter 13, "I/O Ports and Devices."

3.32. System includes connection for external serial devices
Required for all system types
Recommended: USB or CardBus.

The requirement for an external connection for serial devices can be met by using USB or CardBus. An RS-232C serial connection can also be implemented using a 16550A or equivalent serial port, but a legacy serial port is not recommended. For complete serial port requirements, see Chapter 13, "I/O Ports and Devices."

3.33. System includes IR devices compliant with IrDA specifications
Recommended for all system types
Wireless capabilities are not required; if they are implemented, infrared (IR) devices included with PC 99 systems must comply with approved Infrared Data Association (IrDA) Data, IrDA Control, or both specifications. This includes wireless data transfer devices, as well as wireless input devices, for example, IR keyboards, pointing devices, joysticks, game pads, and so on.

If the system is intended to run data transfer applications with other IrDA Data devices, it must be in compliance with the IrDA Data specifications and must support standard Fast IR (FIR) input speeds of 4 Mb/s. An IrDA Data device must use an NDIS 5.0 miniport driver.

If an IrDA Control application is used in a PC 99 system, it must be in compliance with the IrDA Control specification. If a system is intended for the consumer market, support for both IrDA Control and IrDA Data is recommended to meet the consumer's expectations for IR device interoperability. The emergence of still-image cameras with IrDA Data capability increases the importance of IrDA Data support in consumer systems.

For background information about designing IR solutions, see "Wireless Design Issues" in Chapter 2, "PC 99 Design Issues." For information about wireless requirements, see Chapter 13, "I/O Ports and Devices."

3.34. System includes PC 99-compatible CD or DVD drive and controller

Consumer	Office	Mobile	Workstation	Entertainment
Required	*Recommended*	*Recommended*	*Required*	*DVD required*

Recommended: DVD drive.

The host controller for the CD or DVD drive must meet the specific requirements defined for SCSI or ATA/ATAPI or the related bus it uses in Part 3 of this guide. The CD or DVD drive must meet the requirements defined in Chapter 18, "Storage and Related Peripherals."

Mobile PC Note   If a CD drive is provided, the minimum media transfer rate must be no less than 1200 KB per second. The minimum required media transfer rate for a CD drive on a mobile PC must be no less than 600 KB per second.

If a DVD drive is provided, the minimum media transfer rate must be at least 2 MB per second for read operations from the disk. Support for DVD-Video playback is recommended, which must meet the requirements for quality standards defined in Chapter 15, "Video and Broadcast Components."

3.35. System includes audio support that meets PC 99 requirements

Consumer	Office	Mobile	Workstation	Entertainment
Recommended	*Recommended*	*Recommended*	*Recommended*	*Required*

Although audio is a standard feature in most PC market segments, it is understood that certain small office/home office (SOHO) and Office PC designs that focus on cost will not require audio. For PC 99 systems that contain audio, the audio must meet the performance metrics defined in Chapter 17, "Audio Components."

3.36. System includes a modem or other public network communications support

Consumer	Office	Mobile	Workstation	Entertainment
Required	*Recommended*	*Required*	*Recommended*	*Required*

PC 99A errata: A modem or other communications support is **not** required for Workstation systems.

The minimum modem requirements call for an internal 56-Kbps V.90 data/fax modem, representing the current market trends for modems available in 1999.

This requirement can also be met by including support for alternative digital or analog public network communications devices, including ISDN, xDSL, or cable modem, as appropriate to customer demand and geographic locale. For complete information about requirements for communications devices, see Chapter 19, "Modems."

Mobile PC Note   The presence of a CardBus slot on the mobile PC meets the requirements for providing a modem. The minimum capabilities for an integrated modem is V.80 or better, as defined in Chapter 6, "Mobile PC 99."

3.37. System includes a network adapter

Consumer	Office	Mobile	Workstation	Entertainment
Recommended	*Required*	*Recommended*	*Required*	*Recommended*

Ethernet adapters are recommended for Consumer and Entertainment PCs, to enable easy home networking and connection to high-speed Internet access devices, such as cable and xDSL modems.

For complete information about network adapter requirements, see Chapter 20, "Network Communications."

Mobile PC Note   The presence of a CardBus slot on the mobile PC meets the requirements for providing a network adapter, as defined in Chapter 6, "Mobile PC 99."

