Legacy Plug and Play Guidelines

A Technical Reference for Legacy PCs and Peripherals for the Microsoft® Windows ® Family of Operating Systems

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Intel Corporation and Microsoft Corporation

Welcome

This guide is for engineers who build personal computers, expansion cards, and peripheral devices that will be used with the Microsoft® Windows® 32-bit operating systems and that incorporate legacy components. The specific focus of this guide is Plug and Play configuration of resources for the following system components:

- Industry Standard Architecture (ISA) bus and devices
- Serial ports and devices
- IEEE 1284-based parallel ports and devices
- Keyboard and mouse ports and devices

Important: In general, it is strongly recommended that system designers implement Plug and Play for Windows 2000 and Windows 98 based on the requirements defined in *Advanced Configuration and Power Interface Specification, Version 1.0* or later (ACPI 1.0), plus the driver guidelines defined in the Microsoft Windows 2000 Driver Development Kit (DDK).

In addition, designers are strongly encouraged to seek legacy-free alternatives for system design, avoiding the ISA bus because of the throughput bottlenecks and resource limitations of ISA design.

However, it is recognized that to meet some customer requirements, system manufacturers must provide some systems that support the legacy ISA bus. The goal of this document is to provide guidelines for legacy hardware design that will result in the optimal user experience when the hardware is used with the Windows family of operating systems.

This guide is a supplement to the legacy Plug and Play specifications (available at http://www.microsoft.com/hwdev/respec/pnpspecs.htm), and the driver implementation guidelines defined in the Microsoft Windows 95 DDK. All material in this guide has previously appeared in the following documents:

- *PC 97 Hardware Design Guide* (Microsoft Press®, 1997; ISBN 1-57231-381-1)
- *PC 98 System Design Guide* (Microsoft Press, 1997; ISBN 1-57231-716-7)
- *PC 99 System Design Guide* (Microsoft Press, 1998; ISBN 0-7356-0518-1)

How to Use This Guide

This guide is divided into several chapters, with appendixes that list detailed settings.

Chapter	Contents
Chapter 1, “Basic Legacy Plug and Play”	Defines basic specifications and guidelines for implementing legacy Plug and Play.
Chapter 2, “ISA Plug and Play”	Provides specific guidelines for implementing Plug and Play ISA, for the computer system and for individual devices.
Chapter 3, “I/O Ports and Devices”	Provides Plug and Play guidelines for legacy serial and parallel ports and for legacy mouse and keyboard connectors.
Appendix A, “IRQ, DMA, and I/O Port Addresses”	IRQ, DMA, and I/O Port Addresses
Appendix B, “Device Identifiers”	Lists compatible IDs for legacy and ISA devices.

This guide is co-authored by Intel Corporation and Microsoft Corporation.

Additional information about hardware design is available from Intel Corporation at http://developer.intel.com.

Additional information about hardware design is available from the Microsoft web sites at http://www.microsoft.com/hwdev/.

Conventions Used in This Guide

The following conventional terms are used throughout this guide.

Add-on devices

Devices that are traditionally added to the base server system to increase functionality, such as audio, networking, graphics, and so on. Add-on devices fall into two categories: devices built onto the system board set and devices on expansion cards added to the system through a system-board connector such as Peripheral Component Interconnect (PCI).

Intel Architecture

Refers to computers based on 64-bit and 32-bit microprocessors that use the Intel Architecture instruction set, such as Intel® Pentium®, Intel Pentium with MMX™ technology, Pentium Pro, Pentium II, Pentium II Xeon™, or compatible processors. MMX technology refers to Intel’s media-enhancement technology that includes new instructions added to the Intel Architecture instruction set.

Legacy
: Refers to any feature in the system based on older technology for which compatibility continues to be maintained in other system components.

System devices
: Also *on-board devices.* Refers to devices on the system board set such as interrupt controllers, keyboard controller, real-time clock, direct memory access (DMA) page registers, DMA controllers, memory controllers, floppy disk controller (FDC), AT-Attachment (ATA) ports, serial and parallel ports, PCI bridges, and so on. In today's servers, these devices are typically integrated with the supporting chip set.

Windows
: Refers to the Microsoft Windows 95 or Windows 98 operating systems, including any add-on capabilities and any later versions of the operating system.

Windows 2000
: Refers to the Microsoft Windows 2000 operating system, including any add-on capabilities and any later versions of the operating system.

