C H A P T E R   1 3

I/O Ports and Devices

This chapter presents requirements and recommendations for I/O ports and devices, including serial and parallel ports, wireless capabilities, and input devices and connectors.

System designers are encouraged to consider solutions such as USB rather than traditional connections for external devices. USB support is required for PC 99 systems, and easy connectivity is important in situations where devices might be interchanged on a regular basis. USB is expected to replace legacy serial and parallel ports as the dominant external connector in the near future.

Contents

System Requirements for I/O Ports and Devices

This section summarizes requirements for serial and parallel ports.

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

Recommended: USB or PC Card.

This capability can also be provided as a 16550A serial port or as equivalent I/O capabilities in the system. If a legacy serial port is implemented in a PC 99 system, it must meet the requirements defined in this chapter. If two legacy serial ports are implemented, additional requirements are defined.

For Office PC systems, remote management capabilities must be implemented as defined in *Network PC System Design Guidelines, Version 1.0b*.

See also requirement 3.5.9, "System BIOS support for console redirection of a serial port." This capability provides support during system startup for debugging and troubleshooting activities. The BIOS must configure at least one serial port to use either 2F8h or 3F8h. This allows the port to be treated as a boot device by the BIOS and is intended 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.

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

Recommended: USB, IEEE 1394, or PC Card.

This connection can also be provided as a parallel port with extended capabilities port (ECP)-mode capabilities. If a legacy port is implemented in a PC 99 system, it must meet the requirements defined in this chapter.

If a parallel port is present, remote management capabilities must be implemented as defined in *Network PC System Design Guidelines*. On a RISC-based system, the keyboard must work as the input device using the Advanced RISC Computing (ARC) interfaces.

13.3. System includes external connection for keyboard
Required for all system types

Recommended: USB.

Although USB is the preferred solution, this connection can also be implemented as a PS/2-style port or by using wireless capabilities in the system.

Mobile PC Note   For a mobile PC, the required USB port can be used to support the requirement for an external pointing device and keyboard connections. However, two PS/2-style ports can be implemented for the pointing device and keyboard, or a single PS/2-style port can be provided for both the pointing device and the keyboard. If a single PS/2-style port is used, the design must include two separate clocks and two separate data lines, and a special cable must be provided that allows both the external keyboard and pointing device to use the single port.

13.4. System includes pointing-device connection and pointing device

Required for all system types

Recommended: USB or wireless.

Although USB is the preferred solution, this connection can also be implemented using a PS/2-style port.

Mobile PC Note   For issues related to mobile PCs, see requirement 13.3, "System includes external connection for keyboard."

13.5. System includes USB game pad or joystick

Required for all system types; wireless recommended for Entertainment PC

PC 99A errata: The requirement is meant to state that if a game pad or joystick is included in a PC system, it should be implemented using USB. It is *not* required to include any such devices on a system.

PC 99A note: No devices that use legacy or proprietary ports can be included in a PC system.

This device must support the *USB Human Interface Device Class Specification, Version 1.0* or later. For more information about requirements for USB peripherals, see Chapter 7, "USB."

Important: No devices that use legacy or proprietary ports can be included in a PC 99 system.

13.6. System includes built-in wireless capabilities

Recommended for all system types

Wireless capabilities can be provided as built-in capabilities in the system or by using PC Card, IEEE 1394, or USB. If wireless capabilities are included in the system, the requirements must be met that are defined in "Wireless Component Requirements" later in this chapter.

13.7. Devices use USB or external bus connections rather than legacy serial or parallel ports

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

This will become a requirement for all system types in future versions of these guidelines.

Although legacy parallel and serial ports can be provided on a PC 99 system, no devices that use these ports should be provided with a system, with the exception of printers. A legacy serial port cannot be used as the connection for the mouse or modem.

13.8. All devices meet PC 99 general device requirements

Required

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

Serial Port Requirements

Serial ports have been used on computers for decades. In the past, standard baud rates for most serial ports were around 19.2K. Now that systems and peripherals have become more demanding, higher-speed devices are necessary to meet the needs of the newest generation of serial ports.

This section summarizes the hardware design features for serial ports. The general device requirements are defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

Non-legacy Serial Port Requirements

This section defines requirements for non-legacy implementations in support of serial port capabilities.

13.9. Serial port meets device class specifications for its bus

Required

As required for all PC 99 devices, a serial port implementation that uses a non-legacy bus must meet the specific device class requirements for that bus.

For example, a USB serial port implementation must comply with all related USB specifications, including:

- *Universal Serial Bus Specification, Version 1.0* or later (also known as the USB core specification)
- *Universal Serial Bus Device Class Definition for Communication Devices, Version 1.0* or later

The "Standard Serial Interface Circuit Emulation" appendix in the *USB Device Class Definition for Communication Devices* specifically addresses serial-port compatibility.

Legacy Serial Port Requirements

This section defines requirements for legacy serial ports. Legacy ports are not recommended for PC 99 systems, but if implemented, such ports must meet the requirements defined in this section.

