C H A P T E R   1 3

I/O Ports and Devices

This chapter presents PC 98 requirements and recommendations for I/O ports and devices, including serial and parallel ports, wireless capabilities, and input devices and connectors.

In general, system designers are encouraged to consider solutions such as USB rather than traditional connections for external devices. USB support is required for PC 98 systems, and easy connectivity is important in situations where devices might be interchanged on a regular basis. System designers are encouraged to take advantage of USB.

Legacy and proprietary game-pad solutions are not acceptable for PC 98. Game pads, joysticks, and other input devices must be implemented as USB devices.

Contents

System Requirements I/O Ports and Devices

This section summarizes PC 98 requirements for serial and parallel ports.

1. System includes connection for external serial devices

Consumer PC 98	Office PC 98	Entertainment PC 98
Required	Required	Required

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 98 system, it must meet the requirements defined in this chapter. If two legacy serial ports are implemented, additional requirements are defined.

For Net PC systems and Office PC 98 systems, remote management capabilities must be implemented as defined in *Network PC System Design Guidelines,* attached as Appendix E in the References part of this guide.

2. System includes connection for external parallel devices

Consumer PC 98	Office PC 98	Entertainment PC 98
Required	Required	Required

Recommended: USB, IEEE 1394, or PC Card.

This connection can also be provided as a parallel port with ECP-mode capabilities. If a legacy port is implemented in a PC 98 system, it must meet the requirements defined in this chapter.

For an Office PC 98 system or a Net PC system, if a parallel port is present, it must be implemented as an ECP-mode parallel port, and 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.

3. System includes external connection for keyboard

Consumer PC 98	Office PC 98	Entertainment PC 98
Required	Required	Required

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.

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.

4. System includes external connection for pointing device

Consumer PC 98	Office PC 98	Entertainment PC 98
Required	Required	Required

Recommended: USB or wireless.

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

See the "System includes external connection for keyboard" requirement earlier in this section for issues related to mobile PCs.

5. System includes USB game pad or joystick

Consumer PC 98	Office PC 98	Entertainment PC 98
Recommended	Recommended	Recommended; wireless

This device must support the *USB Human Interface Device Class Specification, Version 1.0* or higher. For more information about requirements for USB peripherals, see the "USB" chapter in Part 3 of this guide.

Important: No devices that use legacy or proprietary ports can be included in a PC 98 system.

6. System includes built-in wireless capabilities

Consumer PC 98	Office PC 98	Entertainment PC 98
Recommended	Recommended	Recommended

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, PC 98 requirements must be met as defined in the "Wireless Component Requirements" section later in this chapter.

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

Consumer PC 98	Office PC 98	Entertainment PC 98
Required	Recommended	Required

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

Although legacy LPT and COM ports can be provided on a PC 98 system, no devices except printers should be provided with a system that uses these ports. For PC 98, a legacy serial port cannot be used as the connection for the mouse or modem.

8. All devices meet PC 98 general device requirements

Consumer PC 98	Office PC 98	Entertainment PC 98
Required	Required	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 the "Basic PC 98" chapter in Part 2 of this guide.

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 PC 98 serial ports. The PC 98 general device requirements are defined in the "System Requirements for I/O Ports and Devices" section earlier in this chapter, including the requirements for a device ID, automated software-only settings for device configuration, device drivers and Windows-based installation, and icons for external connectors.

Non-legacy Serial Port Requirements

This section defines PC 98 requirements for non-legacy implementations in support of serial port capabilities.

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

As required for all PC 98 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 higher (also known as the USB core specification)

- *Universal Serial Bus Device Class Definition for Communication Devices, Version 1.0* or higher

  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 PC 98 requirements for legacy serial ports. Legacy ports are not recommended for PC 98 systems, but if implemented, such ports must meet the requirements defined in this section.

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.

11. Legacy serial port supports flexible resource configuration and dynamic disable capabilities
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, 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.

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.

PC 98 Parallel Port Requirements

This section summarizes the basic PC 98 design features for parallel ports and peripherals. Each parallel port on a PC 98 system must meet the requirements listed in this section. The PC 98 general device requirements are defined in the "System Requirements for I/O Ports and Devices" section earlier in this chapter, including the requirements for a device ID, automated software-only settings for device configuration, device drivers and Windows-based installation, and icons for external connectors.

Non-legacy Parallel Port Requirements

This section defines PC 98 requirements for recommended non-legacy implementations to support parallel port capabilities.

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

As required for all PC 98 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 PC 98 requirements for legacy parallel ports.

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.

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.

16. Compatibility, nibble mode, and ECP protocols meet IEEE 1284-1994 specifications
Required
Support for a parallel port must include, at 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.

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.

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, with a unique identification string.