For a list of acronyms and definitions of technical terms, see the Glossary.

References and Resources

The following represents some of the information resources, services, and tools available to help build hardware optimized to meet the requirements defined in this guide. This section also lists technical references for the specifications cited in this guide.

Information Resources

Intel developer information
: http://developer.intel.com

Microsoft hardware developer information
: http://www.microsoft.com/hwdev/

Microsoft Developer Network (MSDN) Professional Subscription
: Phone: (800) 759-5474
Outside North America: (510) 275-0763
Fax: (510) 275-0762
http://msdn.microsoft.com/

Technical References

Advanced Configuration and Power Interface Specification, Version 1.0
http://www.teleport.com/~acpi/

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: (800) 879-275
Or contact an IBM sales representative

Microsoft Platform SDK, Windows 95 DDK, and Windows 2000 DDK
Provided through MSDN Professional subscription;
http://msdn.microsoft.com/subscriptions/

Microsoft Windows Hardware Compatibility List (HCL)
http://www.microsoft.com/hwtest/hcl/

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

Chapter 1 Basic Legacy Plug and Play

This chapter defines the basic specifications and implementation guidelines for legacy Plug and Play.

For information about Plug and Play drivers support under Windows 95, see the Windows 95 DDK. Plug and Play for VxD drivers under Windows 98 should also follow the guidelines defined in the Windows 95 DDK.

For information about Plug and Play support under Windows 2000, see the Windows 2000 DDK.

Legacy Plug and Play Specifications

Each bus and device provided in the computer system must meet the current Plug and Play specifications related to its class, including requirements clarifications published for some Plug and Play specifications. For ACPI-based systems, buses and devices must also meet the requirements defined in Section 6 of the *Advanced Configuration and Power Interface Specification, Revision 1.0*. This specification defines the requirements for automatic device configuration, resource allocation, and dynamic disable capabilities.

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

- *Plug and Play BIOS Specification Version 1.0a*

  Important: This specification applies only for non-ACPI-based systems. ACPI-based systems must follow the requirements defined in ACPI 1.0.
- *Plug and Play External COM Device Specification, Version 1.0*
- *Plug and Play Industry Standard Architecture (ISA) Specification, Version 1.0a*
- *Clarification to Plug and Play ISA Specification, Version 1.0a*
- *Plug and Play Parallel Port Device Specification, Version 1.0b*
- *Plug and Play Small Computer System Interface Specification, Version 1.0*

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

All system-board devices must use ISA-compatible addresses. This includes devices with I/O port addresses within the reserved range 0h–0xFFh. For

information about legacy system I/O addresses, see Appendix A, "IRQ, DMA, and I/O Port Addresses."

Unique Plug and Play Device IDs

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

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

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

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

- Legacy devices attached to the ISA bus on the system board do not have unique Plug and Play IDs—for example, serial ports, parallel ports, or Personal System/2 (PS/2) compatible port devices. The method for device identification is defined in the *Plug and Play ISA Specification, Version 1.0a,* and the ACPI 1.0 specification.
- Some multifunction devices, such as Super I/O, might include devices that do not have unique Plug and Play IDs or unique PCI subsystem IDs, but that are supported by drivers provided with the Windows operating system.
- A device such as a multifunction PCI device that supports a number of functions but uses only a single set of relocatable resources does not have to provide separate IDs for each function included on the device.

Option ROM Guidelines

These guidelines apply for devices that use option ROM on systems based on Intel Architecture processors, whether the device is present on the system board or provided through an expansion card.

Option ROMs are usually located on cards used as system boot devices. During the boot process, option ROMs initialize the boot devices, which provide the primary input, primary output, and Initial Program Load (IPL) device to boot the

system. However, Plug and Play option ROMs can be used to supply the Plug and Play expansion header to devices other than boot devices, enabling them to initialize both devices when the system boots.

"PNP" Vendor Codes and Compatible IDs

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

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

For information about using PNP CIDs, see Appendix B, "Device Identifiers." To obtain a unique PNP vendor ID, complete the form provided at http://www.microsoft.com/hwdev/pnpid.htm.

I/O Decoding

Each device must support a unique I/O port address in the 16-bit address range. This requirement means that, at a minimum, the upper address lines (A10–A15) can be used as the device enable address, so that the device does not respond to addresses outside of the 10-bit address range.