Note: It is recognized that OEMs supply Office PC systems to corporations with specific feature requirements. For example, a customer might want to insert network adapters at the end-user site. An Office PC system submitted for compliance testing must include a network adapter.

Including the network adapter with the PC system assists in enabling remote new system setup. To meet the requirements for remote new system setup, a vendor's implementation method must be compatible with the technology defined in *Network PC System Design Guidelines, Version 1.0b*. One possible implementation for remote new system setup for Intel Architecture platforms is described in *Wired for Management Baseline, Version 1.1a.*

3.38. System includes smart card support

Recommended for all system types

If implemented in a PC 99 system, smart card readers and cards must be compatible with *Interoperability Specification for ICCs and Personal Computer Systems,* available at http://www.smartcardsys.com.

In addition, smart card readers and device drivers must be Plug and Play-compliant and must adhere to the Microsoft Smart Card DDK for the Windows 98 and Windows 2000 platforms. Smart card applications and service-provider dynamic link libraries (DLLs) must adhere to the Microsoft Smart Card SDK that is part of the Microsoft Platform SDK. For complete smart card requirements, see Chapter 13, "I/O Ports and Devices."

PC 99A clarification: Smart Card SDK is part of the Windows Base Services within the Microsoft Platform SDK. Smart Card driver information is available in "Smart Card Driver Overview" in the Windows 98 DDK and the Windows 2000 DDK (on the web at http://www.microsoft.com/ddk/ddkdocs/win98ddk/scovr_8ugn.htm and http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/scovr_8ugn.htm, respectively).

The smart card system for a system with digital satellite television support represents a different technology, as discussed in Chapter 15, "Video and Broadcast Components."

PC 99 Graphics Adapters, Video, and Broadcast Services

This section summarizes the requirements for graphics adapters and monitors. For complete details, including recommendations for hardware acceleration, see Chapter 14, "Graphics Adapters."

3.39. Graphics adapter meets PC 99 minimum requirements

Required for all system types, with specific guidelines for each system type

The following list summarizes the key requirements for graphics adapters on desktop PC systems:

- Graphics adapters must use PCI, Accelerated Graphics Port (AGP), or other high-speed bus. For maximum performance, it is recommended that AGP be used for the primary graphics adapter.

- Graphics adapters for Consumer PC, Entertainment PC, and Workstation PC systems (depending on the intended market) must support 3-D hardware acceleration.

  Graphics adapter works normally with the default VGA mode driver, which is required for operating system installation.

  The adapter and driver must support multiple adapters and multiple monitors, which ensures that the end user has guaranteed automatic support to allow the operating system to correctly configure use of multiple monitors or multiple graphics adapters.

- Graphics adapters must support screen resolutions as defined by VESA up to the required maximum, including:

  $640 \times 480 \times$ [8, 15 or 16, 24 or 32] bpp
  $800 \times 600 \times$ [8, 15 or 16, 24 or 32] bpp
  $1024 \times 768 \times$ [8, 15 or 16] bpp

Mobile PC Note   For information about application-specific requirements for workstations, see Chapter 4, "Workstation PC 99." For information about requirements for the built-in display adapter on a mobile PC, see Chapter 6, "Mobile PC 99."

3.40. Color monitor is DDC-compliant with unique EDID identifier

Required for all system types, with exceptions for mobile PCs

A monitor designed for or included with a PC 99 system must be compliant with *Display Data Channel Standard, Version 3.0,* Level 2B (DDC2B), which defines the communications channel between the display and host system.

PC 99A clarification: The required support defined in Version 3.0 of these standards is also defined in the earlier version and revisions of these standards. As such, the Version 3.0 standards provide the correct references for both Windows 2000 and Windows 98.

The monitor also must transmit an Extended Display Identification Data (EDID) structure containing unique ID Manufacturer Name and ID Product Code identifiers, plus all required fields as defined in Section 3 of *Extended Display Identification Data Standard, Version 3.0* or later.

For complete requirements for monitors, including requirements for Integrated Color Management (ICM), ergonomic timing standards, and display data channel (DDC) support, see Chapter 16, "Monitors."

Mobile PC Note   For exceptions and guidelines that apply for the built-in display on mobile systems, see Chapter 6, "Mobile PC 99."

3.41. System meets PC 99 DVD-Video and MPEG-2 playback requirements, if system supports DVD-Video

Required for all system types, with exceptions for mobile PCs

Systems with DVD drives are not required to support DVD-Video playback. If the system is designed to support DVD-Video, it must meet the requirements for DVD-Video and Moving Picture Expert Group (MPEG)-2 playback.