For PC 98, 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 (that is, 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 and Windows NT DDKs.

19. Device identification string provides CompatibleID key
Recommended

The CompatibleID (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.

Mouse Port and Peripheral Requirements

This section defines the specific PC 98 requirements for pointing-device connections and peripherals. Because the Windows and Windows NT operating systems require a pointing device, a PC 98 system board should include an auxiliary port for an external pointing device (most commonly a mouse). For PC 98, 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 PC 98 general device requirements are defined in the "System Requirements for I/O Ports and Devices" section earlier in this chapter, including 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 wireless-capabilities requirements, see the "Wireless Component Requirements" section later in this chapter.

20. 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 this 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 8042 chip
  initiates a PIC-based IRQ 12 interrupt when the pointing device is connected to
  the port.
- 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 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 higher
- Meet requirements in *USB Human Interface Device Class Specifications,
  Version 1.0* or higher
- Implement minidriver support based on WDM Human Interface Device (HID)
  class support in the operating system

21. Remote control provides PC 98 minimum support
Recommended

If a remote-control device is provided with a PC 98 system, the range of functions
implemented on the device will depend on whether the remote control is designed
for the business desktop or for the Entertainment PC 98.

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 the "Keyboard
  Port and Peripheral Requirements " section 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.
- Directional capabilities, which function similarly to the arrow keys on
  a keyboard.
- Select button that functions similarly to the ENTER key on a keyboard.

The following functions and buttons can also be considered for a remote-control device used with an Entertainment PC 98 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 PC 98 keyboards. Also, these design requirements do not exclude (but do not encourage) implementing a legacy AT-style keyboard port.

This section summarizes the specific PC 98 hardware feature requirements for keyboard ports and peripherals. Some keyboard port requirements differ, depending on the type of port being used.

The PC 98 general device requirements are defined in the "System Requirements for I/O Ports and Devices" section earlier in this chapter, including 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 requirements that apply if wireless capabilities are provided for the keyboard, see the "Wireless Component Requirements" section later in this chapter.

22. 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 higher
- *USB Human Interface Device Class Specifications, Version 1.0* or higher
- 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 the "Basic PC 98" chapter in Part 2 of this guide and as defined in *Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9* or higher.

23. No interference occurs between multiple keyboards
Required

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 combination, see the "Mobile PC 98" chapter in Part 2 of this guide.

24. 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*.
- 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.

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 Pad Requirements

This section presents the minimum PC 98 requirements for game-control devices.

The PC 98 general device requirements are defined in the "System Requirements for I/O Ports and Devices" section earlier in this chapter, including the requirements for a device ID, automated software-only settings for device configuration, device drivers and Windows-based installation, and icons for external connectors.

25. Device meets USB HID class specification requirements
Required

PC 98 game-control devices and drivers must support the *USB Human Interface Device Class Specification, Version 1.0* or higher.

Wireless Component Requirements

This section summarizes the basic design features for wireless components, provided either as IR or RF adapters. IR solutions are based on communication standards developed by the Infrared Data Association (IrDA). IR solutions are further differentiated as IrDA and Control IR based on the following features:

- IrDA devices perform high-speed, point-to-point, bi-directional, short-range data communications such as file transfers among laptop, Personal Digital Assistant (PDA), and desktop systems.

- Control IR devices simultaneously perform low-speed, longer-range communications between multiple devices and can be implemented as bi-directional devices such as keyboards, multimedia, and game controls or as unidirectional devices such as remote controls. An IrDA-approved Control IR specification is expected in 1997, with first products expected to ship in 1998.

No standard exists for legacy consumer IR, which is in wide use today to control consumer-electronics devices such as televisions, VCRs, CD players, and so on. PC systems designed to control such devices or to be controlled by existing IR remote controls must accommodate the lack of standards by adopting a universal consumer-IR approach. Therefore, no PC 98 protocol recommendations are made for interoperability with legacy consumer-IR devices. Because some IR transceiver manufacturers add support for consumer IR in their IrDA transceivers, PC 98 requirements are specified for using such multiprotocol IR devices in a PC.

Many manufacturers are implementing integrated IR solutions for mobile PCs. Various form-factor and environmental issues have limited the adoption of wireless solutions for desktop PCs, including receiver placement in the office environment and limiting conflicting device signals. USB IR bridging devices or hubs will resolve many of these physical placement issues.

A USB working group is developing guidelines on how USB will interface with both IrDA and Control IR devices, with first products expected to ship around the middle of 1998. These guidelines are expected to address an RF bridge in anticipation of future home RF standards that should emerge and will be required for PC 98 when finalized by the working group.