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

Notice that this requirement does not apply for the three ISA auto-configuration registers used during device enumeration and configuration. The ADDRESS, WRITE_DATA, and READ_DATA registers will continue to use 12-bit decoding as described in the *ISA Plug and Play Specification, Version 1.0a.*

Chapter 2 ISA Plug and Play

This chapter summarizes Plug and Play requirements for any ISA legacy implementations.

In addition to ISA expansion cards, the following are also ISA devices:

- 8042 and similar controllers, ports, keyboards, and mice
- Direct memory access (DMA) controllers and slaves
- Floppy disk controllers (FDCs)
- Interrupt controllers
- Legacy parallel and serial ports
- Math coprocessors
- Programmable interrupt timers (PITs)
- VGA controllers

However, any such devices located at I/O addresses below 100h can use fixed resources and are exempt from Plug and Play requirements for unique IDs, flexible resource configuration, and dynamic disable capabilities.

For details about the interrupt request (IRQ) settings, DMA address, and I/O port addresses for specific devices, see Appendix A, “IRQ, DMA, and I/O Port Addresses.”

System Requirements for Plug and Play ISA

This section summarizes the basic requirements for a PC system that includes the ISA bus.

If ISA support is included in a system, the manufacturer must implement the standards described in the following Plug and Play specifications:

- *Plug and Play ISA Specification, Version 1.0a*
- *Plug and Play BIOS Specification, Version 1.0a*
- *Clarifications to the Plug and Play BIOS Specification, Version 1.0a*.

The Plug and Play specifications are available from the web site at http://www.microsoft.com/hwdev/respec/pnpspecs.htm.

Additional ISA clarifications and white papers related to ISA Plug and Play under the Microsoft Windows operating system are available from the web site at http://www.microsoft.com/hwdev/legacy/.

Note: Standard system devices are excluded from this requirement. The system can reserve static resources for devices such as interrupt controllers 1 and 2, 8254-

2 timer, 8042 keyboard controller, real-time clock, DMA page registers, DMA controllers 1 and 2, and math coprocessor (if present). For a system based on Intel Architecture, these fixed resources are located at I/O addresses below 100H and can also include an NMI mask.

Plug and Play ISA Device Requirements

This section includes additional requirements for ISA cards, including requirements for design implementations that appear only as recommendations in the ISA specification, to ensure that such cards will perform correctly under Windows.

The information in this section is provided for manufacturers of ISA devices who want to ensure that their devices are completely compatible with Plug and Play operating systems.

For more details, see the Plug and Play ISA Specification, version 1.0a.

Plug and Play ISA Standards for Devices

Any card or bus that implements Plug and Play ISA must fully implement the standards defined in the *Plug and Play ISA Specification, Version 1.0a.* This specification also defines the requirements for a unique ID for each ISA device. The unique ID is used to identify the device for Plug and Play configuration.

Option ROMs for ISA Boot Devices

Option ROMs must be used only on cards that contain boot devices.

Cards with option ROMs must not hook the primary boot interrupts (Int 9h, Int 10h, Int 13h, Int 18h, and Int 19h) until the system calls the boot connection vector in the selected option ROM expansion header.

For cards with option ROMs, the default configuration must be able to be disabled after the card has been isolated.

I/O Decoding for ISA Device

This circuit can be simple enough to limit I/O addresses to the 0h to 3FFh range, or it can be flexible enough to use the upper address regions.

The device must meet the guidelines for 16-bit I/O decoding defined in Chapter 1, “Basic Legacy Plug and Play,” in this guide.

ISA IRQ Sharing

Under Windows 95/98 (but not Windows NT® 4.0 or Windows 2000), an ISA device and its driver can support IRQ sharing if resource requirements

cannot be met. This capability applies only for devices of the same class, not across device classes.

To share IRQs, the following requirements must be met:

- The IRQ line must be pulled high by the system board.
- The IRQ line must never be driven high by the devices.
- To signal an interrupt, devices must pull the IRQ line low for a minimum of 100 nanoseconds and then release it. The interrupt is signaled by the rising edge that occurs as a result of the pull-up on the IRQ line.
- The drivers for all devices connected to the IRQ line must correctly support the interrupt-sharing services of the virtual programmable interrupt controller device (VpicD). This means that after dispatching an interrupt from VpicD, the drivers must respond to VpicD and correctly indicate whether they actually processed an interrupt for their devices. VpicD will ensure that all devices with pending interrupts have been serviced before returning from the interrupt.
- IRQ sharing support implemented in the device driver for servicing interrupts.