Under Windows 98 and Windows 2000, operating-system playback support for MPEG-1 is provided through Microsoft DirectShow. This requirement refers to built-in system support for DVD-Video playback or any other MPEG-2 playback capabilities, whether provided as a hardware decoder, a software decoder, or a combination of the two.

The graphics adapter requirements for supporting MPEG-2 and DVD-Video playback are described in Chapter 14, "Graphics Adapters," and Chapter 15, "Video and Broadcast Components."

Mobile PC Note   These capabilities are recommended for mobile PCs, with modified requirements, as described in Chapter 6, "Mobile PC 99."

3.42. Adapter supports television output if system does not include a large-screen monitor

Recommended for all system types

The ability to connect and use a standard National Television System Committee (NTSC) or Phase Alternation Line (PAL) television as a large display surface is key to the ability to deliver realistic television, movie, and game experiences.

For complete information about the television output requirements, see Chapter 14, "Graphics Adapters." For information about large-screen monitor requirements for Entertainment PC systems, see Chapter 16, "Monitors."

3.43. System supports PC 99 analog video input and capture capabilities

Recommended for all system types

If video-capture capability is implemented in a PC 99 system, it must meet the requirements defined in Chapter 15, "Video and Broadcast Components."

Support for video input and capture is recommended, implemented as an add-on device or a direct interface on the system board. Systems with USB or IEEE 1394 support are capable of supporting the new low-cost digital video cameras entering

the market. It is recommended that systems include more than one IEEE 1394 port if the PC comes bundled with an IEEE 1394 video conferencing camera.

All video input sources and capture devices must implement driver support as defined for the WDM Stream class in the Windows 2000 DDK.

3.44. System includes analog television tuner
Recommended for all system types
Recommended: Digital broadcast or satellite television tuner.

If this capability is implemented in a PC 99 system, it must meet the requirements defined in Chapter 15, "Video and Broadcast Components."

PC 99 Storage and Related Peripherals

This section summarizes the requirements for storage devices. For system requirements related to CD drives and floppy disk drives, see the "PC 99 Buses and Devices" section earlier in this chapter.

3.45. System BIOS and option ROMs support Int 13h Extensions
Required for all system types
This requirement applies for systems that run either Windows 98 or Windows 2000, but does not apply for DEC Alpha PCs.

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. 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 Windows 2000 DDK and in the "Layered Block Device Drivers" section of the Windows 95 DDK.

3.46. Host controller for storage device meets PC 99 requirements
Required for all system types
The host controller in a PC 99 system must meet requirements defined for the bus it uses. ATA or SCSI controllers must also meet the requirements outlined in Chapter 10, "ATA and ATAPI," or Chapter 11, "SCSI."

3.47. Host controllers and hard disk devices support bus mastering
Required for all system types
Recommended: IEEE 1394 as the host controller for secondary storage.

The host controller for hard disk devices must support bus mastering, whether using ATA, SCSI, or IEEE 1394. Bus mastering support must also be enabled for secondary storage devices, including hard disks, CD, DVD, and tape drives.

Bus master capabilities must meet the related specification for the particular controller, as defined in Chapter 10, "ATA and ATAPI," and Chapter 11, "SCSI."

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

Use of the ISA bus by storage devices is not acceptable for PC 99 systems.

Note: This requirement does not apply to legacy FDCs and will not become a requirement for FDCs in the future.

3.48. Hard drive meets PC 99 requirements
Required for all system types

The hard disk drive must meet the requirements defined in Chapter 18, "Storage and Related Peripherals," plus the requirements in the following related bus chapter:

- Hard disk drives implemented as ATA peripherals must also meet the requirements outlined in Chapter 10, "ATA and ATAPI."
- Hard disk drives implemented as SCSI peripherals must also meet the requirements outlined in Chapter 11, "SCSI."
- Storage devices that use the IEEE 1394 bus must meet the requirement defined in Chapter 8, "IEEE 1394."

3.49. Operating system recognizes the boot drive in a multiple-drive system
Required for all system types

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.

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

PC 99A clarification: It is the intent of *PC 99 System Design Guide* to discourage the use of a legacy floppy drive and to encourage system designers to seek other alternatives for both the installation boot drive and casual storage.