13.10. Legacy serial port is implemented as 16550A UART or equivalent and supports 115.2K baud

Required

A 16550A buffered Universal Asynchronous Receiver/Transmitter (UART) or equivalent buffered legacy serial port is required to support high-speed communications while reducing the CPU requirements for servicing the device. The device must be able to support 115.2K baud.

13.11. Legacy serial port supports dynamic resource configuration

Required

A legacy serial port must provide flexible resource configuration and complete dynamic disable capabilities as defined in the *Plug and Play External COM Device Specification, Version 1.0.*

These are the recommended resource settings for non-PCI devices:

- Four I/O locations for each port, where the standard ISA I/O addresses are 3F8h, 2F8h, 3E8h, 2E8h. Using the standard addresses ensures the proper functioning of software that directly addresses these locations.

- Two IRQ signals, where the standard is programmable interrupt controller-based (PIC-based) IRQ 3 and IRQ 4. Using the standard IRQ signals ensures the proper functioning of software written for systems that use standard IRQ signals.

Two IRQs are required for each port. If two serial ports are implemented in the system, the IRQs can be assigned as follows:

- For serial port A: PIC-based IRQ 4 and IRQ 11
- For serial port B: PIC-based IRQ 3 and IRQ 10

An IR adapter port might replace a serial port in a system. In such a case, the IR port should use the resource configuration that would otherwise be assigned to the second serial port.

Notice that, as for all devices, IRQ sharing is required if the minimum resource requirement cannot be met.

PC 99A clarification: For information about how the system determines the correct peripheral device driver, see "Device Installation Functions" in the Windows 98 DDK and the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/devinst_12uw.htm and http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/di-rtns_85ma.htm, respectively).

13.12. Conflict resolution for legacy serial port ensures availability of at least one serial port
Required

In the event of an irreconcilable conflict with other serial ports on the system, a legacy serial port must be capable of being disabled by Plug and Play software. This allows at least one of the two conflicting serial ports to operate correctly.

Parallel Port Requirements

This section summarizes the basic design features for parallel ports and peripherals. Each parallel port on a PC 99 system must meet the requirements listed in this section. The general device requirements are defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

Non-legacy Parallel Port Requirements

This section defines requirements for recommended non-legacy implementations to support parallel port capabilities.

13.13. Parallel port meets device class specifications for its bus
Required

As required for all PC 99 devices, a parallel port implementation that uses a non-legacy bus must meet the specific device class requirements for that bus.

For example, a parallel port implementation that uses USB must comply with all related USB specifications, including the USB core specification and any specific device class specification.

Legacy Parallel Port Requirements

This section defines requirements for legacy parallel ports.

13.14. Flexible resource configuration supported for each parallel port
Required

A legacy parallel port must provide flexible resource configuration following the *Plug and Play Parallel Port Device Specification, Version 1.0b*. Resource requirements must be met for each device of this type on the system. The requirements cannot be split between two ports on the system.

For non-PCI devices, the following are the minimum resource requirements for each parallel port on the system:

- Required: Support ISA I/O addresses of 378h and 278h, plus 3BC or a vendor-assigned I/O address. Using these standard I/O addresses ensures proper functioning of software written for operating systems that directly address these locations.

Recommended: Map the base I/O address to four additional locations.

- Required: Support PIC-based IRQ 5 and IRQ 7. Using these standard IRQs ensures proper functioning of software written for operating systems that use standard IRQ signals.

  Recommended: Support five additional IRQ signals.

- Required: Support two unique DMA channel selections if the parallel port design supports block data transfers to memory using DMA controllers. Notice also that the DMA function will not work on a parallel port without an IRQ because the end of a DMA transfer is signaled by an interrupt.

  To ensure Plug and Play support for resolution of resource conflicts, a full list of options for all possible configuration combinations must be enumerated, including:

- Options for both ECP mode, which requires an I/O address, an IRQ, and a DMA selection, and standard LPT mode, which requires only an I/O address.

- Options that specify only the I/O address, allowing Windows to assign the IRQ and DMA channel.

  On Intel Architecture systems, the operating system considers the parallel port base address (/) stored in the first BIOS Data Area (BDA) locations to be LPT1. The address stored in the second location is LPT2, and so on. On RISC-based systems, the information is in the ARC tree. On all ACPI-based systems, the information is obtained through the ACPI tree.

13.15. EPP support does not use restricted I/O addresses
Required

Some enhanced parallel port (EPP) implementations require eight contiguous I/O ports. If EPP support is implemented, the hardware cannot use the ISA I/O address 3BCh as a base I/O address because VGA devices require use of port 3C0h.

13.16. Compatibility, nibble mode, and ECP protocols meet IEEE 1284-1994 specifications
Required

Support for a parallel port must include, at a minimum, the compatibility-mode and nibble-mode protocols required by the IEEE 1284-1994 specification. This allows other IEEE 1284-compliant devices to be connected without problems.

The port must also support the ECP protocol as defined by IEEE 1284 to allow connections with higher-speed parallel peripherals.

Recommended: Enable ECP by default.