Deterministic Values for Unimplemented Registers

Any unimplemented registers in the range 00h–2Fh must return a deterministic value when they are read. Unimplemented configuration registers must return the "disabled" or "unused" value (not necessarily 0) when they are read.

Correct Identifiers for ISA Devices

In the Plug and Play ISA specification, it is required that a Plug and Play card have both:

- An industry-unique Vendor ID (acquired by completing the form provided at http://www.microsoft.com/hwdev/pnpid.htm)
- A company-unique Product ID (assigned by the manufacturer)

The specification requires that this Product ID be unique among all Plug and Play ISA cards manufactured by that company.

This means each product (for example, fax card, display adapter, sound adapter, and so on) and every model (for example, 14.4 fax, 28.8 fax, and so on) from the same manufacturer must have different product identifiers.

This is a requirement because it allows the operating system to isolate and identify these different cards. The user must never have a Plug and Play card that cannot be identified because it cannot be distinguished from other models of cards from

the same manufacturer. The use of a unique Product ID does not solve the problems that occur when a user installs two of the same cards in a PC system.

In those cases, the user might install a Plug and Play card but will not receive indication that it was installed and the card will not work. For this purpose, the Plug and Play ISA specification defines a unique serial-number field that can be added to the Vendor and Product IDs to make the card completely unique. A board-unique number in the serial-number field is required for ISA devices included on a system.

BIOS Reporting or Serial ID for System Board Devices

A peripheral ISA device implemented on the system board can use a fixed Serial ID (which is not unique) if the device is reported through the BIOS.

If the system board device participates in the Plug and Play ISA isolation scheme (rather than being reported through the BIOS), then it must meet the same requirements for a unique Serial ID as for an add-on card.

Notice that it is possible that an add-on card containing an ISA chip might be added to a PC system that contains the same chip on the system board. In such a case, the add-on device will be found only if it has a different Serial ID.

PNP Suffixes and Compatible Device IDs

Device IDs that use the three-character PNP suffix are allowed only in the Compatible Device ID field and cannot be used as Device ID or Logical Device ID fields. The exception would be the device to which the PNP-based ID was originally assigned.

Resource data describe what resources must be available for each logical device on the card (for example, number of available IRQ numbers, address ranges of memory, and so on). Resource data can be stored in the same nonvolatile storage device (such as a serial ROM) that contains the serial identifier. The resource data in the nonvolatile storage device must be sequentially loaded into the resource data register (04h).

The content of the nonvolatile storage device must be programmed with the information the system needs to interpret which resources the card requires. The structure of the data contained in the storage device is variable, depending on what resources are needed.

The resource data for a Plug and Play ISA card can be read while the card is in the Config state. This card can enter the Config state either after it has been isolated during the isolation sequence or whenever it receives a Wake (Card Select Number [CSN]) software command in which the CSN matches the CSN assigned to the card. Only one card at a time can be in the Config state.

Option ROMs for Boot Devices

Plug and Play ISA expansion cards that contain boot devices require some special considerations to properly boot the system. The system must implement support for Plug and Play ISA boot devices and option ROMs as described in the Plug and Play BIOS specification.

The types of devices required for the boot process include the primary input device (usually a keyboard), the primary output device (usually a display adapter and monitor), and any IPL devices.

Any Plug and Play ISA expansion card that provides a boot function must be active when the system powers up. This gives non-Plug and Play systems the means for using Plug and Play ISA devices during a legacy boot process.

In this case, a non-Plug and Play system BIOS will not perform the isolation sequence but will instead perform a ROM scan to detect the presence of a boot device. After the ROM scan detects the presence of an option ROM on the boot device, the system ROM will jump to the option ROM to initialize the device. The Plug and Play option ROM on the card will detect that the system BIOS is not Plug and Play-compatible and will respond accordingly.

Although an initial set of static resources must be provided during this legacy boot, the Plug and Play ISA card must be capable of changing these resources using the standard Plug and Play ISA isolation and configuration process.

As required in the Plug and Play ISA specification, resource usage of a card is always reflected in the card’s configuration registers. This information allows Windows to easily determine the default settings of a Plug and Play boot device. The default settings can then be overridden by the operating system with full cooperation of the device driver.

Chapter 3 I/O Ports and Devices

This chapter presents guidelines for legacy I/O ports and devices, including serial and parallel ports.

Legacy Serial Port

This section defines requirements for legacy serial ports.