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

Any floppy disk implementation or legacy FDC that is included on a PC 99 system must meet the requirements specified in Chapter 18, "Storage and Related Peripherals." 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."

Manageability Component Instrumentation Requirements

This section presents new requirements and recommendations for PC 99 systems related to the Wired for Management (WfM) initiative and the Zero Administration initiative for Windows. The WfM initiative seeks to raise the level of management capabilities for mobile, desktop, and server platforms. The Zero Administration initiative seeks to ensure a controlled, highly manageable enterprise.

The baseline for these requirements is *Windows Hardware Instrumentation Implementation Guidelines*, *Version 1.0* (WHIIG), which also defines the Windows-specific requirements of the *Wired for Management Baseline Specification, Version 2.0,* for hardware instrumentation.

Collectively, the items in this section represent the Manageability Baseline requirements for Office PC 99. Platform management information requirements are defined for two key areas:

- Component instrumentation: Interfaces through which information is supplied by platform management components.

- Management information providers: Interfaces used by applications to access platform management information.

Tips for implementing management capabilities. For PC 99 systems and components, these are the design steps to pursue:

- For each component, implement the component instrumentation features defined for PC 99 systems in WHIIG.

- For each component, extend the Web-Based Enterprise Management (WBEM) and Common Information Model (CIM) schema to expose the device's custom features in any CIM-ready management browser.

- For all instrumented components, test against the baseline features required in WHIIG.

- For those components that require Windows Management Instrumentation (WMI), ensure that WMI is enabled in device minidrivers as defined in the Windows 2000 DDK.

- Refer to WHIIG for other driver requirements and design tips.

PC 99A clarification to WHIIG The requirements in items 3.51-3.53 will not be tested or enforced until nine months after *Windows Hardware Instrumentation Implementation Guide* (WHIIG) V.1.0 is published. The current version of WHIIG is available on http://www.pcdesguide.org.

3.51. System supports WHIIG

Consumer	Office	Mobile	Workstation	Entertainment
Not applicable	Required	Required with Windows 2000	Required	Not applicable

The related requirement is defined in *Windows Hardware Instrumentation Implementation Guidelines*, *Version 1.0*.

Mobile PC Note   Support for WHIIG, WMI, and enabling a management information service provider are required for mobile systems that come with Windows 2000 preinstalled.

3.52. System includes driver support for WMI

Consumer	Office	Mobile	Workstation	Entertainment
Not applicable	Required	Required with Windows 2000	Required	Not applicable

Requirements and recommendations related to implementing WMI for Windows 2000 and Windows are defined in WHIIG.

Support for WMI, CIM, and Win32 extension schema objects and data must be implemented as defined in WHIIG.

3.53. Management information service provider enabled by default

Consumer	Office	Mobile	Workstation	Entertainment
Not applicable	*Required*	*Required with Windows 2000*	*Required*	*Not applicable*

The management information service providers must be enabled on Office PC 99 systems as defined in WHIIG.

Also, newly developed applications for managing WBEM-capable systems must comply with the appropriate CIM schema specifications and Windows-based applications programming models.

3.54. Expansion devices can be remotely managed

Consumer	Office	Mobile	Workstation	Entertainment
Not applicable	*Required*	*Recommended*	*Required*	*Not applicable*

Devices provided as expansion devices must be capable of being remotely managed to ensure that control and TCO policies can be realized. For example, for any implementation of a floppy disk drive on an Office PC system, the drive must be capable of being remotely disabled as a boot selection and provisions must be made for locking.

It is not a requirement that certain devices be capable of being remotely disabled, including the primary hard disk drive, the network adapter, and any standard devices that use legacy connections, such as a keyboard or pointing device that uses a PS/2-compatible connection. However, it must be possible that permissions, policies, or other methods can be used to remotely manage capabilities such as hard disk access or to control end-user ability to change the MAC address or configuration settings for the network adapter.

See also requirement 3.5, "BIOS meets PC 99 requirements for boot support."

3.55. SMBIOS 2.2 static table support is provided

Consumer	Office	Mobile	Workstation	Entertainment
Not applicable	*Required*	*Recommended*	*Required*	*Not applicable*

Windows 2000 can present SMBIOS 2.2 or later static table data in WBEM. System designers can provide platform-specific static information at boot time using this mechanisms. For more information about SMBIOS, see *System Management BIOS Reference Specification, Version 2.2.*

SMBIOS static table support is likely to become a requirement in future versions of these guidelines.