13.17. Port connectors meet IEEE 1284-I specifications, minimum

Required

IEEE 1284-I–compliant ports use a standard DB25 connector found on existing system parallel port designs. This is called an IEEE 1284-A connector in the specification.

IEEE 1284-II–compliant ports use an IEEE 1284-C connector. This connector is used on both the port and the peripheral device.

The parallel port design must provide enough space between the connectors and the surrounding enclosure to allow for a mating connector, connector shell, and latch assembly. The IEEE 1284 specification recommends an IEEE 1284-C connector for all new ports and devices.

13.18. IEEE 1284 peripherals have Plug and Play device IDs

Required

The device ID is described fully in the IEEE 1284 specification. All characters in the device identification string must consist only of ASCII values 20h–7Fh. The device identification string consists of a leading zero (0), a hexadecimal value that represents the length of the string, and then a set of fields in ASCII that have a unique identification string.

In addition to the requirements specified in *Plug and Play Parallel Port Device Specification, Version 1.0b,* the device ID string must contain the following keys, at minimum. The keys are case-sensitive and can be abbreviated in INF files as indicated.

Key	Abbreviated string
MANUFACTURER	MFG
MODEL	MDL
CLASS	CLS
DESCRIPTION	DES

All MANUFACTURER and MODEL key values must remain unique for each manufacturer. All MANUFACTURER, MODEL, CLASS, and DESCRIPTION key values must remain static for a specific unit, where ID values do not change for different hardware configurations. For example, a user simply adding a memory module to a printer should not change the MODEL key value reported as part of the device ID. However, if the user adds memory by installing an upgrade kit that requires a different driver or requires the existing driver to behave differently, then changing the MODEL value is acceptable as part of the upgrade installation process.

The CLASS key describes the type of parallel device. The CLASS key can contain the values PRINTER, MODEM, NET, HDC, PCMCIA, MEDIA, FDC, PORTS, SCANNER, or DIGCAM. HDC refers to hard disk controller. MEDIA refers to any multimedia device. FDC refers to floppy disk controller.

The DESCRIPTION key is an ASCII string of up to 128 characters that contains a description of the device the manufacturer wants to have presented if a device driver is not found for the peripheral.

For information about how the system determines the correct peripheral device driver, see the Windows 95 DDK and Windows 2000 Professional DDK.

13.19. Device identification string provides a Compatible ID key
Recommended

The Compatible ID (CID) key can provide a value that exactly matches a peripheral name supported by a device driver shipped with Windows. The value must match a value listed in the device's INF file.

13.20. Daisy-chained parallel port device is Plug and Play capable
Required

Daisy-chained parallel port devices must be Plug and Play capable. The daisy-chained parallel port device must be capable of answering Plug and Play requests from the host.

Because of end-of-chain issues with IEEE 1284 and IEEE 1284.3, it is also required that all pass-through devices comply with IEEE 1284.3.

Mouse Port and Peripheral Requirements

This section defines the specific requirements for pointing-device connections and peripherals. Because the Windows 98 and Windows 2000 operating systems require a pointing device, a PC 99 system board should include an auxiliary port for an external pointing device, most commonly a mouse. It is recommended that systems designers use the USB port for the connection and also that they consider implementing wireless support for an external pointing device.

The general device requirements are defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

For wireless capabilities requirements, see "Wireless Component Requirements" later in this chapter.

13.21. Pointing-device connection meets requirements for its bus class
Required

The following requirements must be met, depending on the connection type used in the system. These requirements ensure that all Plug and Play requirements are met and that Microsoft drivers support the pointing device. If a PS/2-style port is used, the following requirements must be met:

- Comply in full with requirements in *Personal System/2 Specification,* by IBM.

- Use an 8042 chip (or equivalent) to ensure compatibility with Windows. In most cases, the existing 8042 keyboard port is sufficient; the chip initiates a PIC-based IRQ 12 interrupt when the pointing device is connected.

- Support PCI-based IRQ 12 to ensure the proper functioning of software written for legacy systems that use this IRQ signal.

- Return expected codes, including send ID (0F2h) and response acknowledgement (ACK) (0FAh), plus 1-byte ID.

  If a USB port is used, the following requirements must be met:

- Meet requirements in *USB Specification, Version 1.0* or later

- Meet requirements in *USB Human Interface Device Class Specifications, Version 1.0* or later

- Implement minidriver support based on WDM Human Interface Device (HID) class support in the operating system, as defined in the Windows 2000 DDK

  PC 99A clarification: For information about implementing minidriver support based on WDM Human Interface Device (HID) class support in the operating system, see "Chapter 1 I/O Requests for HID Minidrivers" in the Windows 2000 DDK, which defines the implementation for both Windows 98 and Windows 2000 (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/hidioreq_92k2.htm).

13.22. Remote control pointing device provides PC 99 minimum support

Recommended

If a remote-control device is provided with a PC 99 system, the range of functions implemented on the device will depend on whether the remote control is designed for the business desktop or for Entertainment PC 99. For specific requirements for Entertainment PC 99, see requirement 5.4, "Entertainment PC includes a remote-control pointing device."