A 16550A buffered Universal Asynchronous Receiver/Transmitter (UART) or equivalent buffered legacy serial port is the standard implementation. For acceptable performance under Windows, the device must be able to support 115.2K baud.

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 legacy serial 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 infrared (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 IRQ sharing can be implemented under Windows if the minimum resource requirement cannot be met.

Important: Conflict resolution for legacy serial port must ensure the availability of at least one serial port. 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.

Legacy Parallel Port

This section presents guidelines for legacy parallel ports.

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 legacy parallel 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 extended capabilities port (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.

EPP Support and Restricted I/O addresses

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.

Compatibility, Nibble Mode, and ECP Protocols

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.

IEEE 1284 Port Connector Specifications

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.

Plug and Play Device IDs for IEEE 1284 Peripherals

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 DDK.

Compatible ID Key for Parallel Device ID

The CID key in the device identification string 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.

Legacy Mouse Port and Devices

The following requirements must be met to ensure that all Plug and Play requirements are met and that built-in Microsoft-supplied 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.

Legacy Keyboard Port and Devices

If a PS/2-style keyboard port is used, it must meet the following requirements, which ensure that all Plug and Play requirements are met and that built-in Microsoft-supplied drivers support this device.

- 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.

Legacy FDC

The following resource requirements must be met for each legacy FDC device on the system:

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

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

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

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

Appendix A IRQ, DMA, and I/O Port Addresses

This appendix lists resource assignments for IRQ, DMA, and I/O port addresses used by built-in devices on legacy system boards.

Fixed Interrupts

See "ISA Interrupts" in Appendix A of PC 2001 System Design Guide.

Legacy DMA Assignments

See "Legacy ISA DMA Assignments" in Appendix A of PC 2001 System Design Guide.

Legacy I/O Address Assignments

See "Legacy ISA I/O Address Assignments" in Appendix A of PC 2001 System Design Guide.

Appendix B Device Identifiers

This appendix lists CIDs for Plug and Play vendor IDs and device IDs.

Note: For non-BIOS enumerated ISA devices, new vendor IDs must be registered by completing the form provided at http://www.microsoft.com/hwdev/pnpid.htm or by sending mail to ihv@microsoft.com with "**PNPID**" in the subject line.

Plug and Play Vendor and Device IDs

All non-BIOS enumerated devices must not use "PNP" in their vendor and device codes. Instead, the vendor must register a three-character vendor code. The PNP vendor code is reserved for Microsoft and can be used only when defining a device's CID after indicating the device's Hardware ID in the Plug and Play header.

Use of CIDs is strongly recommended for devices that use inbox device drivers, such as a "Standard PC COM Port" (PNP0500).

The following example output of a Plug and Play header is provided as a reference for the Microsoft Windows operating system.

```
Vendor ID:     XXXFFFF
Serial Number: 00000001
Checksum (reported): 0x5E
PNP Version:   1.0
Vendor Ver.:   10
Device Description: IDE Port
Device ID:  XXX0001
Doesn't Support I/O Range Checking
Vendor Defined Logical Device Control Registers:
None
Compatible Device ID: PNP0600
Device Description: IDE

Dependent Function 0
Dependent Function 1
End of Dependent Functions
```

When the user is installing devices that use this method, a dialog box appears at the beginning of the enumeration sequence to suggest use of the Windows 95/98 default driver. Windows 95/98 also provides the option of using a manufacturer-supplied disk in case the user wants to choose a manufacturer-supplied driver.

For multifunction adapters, you should supply an INF file that chooses the appropriate drivers, including default drivers, for all the adapter's devices. This

prevents additional dialog boxes from repeatedly requesting the default driver or a manufacturer's disk for the remaining devices on the adapter.

When an INF file is used in this manner for default driver selection, it must link the Hardware ID (XXX0000) to the appropriate compatible device driver from the Windows 95/98 distribution CD or installation disks. If this is not done, Windows 95/98 will continue to query the user for either the default driver or a new driver, thus defeating the purpose of using the INF file in this way.

Generic Windows Device IDs

Many devices, such as the interrupt controller or the keyboard controller, have no standard Extended Industry Standard Architecture (EISA) ID. Also, a set of compatible devices, such as video graphics array (VGA) and Super VGA (SVGA), are not actually devices but define a compatibility hardware subset. Yet another set of IDs needs to be used to identify buses.