PC 99 System References

The following represents some of the references, services, and tools available to help build hardware that is optimized to work with Windows operating systems.

Advanced Configuration and Power Interface Specification, Revision 1.0 and later
http://www.teleport.com/~acpi/tech.htm.

ATAPI Removable Media BIOS Specification (ARMD), Version 1.0
Other ATA and SCSI specifications
   Global Engineering Documents
   Fax: (303) 397-2740
   Phone: (800) 854-7179 (U.S.)
            (613) 237-4250 (Canada)
            (303) 792-2181 (Outside North America)

Plug and Play External COM Device Specification, Version 1.0
Plug and Play Industry Standard Architecture (ISA) Specification, Version 1.0a
      and *Clarification to Plug and Play ISA Specification, Version 1.0a*
Plug and Play Parallel Port Device Specification, Version 1.0b
Plug and Play Small Computer System Interface Specification, Version 1.0
   http://www.microsoft.com/hwdev/respec/pnpspecs.htm

Default Device Class Power Management Specification, Version 1.0
   http://www.microsoft.com/hwdev/specs/Pmref/PMdefault.htm

Device Bay Interface Specification, Version 1.0
   http://www.device-bay.org

Display Data Channel Standard, Version 3.0
Extended Display Identification Data Standard, Version 3.0
   http://www.vesa.org

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

*Instantly Available PC System Power Delivery Requirements
      and Recommendations Specification*
   http://developer.intel.com/design/power/supply98.htm

Interoperability Specification for ICCs and Personal Computer Systems
   http://www.smartcardsys.com

Low Pin Count Interface Specification
   http://developer.intel.com/design/pcisets/lpc/index.htm

Media Status Notification Support Specification, Version 1.03
   http://www.microsoft.com/hwdev/respec/storspec.htm

Microsoft Windows 95 DDK, Windows 98 DDK, and Windows 2000 DDK
   MSDN Professional subscription

MultiProcessor Specification, Version 1.4
   Intel part number 242016-002
   http://developer.intel.com/design/pro/datashts/242016.htm

Network PC Design Guide, Version 1.0b
   http://www.microsoft.com/hwdev/netpc.htm
   http://www.intel.com/businesscomputing/netpc/netpc.htm

PCI Local Bus Specification, Revision 2.1 (PCI 2.1) and later
PCI Power Management Specification, Revision 1.1 (PCI-PM 1.1)
   http://www.pcisig.com

Serial Infrared (SIR) Physical Layer Specification
Control IR (CIR or IrBUS) Specification
   Other Infrared Data Association documents (available only to IrDA members)
   Fax: (510) 943-5600
   E-mail: irda@netcom.com

Simple Boot Flag Specification, Version 1.0
   http://www.microsoft.com/hwdev/desinit/simp_bios.htm

System Management BIOS Reference Specification, Version 2.2
   ftp://download.intel.com/ial/wfm/smbios.pdf
   http://www.phoenix.com/techs/specs.html

Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9
Universal Serial Bus Specification, Version 1.0 or later
USB Device Class Definition for Human Interface Devices, Version 1.0
   Other USB device class specifications
   http://www.usb.org

Web-Based Enterprise Management (WBEM) information
   http://wbem.freerange.com
   http://www.dmtf.org/work/cim.html
   http://www.microsoft.com/management/wbem/

Windows Hardware Instrumentation Implementation Guidelines (WHIIG), *Version 1.0*
   http://www.microsoft.com/hwdev/desguid/whiig.htm

Wired for Management Baseline Specification
   Version 1.1a—http://www.intel.com/managedpc/spec.htm
   Version 2.0—http://developer.intel.com/ial/wfm/

Checklist for PC 99 Basic Requirements

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

Consumer	Office	Mobile	Workstation	Entertainment
3.1. System performance meets PC 99 minimum requirements				
300 MHz,	*300 MHz,*	*233 MHz,*	*400 MHz,*	*300 MHz*
32 MB	*64 MB*	*32 MB*	*128 MB*	*64 MB*

3.2. System design meets ACPI 1.0 specification and PC 99 requirements
Required for all system types, with exceptions for mobile PCs

3.3. Hardware design supports OnNow and Instantly Available PC initiatives
Required for all system types, with exceptions for mobile PCs