There is no defined list of functions that must be included on a remote-control device, but such a device might provide the following types of functions and buttons:

- Power button that turns devices on and off.

- Start button, such as the Windows logo key, that causes a Start menu to be displayed. For information about the Windows logo key, see "Keyboard Port and Peripheral Requirements" later in this chapter.

- Menu button that causes an application-specific menu to be displayed.

- Help button that causes application-specific Help file to be displayed.

- Select button that functions similarly to the ENTER key on a keyboard.

- Directional capabilities, which function similarly to the arrow keys on a keyboard.

  The following functions and buttons can also be considered for a remote-control device used with an Entertainment PC system:

- Television button to select the television as the device that will receive input

- Mute button
- Device control buttons, including Volume Up, Volume Down, Channel Up, Channel Down, Fast Forward, Rewind, Play, Stop, Pause, and Record
- Number keys equivalent to a telephone keypad

Keyboard Port and Peripheral Requirements

The primary input component for a PC is the keyboard. An 8042 microcontroller or its equivalent has traditionally controlled the keyboard connection on the system board. However, USB connections and wireless connections are important design considerations for keyboards. These design requirements do not exclude—but they do not encourage—implementing a legacy AT-style keyboard port.

This section summarizes the specific hardware feature requirements for keyboard ports and peripherals. Some keyboard port requirements differ, depending on the type of port being used.

The general device requirements are defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

For requirements that apply if wireless capabilities are provided for the keyboard, see "Wireless Component Requirements" later in this chapter.

13.23. Keyboard connection meets requirements for its bus class
Required

These requirements depend on the type of connection designed into the system and ensure that all Plug and Play requirements are met, and that Microsoft drivers support this device.

If a PS/2-style keyboard port is used, it must meet the following requirements:

- Support IRQ 1 on Intel Architecture to ensure the proper functioning of software written for legacy systems, which expect to use this IRQ signal
- Map the I/O address ports to 60h and 64h
- Return expected scan codes, including send ID (0F2h) and response ACK (0FAh), plus 2-byte ID

If a USB connection is used, it must meet the following requirements:

- *USB Specification, Version 1.0* or later
- *USB Human Interface Device Class Specifications, Version 1.0* or later
- Minidriver support based on WDM HID class support in the operating system

If a USB keyboard is the sole keyboard implementation in an Intel Architecture system, it must support the USB Boot Device specification. The system BIOS must provide boot support as specified in requirement 3.5, "BIOS meets PC 99

requirements for boot support," and as defined in *Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9* or later.

13.24. No interference occurs between multiple keyboards

Required

Mobile PC Note

If the system includes more than one keyboard, there must be no conflicts. For example, when a mobile PC is connected to a docking station, more than one keyboard can be attached to the system simultaneously. The keyboard ports on a mobile PC and a docking station must be able to resolve conflicts between the two ports when the mobile unit is docked. Windows supports multiple configurations through the registry and will determine which keyboard to enable.

For more information about managing resources and devices for a mobile PC/docking station pair, see Chapter 6, "Mobile PC 99."

13.25. Keyboard includes Windows and Application logo keys

Recommended

The following are requirements for a keyboard design that includes any Windows logo keys:

- The keyboard must be developed according to technical requirements in *New Key Support for Microsoft Windows Operating Systems and Applications*.

  PC 99A note: The correct listing of all keyboard scan codes for Windows operating systems is being made available at http://www.pcdesguide.org/documents/keycode.htm. This online listing replaces the previous reference to *New Key Support for Microsoft Windows Operating Systems and Applications*.

- The keyboard must be compatible at the Windows virtual key-code level.
- The keyboard must pass the requirements in the Windows logo key testing software.
- The Windows logo key must function as a modifier (CTRL, SHIFT, or ALT).
- The Windows Flag trademark must be clearly distinguished on the key top according to the guidelines provided in *New Key Support for Microsoft Windows Operating Systems and Applications*.

The following are recommendations for a keyboard design that includes any Windows logo keys:

- Both left and right Windows logo keys are not required in order to offer full functionality under the Windows operating system.
- The Application key can be a dual-function key and can be used to replace the FN key. In this case, a single press-and-release action sends the scan code for the Application key, and holding this key down while pressing another key will modify it to perform the FN function.

Mobile PC Note   Given the crowded nature of compact keyboards on mobile PCs and keyboards that support double-byte characters, such as Japanese-language keyboards, it might be difficult to add three new keys. For mobile PCs, minimal implementation of new keys includes the addition of one Windows logo key and one Application key.

Game Controller Requirements

This section presents the minimum requirements for game-control devices.

Legacy and proprietary game-pad solutions are not acceptable for PC 99. Game pads, joysticks, and other input devices must be implemented as USB devices.

The general device requirements are defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

13.26. Device meets USB HID class specification requirements
Required

Game-control devices and drivers must support the *USB Human Interface Device Class Specification, Version 1.0* or later.