It is recommended that manufacturers move their wireless designs to incorporate fast IR solutions as soon as possible. Fast IR transmits and receives data at speeds of 1.152 Mb/s and 4.0 Mb/s. Fast IR includes design implementations that improve usability. To minimize interoperability issues, manufacturers need to include Serial IR (SIR) backward compatibility in their fast IR solutions.

Manufacturers who are planning to produce wireless PC peripherals such as keyboards, pointing devices, and joysticks are encouraged to use Control IR instead of RF as the communications medium. The Control IR specification was based on the requirement to support a minimum of four joysticks on systems such as Entertainment PC.

Not using RF will help to minimize RF interference to devices that require between-room communications, such as cordless phones. This recommendation does not apply to wireless PC peripherals used in offices, where RF might be the only viable solution sufficiently diffuse and able to go through barriers, and where it is less important to have an RF connection to a desktop PC in order to support voice and data communications. There might also be a need to use RF in the home environment if IR is not sufficiently diffuse or is unable to bounce around obstacles.

The requirements listed in this section must be met if wireless capabilities are provided in the system. Power management requirements for wireless devices are defined in the "Power Management for I/O Ports and Devices" section later in this chapter.

IR Requirements

An IR implementation is recommended for all system types, but especially for Entertainment PCs. If IR capabilities are included, the system must meet the basic design features for IR components, devices, and systems specified in this section.

Manufacturers who are implementing designs that include Control IR devices are strongly encouraged to join IrDA and to obtain the latest copies of the Control IR specification plus information on the availability of parts and driver software.

26. IR device uses NDIS 5.0 miniport driver
Required

This requirement applies for IrDA devices. An NDIS 5.0, IrDA miniport driver is required for all IR devices. Full documentation and sample source code for building such a miniport driver can be found in the Windows NT 5.0 DDK.

27. IR device meets IrDA specifications
Required

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

An IR device must be designed to comply with approved IrDA specifications, including IR data devices, bi-directional IR peripherals (Control IR), and unidirectional IR remotes (Control IR).

If the system is intended to run data transfer applications with other IrDA devices, support of the IrDA specification is required. The emergence of digital still-image cameras with IrDA capability increases the importance of IrDA support in home systems. If the system is intended for the home market, support for Control IR and IrDA is recommended to ensure that the consumer will have the expected IR device interoperability.

28. IR device meets IrDA Control IR specification
Required

The IrDA-approved Control IR specification is expected in 1997, with the first products expected to ship in 1998. If a Control IR implementation is used in a PC 98 system, it must be in compliance with this specification.

29. IR device meets PC 98 bus and port specifications
Required

The requirements for all bus classes are defined in Part 3 of this guide. 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 the "Serial Port Requirements" section earlier in this chapter. A device that uses a parallel port must comply with the requirements specified in the "Parallel Port Requirements" section earlier in this chapter. A USB device must comply with the requirements specified in the "USB" chapter in Part 3 of this guide.

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

A USB working group is developing guidelines for how USB is to interface with both IrDA and Control IR devices. When these guidelines are finalized, they will be PC 98 requirements for USB IR implementations.

31. IR device supports flexible resource configuration and dynamic disable capabilities
Required

Resource configuration support is specified for IR adapters. 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 for its connection.

32. System supports standard input speeds of 4 Mb/s
Recommended

Device support for input speeds of 4 Mb/s is strongly recommended for all IrDA devices.

33. System differentiates command streams if transceiver includes legacy consumer IR support
Required

This requirement ensures correct implementation for a system that includes IR support for IrDA and consumer IR devices that 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.

The system needs to address IR coexistence issues if a single IR controller is capable of supporting more than one physical-layer IR protocol transceiver, such as legacy consumer IR and IrDA. Such controllers might support only one protocol at a time if they are using a single communication port connection to the PC's I/O subsystem. A method for either switching automatically to alternate modes or notifying the IR driver of the need to switch modes is required. If the second alternative is used, then the device manufacturer must publish the hardware interface that the software can use for mode switching.

IrDA and Control IR have been designed to coexist and to share the IR media. Controllers are expected to 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. For more information, contact the organizations listed in the "References for I/O Ports and Devices" section at the end of this chapter.

RF Recommendations

Support for RF capabilities is optional. If RF is included, the implementation must meet the PC 98 general device requirements. More specific recommendations are expected as RF standards emerge, especially for home PCs.

Manufacturers who are implementing designs that include RF devices are encouraged to join the USB Implementers Forum and other relevant RF industry associations to work with other manufacturers on standardization of RF protocols and media within the computer industry.

The following recommendations are offered to help designers make appropriate choices if RF solutions are being considered in a particular system design:

- **Select a low-power RF alternative.** 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 track-ball devices that need RF instead of Control IR require a maximum range of only 15 to 20 feet.