3.4. BIOS meets PC 99 requirements for OnNow support
Required for all system types

3.5. BIOS meets PC 99 requirements for boot support
Required for all systems, with exceptions for mobile PCs

3.6. All expansion slots in the system are accessible for users to insert cards
Required for all system types, with extra guidelines for mobile

3.7. Audible noise meets PC 99 requirements
Required for all system types

3.8. System and component design practices follow accessibility guidelines
Recommended for all system types

3.9. Internal system modification capabilities are not accessible to end users
Recommended for all system types

3.10. System design provides physical security
Recommended for all system types

3.11. Each device and driver meets PC 99 device requirements
Required for all system types

3.12. Each bus and device meets Plug and Play specifications
Required for all system types

3.13. Unique Plug and Play device ID provided for each system device and add-on device
Required for all system types

3.14. Option ROMs meet Plug and Play requirements
Required for all system types

3.15. "PNP" vendor code used only to define a legacy device's Compatible ID
Required for all system types

3.16. Device driver and installation meet PC 99 requirements
Required for all system types

3.17. Minimal user interaction needed to install and configure devices
Required for all system types

3.18. Connections use icons, plus keyed or shrouded connectors, with color coding
Required for all system types, with exceptions for mobile PCs

3.19. Hot-plugging capabilities for buses and devices meet PC 99 requirements
Required for all system types

3.20. System includes Device Bay 1.0-compatible bay
Recommended for all system types

3.21. Multifunction add-on devices meet PC 99 device requirements for each device
Required for all system types

3.22. All devices support correct 16-bit decoding for I/O port addresses
Required for all system types

3.23. All PC 99 input devices support Microsoft DirectInput and work simultaneously
Required for all system types

3.24. Each bus meets written specifications and PC 99 requirements
Required for all system types

3.25. System includes USB with two USB ports, minimum
Required for all system types, with exceptions for mobile PCs

3.26. System includes support for IEEE 1394
Recommended for all system types, with 3 ports recommended for Entertainment PCs

3.27. If present, PCI bus meets PCI 2.1 or later, plus PC 99 requirements
Required for all system types

3.28. System does not include ISA expansion devices or slots
Required for all system types

3.29. System includes keyboard connection and keyboard
Required for all system types

3.30. System includes pointing-device connection and pointing device
Required for all system types

3.31. System includes connection for external parallel devices
Required for all system types

3.32. System includes connection for external serial devices
Required for all system types

3.33. System includes IR devices compliant with IrDA specifications
Recommended for all system types

3.34. System includes PC 99-compatible CD or DVD drive and controller
Required   Recommended Recommended Required DVD required

3.35. System includes audio support that meets PC 99 requirements
Recommended   Recommended Recommended Recommended Required

3.36. System includes a modem or other public network communications support
Required   Recommended Required Recommended Required

3.37. System includes a network adapter
Recommended   Required Recommended Required Recommended

3.38. System includes smart card support
Recommended for all system types

3.39. Graphics adapter meets PC 99 minimum requirements
Required for all system types, with specific guidelines for each system type

3.40. Color monitor is DDC-compliant with unique EDID identifier
Required for all system types, with exceptions for mobile PCs

3.41. System meets PC 99 DVD-Video and MPEG-2 playback requirements, if system supports DVD-Video
Required for all system types, with exceptions for mobile PCs

3.42. Adapter supports television output if system does not include a large-screen monitor
Recommended for all system types

3.43. System supports PC 99 analog video input and capture capabilities
Recommended for all system types

3.44. System includes analog television tuner
Recommended for all system types

3.45. System BIOS and option ROMs support Int 13h Extensions
Required for all system types

3.46. Host controller for storage device meets PC 99 requirements
Required for all system types

3.47. Host controllers and hard disk devices support bus mastering
Required for all system types

3.48. Hard drive meets PC 99 requirements
Required for all system types

3.49. Operating system recognizes the boot drive in a multiple-drive system
Required for all system types

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

3.51. System supports WHIIG
Not applicable   Required Required with Required Not applicable
Windows 2000

3.52. System includes driver support for WMI
Not applicable   Required Required with Required Not applicable
Windows 2000

3.53. Management information service provider enabled by default
Not applicable   Required Required with Required Not applicable
Windows 2000

3.54. Expansion devices can be remotely managed
Not applicable   Required Recommended Required Not applicable

3.55. SMBIOS 2.2 static table support is provided
Not applicable   Required Recommended Required Not applicable