Wireless Component Requirements

This section defines requirements for wireless components, provided either as infrared (IR) and radio frequency (RF) devices, based on communication standards developed by the Infrared Data Association (IrDA).

For background information about design issues related to IR solutions, see "Wireless Design Issues" in Chapter 2, "PC 99 Design Issues." For information about requirements for wireless networking devices, see "IrDA Requirements for Network Communications" in Chapter 20, "Network Communications."

The requirements listed in this section must be met if wireless capabilities are provided in the system. The general device requirements are defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

Manufacturers who are implementing designs that include IrDA Control devices, also known as IrBus, are strongly encouraged to join IrDA and to obtain the IrDA-approved version of the IrDA Control specification, plus information on the availability of parts and driver software.

13.27. IR device uses NDIS 5.0 miniport driver
Required

This requirement applies for IrDA Data devices. An NDIS 5.0, IrDA miniport driver is required for all IrDA Data devices. For documentation and sample source code for building a miniport driver, see the Windows 2000 DDK.

PC 99A clarification: For documentation and sample source code for building a miniport driver, see "Chapter 10 IrDA Miniport NIC Drivers" in the Windows 2000 DDK (online at http://www.microsoft.com/ddk/ddkdocs/Win2kRC1/210irda_8fdz.htm).

13.28. IR device meets IrDA specifications

Required

Recommended: Support specifications for both IrDA Data and IrDA Control devices.

An IR device must be designed to comply with approved IrDA specifications.

If the system is intended to run data transfer applications with other IrDA Data devices, it must be in compliance with the IrDA Data specification.

If an IrDA Control application is used in a PC 99 system, it must be in compliance with the IrDA Control specification, which was approved by IrDA in early 1998. The first IrDA Control-compliant devices are expected to ship in late 1998.

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.

13.29. IR device meets PC 99 bus and port specifications

Required

The requirements for all bus classes are defined in Part 3 of this guide. In particular:

- The Windows operating system includes built-in support for devices that use a serial I/O interface; in this case, a wireless device must also comply with the requirements specified in "Serial Port Requirements" earlier in this chapter.

- A wireless device that uses a parallel port must comply with the requirements specified in "Parallel Port Requirements" earlier in this chapter.

- A USB wireless device must comply with the requirements specified in Chapter 7, "USB."

13.30. IR device supports dynamic resource configuration

Required

The adapter must provide flexible resource configuration and complete dynamic disable capabilities following the specifications for the bus or legacy port used. Resource configuration requirements are defined in the Plug and Play specification for the bus that the device uses. See also the related sections in this chapter that define configuration resource requirements for serial ports and parallel ports.

13.31. IR device meets USB guidelines for interfacing with IrDA Data and IrDA Control devices

Required

A USB working group is developing guidelines for how USB is to interface with both IrDA Data and IrDA Control devices. When these guidelines are finalized, they will become PC 99 requirements for USB IR implementations.

13.32. System supports standard input speeds of 4 Mb/s

Required

Device support is required for Fast IR (FIR) input speeds of 4 Mb/s for all IrDA Data devices.

13.33. System provides a separate, physically-isolated transceiver for each IR protocol supported

Required

This requirement ensures correct implementation for a system that includes IR support for any combination of devices that use the IrDA Data protocol, the IrDA Control protocol, or the universal consumer-IR approach to legacy remote control, each of which use different device signals. A system that uses only a specific IR device protocol will restrict the ability to use multiple input devices and might also restrict other capabilities.

A PC 99 system that advertises itself as supporting all three IR solutions— IrDA Data protocol, IrDA Control protocol, and legacy remote control IR— must provide a separate transceiver for each solution. The system must also expose each separate transceiver to the operating system.

The transceivers must be physically isolated from each other; an example is placing each transceiver on a different edge of the system case. Although some IrDA member companies have tested IrDA Data, IrDA Control, and legacy remote control IR transceivers without spatial separation and demonstrated adequate performance, interference-free operation cannot be assured without physical isolation.

If multiple IR protocols are supported, controllers must provide separate data connections into the PC using USB. The IrDA and USB industry associations define guidelines for how to build and interface such devices. Contact information can be found in "References for I/O Ports and Devices" later in this chapter.

13.34. System supports RF capabilities

Optional

If RF is included in a system, the implementation must meet the general device requirements defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

Manufacturers of Consumer PC systems and cordless consumer peripherals such as PC-enhanced cordless telephones or RF wireless data devices are encouraged to join the HomeRF Working Group (HRFWG) to obtain

information about the Shared Wireless Access Protocol (SWAP) specification. For more information, see "Wireless Design Issues" in Chapter 2, "PC 99 Design Issues."

The SWAP specification and components required for its implementation are expected to be available in late 1998; until the specification is available, the following recommendations are offered to help designers make appropriate choices if RF solutions are to be implemented in a particular system design.

13.35. RF implementation uses a low-power RF alternative

Recommended

For relatively short-range wireless devices that cannot use IR, it is possible to use low-power RF. Use an RF solution appropriate to the application. For example, cordless keyboard and trackball devices that need RF instead of Control IR require a maximum range of only 15 to 20 feet.