Microsoft has reserved an EISA prefix (PNP) to identify various devices that do not have existing EISA IDs. Microsoft also uses PNP to define compatibility devices. The IDs are defined in the following tables.

Device ID Ranges

ID range	Category
PNP0xxx	System devices
PNP8xxx	Network adapters
PNPAxxx	Small computer system interface (SCSI), proprietary CD adapters
PNPBxxx	Sound, video capture, multimedia
PNPCxxx–Dxxx	Modems

The following obsolete device ID is provided only for compatibility with earlier device ID lists.

Device ID	Description
PNP0802	Microsoft Windows Sound System-compatible device (obsolete; use PNPB0xx instead)

Interrupt Controllers

Device ID	Description
PNP0000	AT interrupt controller
PNP0001	EISA interrupt controller
PNP0002	MCA interrupt controller
PNP0003	Advanced Protocol Interrupt Controller (APIC)
PNP0004	Cyrix SLiC MP interrupt controller

Timers

Device ID	Description
PNP0100	AT timer
PNP0101	EISA timer
PNP0102	MCA timer

DMA

Device ID	Description
PNP0200	AT direct memory access (DMA) controller
PNP0201	EISA DMA controller
PNP0202	MCA DMA controller

Keyboards

Device ID	Description
PNP0300	IBM PC/XT keyboard controller (83-key)
PNP0301	IBM PC/AT keyboard controller (86-key)
PNP0302	IBM PC/XT keyboard controller (84-key)
PNP0303	IBM Enhanced (101/102-key, PS/2 mouse support)
PNP0304	Olivetti keyboard (83-key)
PNP0305	Olivetti keyboard (102-key)
PNP0306	Olivetti keyboard (86-key)
PNP0307	Microsoft Windows keyboard
PNP0308	General Input Device Emulation Interface (GIDEI) legacy
PNP0309	Olivetti keyboard (A101/102-key)
PNP030A	AT&T 302 keyboard
PNP030B	Reserved by Microsoft
PNP0320	Japanese keyboard A01 (106-key)
PNP0321	Japanese keyboard (101-key)
PNP0322	Japanese AX keyboard
PNP0323	Japanese keyboard 002/003 (106-key)
PNP0324	Japanese keyboard 001 (106-key)
PNP0325	Japanese Toshiba desktop keyboard
PNP0326	Japanese Toshiba laptop keyboard
PNP0327	Japanese Toshiba notebook keyboard
PNP0340	Korean keyboard (84-key)

PNP0341	Korean keyboard (86-key)
PNP0342	Korean enhanced keyboard
PNP0343	Korean enhanced keyboard 101b
PNP0343	Korean enhanced keyboard 101c
PNP0344	Korean enhanced keyboard 103

Parallel Devices

Device ID	Description
PNP0400	Standard LPT port
PNP0401	Extended capabilities port (ECP) printer port

Serial Devices

Device ID	Description
PNP0500	Standard PC COM port
PNP0501	16550A-compatible COM port
PNP0502	Multiport serial device (non-intelligent 16550)
PNP0510	Generic IrDA-compatible device
PNP0511	Generic IrDA-compatible device

Disk Controllers

Device ID	Description
PNP0600	Generic ESDI/IDE/ATA-compatible hard disk controller
PNP0601	Plus Hardcard II
PNP0602	Plus Hardcard IIXL/EZ
PNP0603	Generic Integrated Device Electronics (IDE) supporting Device Bay specifications
PNP0700	PC standard floppy disk controller (FDC)
PNP0701	Standard FDC supporting Device Bay specification

Display Adapters

Device ID	Description
PNP0900	VGA compatible
PNP0901	Video Seven VRAM/VRAM II/1024i
PNP0902	8514/A compatible
PNP0903	Trident VGA
PNP0904	Cirrus Logic laptop VGA