- **Provide a method to defeat noise and conflict with other RF devices in the environment.** 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.

- **Obtain separate local certification for the system and for the RF device.** 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.

PC 98 Design Features for Ports

This section summarizes PC 98 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 PC 98 requirements for Plug and Play capabilities.

34. 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 the "PCI" chapter in Part 3 of this guide. A USB device must comply with the *Universal Serial Bus Specification, Version 1.0* or higher, and also must provide a unique ID.

35. Automatic resource assignment and dynamic disable capabilities are supported
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 of 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:

- 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.

- 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 keyboard controller (8042). 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 the "Legacy Support" appendix in the References part of this guide.

Power Management for I/O Ports and Devices

This section summarizes the specific PC 98 power management requirements for I/O ports and devices.

36. 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.

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

For PC 98, 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 PC 98 device driver requirements for I/O ports and devices. The items in this section are requirements for all PC 98 systems.

38. Device drivers and installation meet PC 98 requirements
Required

The manufacturer does not need to supply a driver if a PC 98-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 the "Basic PC 98" chapter in Part 2 of this guide.

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 and Windows NT operating systems.

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 reference specifications
  http://www.microsoft.com/hwdev/onnow.htm

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
  IBM Customer Publications Support
  Or contact an IBM sales representative

IEEE specifications
  ASK*IEEE
  Phone: (800) 949-4333
  Fax: (212) 310-4091
  E-mail: askieee@ieee.org
  http://www.ieee.org

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

Infrared Data Association Serial Infrared (SIR) Physical Layer Specification
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

New Key Support for Microsoft Windows Operating Systems and Applications
Newkeys.zip (self-extracting zip file)
ftp://ftp.microsoft.com/PerOpSys/Win_News

Plug and Play specifications
http://www.microsoft.com/hwdev/specs/

USB specifications
USB HID Usages Table
USB Implementers Forum
Phone: (503) 264-0590
Fax: (503) 693-7975
http://www.usb.org

Universal Serial Bus PC Legacy Compatibility Specification, Version 0.9
http://www.teleport.com/~usb/data/usb_le9.pdf

Windows NT DDK, Windows DDK, and IR Communications for Windows DDK
MSDN Professional membership

Checklist for I/O Ports and Devices

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

Consumer PC 98	Office PC 98	Entertainment PC 98
1. System includes connection for external serial devices		
Required	*Required*	*Required*
2. System includes connection for external parallel devices		
Required	*Required*	*Required*
3. System includes external connection for keyboard		
Required	*Required*	*Required*
4. System includes external connection for pointing device		
Required	*Required*	*Required*
5. System includes USB game pad or joystick		
Recommended	*Recommended*	*Recommended; wireless*
6. System includes built-in wireless capabilities		
Recommended	*Recommended*	*Recommended*
7. Devices use USB or external bus connections rather than legacy serial or parallel ports		
Required	*Recommended*	*Required*
8. All devices meet PC 98 general device requirements		
Required	*Required*	*Required*
9. Serial port meets device class specifications for its bus		
Required		
10. Legacy serial port is implemented as 16550A UART or equivalent and supports 115.2K baud		
Required		
11. Legacy serial port supports flexible resource configuration and dynamic disable capabilities		
Required		
12. Conflict resolution for legacy serial port ensures availability of at least one serial port		
Required		
13. Parallel port meets device class specifications for its bus		
Required		
14. Flexible resource configuration supported for each parallel port		
Required		
15. EPP support does not use restricted I/O addresses		
Required		
16. Compatibility, nibble mode, and ECP protocols meet IEEE 1284-1994 specifications		
Required		
17. Port connectors meet IEEE 1284-I specifications, minimum		
Required		
18. IEEE 1284 peripherals have Plug and Play device IDs		
Required		

19. Device identification string provides CompatibleID key
Recommended

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

21. Remote control provides PC 98 minimum support
Recommended

22. Keyboard connection meets requirements for its bus class
Required

23. No interference occurs between multiple keyboards
Required

24. Keyboard includes Windows and Application logo keys
Recommended

25. Device meets USB HID class specification requirements
Required

26. IR device uses NDIS 5.0 miniport driver
Required

27. IR device meets IrDA specifications
Required

28. IR device meets IrDA Control IR specification
Required

29. IR device meets PC 98 bus and port specifications
Required

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

31. IR device supports flexible resource configuration and dynamic disable capabilities
Required

32. System supports standard input speeds of 4 Mb/s
Recommended

33. System differentiates command streams if transceiver includes legacy consumer IR support
Required

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

35. Automatic resource assignment and dynamic disable capabilities are supported
Required

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

37. Device supports wake-up events
Required for wireless input;

optional for other devices

38. Device drivers and installation meet PC 98 requirements
Required