13.36. RF implementation provides a method to defeat noise and conflict with other RF devices

Recommended

RF devices should be able to defeat noise such as electromagnetic interference (EMI). Also, programmable channel selection, carrier sensing, or the relatively expensive spread-spectrum or frequency-hopping techniques can be used to share the RF medium with other RF devices that might be in the environment.

Many of the issues discussed in this recommendation are addressed by the governing regulatory agencies.

13.37. System and RF device have separate local certification

Recommended

Rules for certifying low-power, short-range, unlicensed RF devices vary greatly from country to country. By configuring the RF device as a system add-on, local certification of the system will not be blocked while waiting for certification of the RF device, which might take longer. Configuring the RF device as a system add-on also enables adding RF support to legacy hardware.

Smart Card Requirements

This section defines requirements for smart card devices. Such devices are not required, but if implemented, must comply with the requirements defined in this section. The general device requirements are defined in "System Requirements for I/O Ports and Devices" earlier in this chapter.

13.38. Smart card reader complies with ISO 7816

Required

A smart card reader must comply with the following ISO specifications:

- ISO 7816-1:1987 Identification cards—Integrated circuit(s) cards with contacts—Part 1: Physical characteristics

- ISO 7816-2:1988 Identification cards—Integrated circuit(s) cards with contacts—Part 2: Dimensions and location of the contacts

- ISO/IEC 7816-3:1997 Information technology—Identification cards—Integrated circuit(s) cards with contacts—Part 3: Electronic signals and transmission protocols

13.39. Smart card reader supports ISO 7816 T=0 and T=1 protocols

Required

A smart card reader must support the asynchronous protocols T=0 and T=1 as described in ISO 7816-3, either in hardware or in the driver for the operating system. Both protocols must be fully supported. The smart card reader and the driver must support cards that can handle both protocols.

The following protocol rules apply for the T=1 protocol:

- A transmission is defined as sending a command to a smart card using one or more T=1 blocks and receiving the corresponding answer using one or more T=1 blocks as defined in ISO 7816-3.

- The very first transmission—after a reset of the smart card—should start with an Information Field Size Device (IFSD) request, as defined in ISO 7816-3, Amendment 1, Section 9.5.1.2.

    If the current card does not support an IFSD request (the card should reply with an R-Block indicating "Other error"), the transmission should continue with an I-Block.

    After a successful RESYNCH request, the transmission must restart from the beginning with the first block with which the transmission originally started.

    Support for protocols other than T=0 and T=1 is optional.

13.40. Smart card reader supports inverse-convention smart cards

Required

A smart card reader must support inverse-convention smart cards either in hardware or in the driver for the operating system.

13.41. Smart card reader supports 258-byte packets in T=0 and 259-byte packets in T=1

Required

A smart card reader must support the exchange of the following in a single transmission:

- 258 byte packets in T=0—that is, 256 data bytes plus the two status words SW1 and SW2

- 259 byte packets in T=1—that is, 254 INF bytes plus NAD, PCB, LEN, and two EDC bytes

13.42. Smart card reader supports a smart card insertion/removal monitor
Required

A smart card reader must be able to detect and report smart card insertions and smart card removals without any user intervention other than removing or inserting the smart card itself. Preferably, the reader uses an interrupt mechanism to report the smart card insertion/removal to the system. A driver polling method to detect smart card insertion and removals is not recommended.

13.43. Smart card reader supports PTS
Required

To support multi-protocol smart cards and smart cards using higher data rates and higher clock frequencies, the reader must support protocol type selection (PTS) according to ISO 7816-3 Amendment 2.

PC 99A correction: The correct citation for the specification is ISO 7816-3 (1997-12-15) Section 7.

13.44. Smart card reader supports 3.5795 MHz minimum clock frequency
Required

A smart card reader must support a minimum clock frequency of 3.5795 MHz.

Recommended: The reader supports higher clock frequencies.

13.45. Smart card reader supports 9600 bps minimum data rate
Required

A smart card reader must support a minimum data rate of 9600 bits per second.

Recommended: The reader supports data higher rates: 3.5795 MHz with default communications settings.

13.46. Smart card reader supports the Power Down command
Required

A smart card reader must support the Power Down command to turn off power of a smart card, as defined in ISO 7816-3 Section 4.1.

PC 99A correction: The correct citation for the specification is ISO 7816-3 (1997-12-15) Section 5.4.

13.47. Smart card reader does not use an additional power supply
Recommended

A smart card reader should use power provided by the system for the smart card and the smart card reader. The reader should not use an external power supply or battery.

PC 99 Design Features for Ports

This section summarizes requirements related to the design initiatives defined in Part 1 of this guide.

Plug and Play and Bus Design for I/O Ports and Devices

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

13.48. Each device has a unique Plug and Play device ID
Required

For a non-bus–specific system-board device, there must be a device-specific ID.

Each bus-specific device must have a Plug and Play device ID as required for the bus it uses, as defined in Part 3 of this guide. For example, a PCI device must comply with PCI 2.1 and also must provide a Subsystem ID and Subsystem Vendor ID, as defined in Chapter 9, "PCI." A USB device must comply with the *Universal Serial Bus Specification, Version 1.0* or later, and also must provide a unique ID.

13.49. Dynamic resource configuration is supported for all devices
Required

The system must be capable of automatically assigning, disabling, and relocating the resources used by this device when necessary, using the method required for the related bus class. When the end user changes this device or adds it to the system, setting resource assignments must not require changing jumpers or switches on either the adapter or the system board.

In the event of an irreconcilable conflict with other devices on the system, the system must be able to disable the device to prevent the system from stalling. If there is a conflict where more than one port or device of the same type is detected on the system, then one of two methods can be used to resolve it:

- Method 1: Completely disable the built-in port or device. For example, if there is a conflict when a second serial port is added to a desktop system, the expansion card overrides the system-board device. Using this method, the system disables the device on the system board and enables the expansion card only. This is the recommended conflict-resolution method for add-on serial, parallel, Musical Instrument Digital Interface (MIDI), and joystick devices.

  Or if an expansion card, such as a display adapter with a built-in pointing-device port, is added to a desktop system that has a system-board pointing-device port, then the expansion card overrides the system-board pointing-device port. Using this method, the system disables the pointing-device port on the system board and only accepts pointing-device input from the expansion card.

- Method 2: Both ports and devices remain active while resolving any conflict by relocating the resources of one or both devices. Using this method, either device can be used. For example, in a docking system, the pointing device on a mobile PC and the pointing device on a docking station can be allowed to share pointing responsibilities. Either pointing device can be used, although the software will use only one.

> **Note:** Fixed (static) resource devices can exist to support standard devices, including the 8042 keyboard controller. For a system based on Intel Architecture, these fixed resources are located at I/O addresses under 100h. Standard system-board devices should use their ISA-compatible addresses. For a system based on Intel Architecture, this includes devices with I/O port addresses within the reserved range 0h–0ffh. For more information about legacy resources and ISA-compatible addresses, see Appendix D, "Legacy Support."

Power Management for I/O Ports and Devices

This section summarizes the specific power management requirements for I/O ports and devices.

13.50. Each device complies with its device class power management reference specification

Required

The related device class power management reference specification applies for each specific type of device. For example, for an input device, the *Input Device Class Power Management Reference Specification* is the relevant specification. These specifications also cover device functionality expected for each power state and possible wake-up event definitions for each class. Power states D0 and D3 are required.

13.51. Device supports wake-up events

Required for wireless input; optional for other devices

The ability to cause a wake-up event as defined in the device class power management reference specification is required for wireless input devices. It is optional for other devices.

Device Drivers and Installation for I/O Ports and Devices

This section summarizes device driver requirements for I/O ports and devices. The items in this section are requirements for all PC 99 systems.

13.52. Device drivers and installation meet PC 99 requirements

Required

The manufacturer does not need to supply a driver if a PC 99-compliant driver provided with the operating system can be used. If the manufacturer supplies a driver, the requirements for the device driver and installation are defined in requirement 3.11, "Each device and driver meets PC 99 device requirements."

The basic requirements include driver support for unattended installation and Help file support if special driver parameters are used.

For input devices that use USB connections, driver support must be implemented as a minidriver under the WDM HID support provided in the Windows 98 and Windows 2000 operating systems.

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

Required

All input devices implemented in a PC 99 system must have drivers that support Microsoft DirectInput if they do not use drivers that are built into the operating system. 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.

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, available through MSDN Professional membership.

PC 99A clarification: For information about implementing drivers that support simultaneous use of devices, see the Microsoft DirectInput DDK, which is provided with the Windows 98 DDK (online at http://www.microsoft.com/ddk/ddkdocs/win98ddk/di_ddk_9rxw.htm).

References for I/O Ports and Devices

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

Device Class Power Management Specifications
   http://www.microsoft.com/hwdev/specs/Pmref/

Home Radio Frequency (Home RF) Working Group
   http://www.homerf.org

IBM Personal System/2 Common Interfaces, Part No. S84F-9809
IBM Personal System/2 Mouse Technical Reference, Part No. S68X-2229
   International Business Machines Corporation
   Order from IBM Customer Publications Support: (800) 879-2755
   Or contact an IBM sales representative

IEEE 1394 Standards
   ASK*IEEE
   Phone: (800) 949-4333
   Fax: (212) 310-4091
   E-mail: askieee@ieee.org

   Global Engineering Documents
   Phone: (800) 854-7179 (US)
      (613) 237-4250 (Canada)
      (303) 792-2181 (Outside North America)
   Fax: (303) 397-2740

ISO/IEC DIS 7816 Identification Cards—Integrated circuit(s) cards with contacts
   Part 1: Physical characteristics
   http://www.iso.ch/cate/d29257.html

Part 2: Dimensions and location of the contacts
http://www.iso.ch/cate/d26536.html

Part 3: Electronic signals and transmission protocols
http://www.iso.ch/cate/d14735.html

Microsoft Windows 98 DDK, Windows 2000 DDK, and DirectX 5.0 DDK
http://www.microsoft.com/ddk/
(or MSDN Professional subscription)

Network PC System Design Guidelines, Version 1.0b
http://www.microsoft.com/hwdev/netpc.htm
http://developer.intel.com/ial/WfM/design/NETREC.HTM

New Key Support for Microsoft Windows Operating Systems and Applications (replacement reference)
http://www.microsoft.com/hwdev/desinit/scancode.htm

PC/Smart Card (PC/SC) Workgroup
http://www.smartcardsys.com

Plug and Play specifications
http://www.microsoft.com/hwdev/respec/pnpspecs.htm
http://msdn.microsoft.com/library/

Serial Infrared (SIR) Physical Layer Specification
Control IR (CIR or IrBUS) Specification
Other Infrared Data Association documents (available only to IrDA members)
Infrared Data Association
PO Box 3883
Walnut Creek, CA 94598 USA
Phone: (510) 943-6546
Fax: (510) 943-5600
E-mail: irda@netcom.com

USB PC Legacy Compatibility Specification, Revision 0.9 or later
http://www.usb.org/developers/index.html

USB HID Usage Tables, Version 1.0
Other USB specifications
Phone: (503) 264-0590
Fax: (503) 693-7975
http://www.usb.org/developers/index.html

White papers and guidelines for Microsoft operating systems
http://www.microsoft.com/hwdev/drvrinfo.htm

Checklist for I/O Ports and Devices

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

Consumer	Office	Mobile	Workstation	Entertainment

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

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

13.3. System includes external connection for keyboard
Required for all system types

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

13.5. System includes USB game pad or joystick
Required for all system types; wireless recommended for Entertainment PC

13.6. System includes built-in wireless capabilities
Recommended for all system types

13.7. Devices use USB or external bus connections rather than legacy serial or parallel ports

Required	Recommended	Recommended	Required	Required

13.8. All devices meet PC 99 general device requirements
Required

13.9. Serial port meets device class specifications for its bus
Required

13.10. Legacy serial port is implemented as 16550A UART or equivalent and supports 115.2K baud
Required

13.11. Legacy serial port supports dynamic resource configuration
Required

13.12. Conflict resolution for legacy serial port ensures availability of at least one serial port
Required

13.13. Parallel port meets device class specifications for its bus
Required

13.14. Flexible resource configuration supported for each parallel port
Required

13.15. EPP support does not use restricted I/O addresses
Required

13.16. Compatibility, nibble mode, and ECP protocols meet IEEE 1284-1994 specifications
Required

13.17. Port connectors meet IEEE 1284-I specifications, minimum
Required

13.18. IEEE 1284 peripherals have Plug and Play device IDs
Required

13.19. Device identification string provides a Compatible ID key
Recommended

13.20. Daisy-chained parallel port device is Plug and Play capable
Required

13.21. Pointing-device connection meets requirements for its bus class
Required

13.22. Remote control pointing device provides PC 99 minimum support
Recommended

13.23. Keyboard connection meets requirements for its bus class
Required

13.24. No interference occurs between multiple keyboards
Required

13.25. Keyboard includes Windows and Application logo keys
Recommended

13.26. Device meets USB HID class specification requirements
Required

13.27. IR device uses NDIS 5.0 miniport driver
Required

13.28. IR device meets IrDA specifications
Required

13.29. IR device meets PC 99 bus and port specifications
Required

13.30. IR device supports dynamic resource configuration
Required

13.31. IR device meets USB guidelines for interfacing with IrDA Data and IrDA Control devices
Required

13.32. System supports standard input speeds of 4 Mb/s
Required

13.33. System provides a separate, physically-isolated transceiver for each IR protocol supported
Required

13.34. System supports RF capabilities
Optional

13.35. RF implementation uses a low-power RF alternative
Recommended

13.36. RF implementation provides a method to defeat noise and conflict with other RF devices
Recommended

13.37. System and RF device have separate local certification
Recommended

13.38. Smart card reader complies with ISO 7816
Required

13.39. Smart card reader supports ISO 7816 T=0 and T=1 protocols
Required

13.40. Smart card reader supports inverse-convention smart cards
Required

13.41. Smart card reader supports 258 byte packets in T=0 and 259 byte packets in T=1
Required

13.42. Smart card reader supports a smart card insertion/removal monitor
Required

13.43. Smart card reader supports PTS
Required

13.44. Smart card reader supports 3.5795 MHz minimum clock frequency
Required

13.45. Smart card reader supports 9600 bps minimum data rate
Required

13.46. Smart card reader supports the Power Down command
Required

13.47. Smart card reader does not use an additional power supply
Recommended

13.48. Each device has a unique Plug and Play device ID
Required

13.49. Dynamic resource configuration is supported for all devices
Required

13.50. Each device complies with its device class power management reference specification
Required

13.51. Device supports wake-up events
Required for wireless input; optional for other devices

13.52. Device drivers and installation meet PC 99 requirements
Required

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