PNP0905	Cirrus Logic VGA
PNP0906	Tseng ET4000
PNP0907	Western Digital VGA
PNP0908	Western Digital laptop VGA
PNP0909	S3 Inc. 911/924
PNP090A	ATI Ultra Pro/Plus (Mach 32)
PNP090B	ATI Ultra (Mach 8)
PNP090C	XGA compatible
PNP090D	ATI VGA Wonder
PNP090E	Weitek P9000 graphics adapter
PNP090F	Oak Technology VGA
PNP0910	Compaq Qvision
PNP0911	XGA/2
PNP0912	Tseng Labs W32/W32i/W32p
PNP0913	S3 Inc. 801/928/964
PNP0914	Cirrus Logic 5429/5434 (memory-mapped)
PNP0915	Compaq Advanced VGA (AVGA)
PNP0916	ATI Ultra Pro Turbo (Mach 64)
PNP0917	Reserved by Microsoft
PNP0918	Matrox MGA
PNP0919	Compaq QVision 2000
PNP091A	Tseng W128
PNP0930	Chips & Technologies SVGA
PNP0931	Chips & Technologies Accelerator
PNP0940	NCR 77c22e SVGA
PNP0941	NCR 77c32blt
PNP09FF	Plug and Play monitors (VESA display data channel [DDC])

Peripheral Buses

Device ID	Description
PNP0A00	ISA bus
PNP0A01	EISA bus
PNP0A02	MCA bus
PNP0A03	Peripheral Component Interconnect (PCI) bus
PNP0A04	VESA/VL-bus

PNP0A05	Generic Advanced Configuration and Power Interface (ACPI) bus
PNP0A06	Generic ACPI Extended I/O (EIO) bus

Real-Time Clock, BIOS, and System Board Devices

Device ID	Description
PNP0800	AT-style speaker sound
PNP0B00	AT real-time clock
PNP0C00	Plug and Play BIOS (only created by the ROOT enumerator)
PNP0C01	System board
PNP0C02	General ID for reserving resources required by Plug and Play system board registers (not specific to a particular device)
PNP0C03	Plug and Play BIOS event notification interrupt
PNP0C04	Math co-processor
PNP0C05	Advanced Power Management (APM) BIOS (version-independent)
PNP0C06	Reserved for identification of early Plug and Play BIOS implementation
PNP0C07	Reserved for identification of early Plug and Play BIOS implementation
PNP0C08	ACPI system board hardware
PNP0C09	ACPI embedded controller
PNP0C0A	ACPI control method battery
PNP0C0B	ACPI fan
PNP0C0C	ACPI power-button device
PNP0C0D	ACPI lid device
PNP0C0E	ACPI sleep-button device
PNP0C0F	PCI interrupt link device
PNP0C10	ACPI system indicator device
PNP0C11	ACPI thermal zone
PNP0C12	Device Bay Controller (DBC)
PNP0C13	Plug and Play BIOS (used when ACPI mode cannot be used)

PCMCIA Controller Chip Sets

Device ID	Description
PNP0E00	Intel 82365-compatible PCMCIA controller
PNP0E01	Cirrus Logic CL-PD6720 PCMCIA controller
PNP0E02	VLSI VL82C146 PCMCIA controller
PNP0E03	Intel 82365-compatible CardBus controller

Mouse

Device ID	Description
PNP0F00	Microsoft bus mouse
PNP0F01	Microsoft serial mouse
PNP0F02	Microsoft InPort mouse
PNP0F03	Microsoft PS/2-style mouse
PNP0F04	Mouse Systems mouse
PNP0F05	Mouse Systems 3-button mouse (COM2)
PNP0F06	Genius mouse (COM1)
PNP0F07	Genius mouse (COM2)
PNP0F08	Logitech serial mouse
PNP0F09	Microsoft BallPoint serial mouse
PNP0F0A	Microsoft Plug and Play mouse
PNP0F0B	Microsoft Plug and Play BallPoint mouse
PNP0F0C	Microsoft-compatible serial mouse
PNP0F0D	Microsoft InPort-compatible mouse
PNP0F0E	Microsoft-compatible PS/2-style mouse
PNP0F0F	Microsoft Serial BallPoint-compatible mouse
PNP0F10	Texas Instruments QuickPort mouse
PNP0F11	Microsoft-compatible bus mouse
PNP0F12	Logitech PS/2-style mouse
PNP0F13 [1]	PS/2 port for PS/2-style mouse
PNP0F14	Microsoft Kids mouse
PNP0F15	Logitech bus mouse
PNP0F16	Logitech SWIFT device
PNP0F17	Logitech-compatible serial mouse
PNP0F18	Logitech-compatible bus mouse
PNP0F19	Logitech-compatible PS/2-style mouse
PNP0F1A	Logitech-compatible SWIFT device
PNP0F1B	HP Omnibook mouse
PNP0F1C	Compaq LTE Trackball PS/2-style mouse
PNP0F1D	Compaq LTE Trackball serial mouse
PNP0F1E	Microsoft Kids Trackball mouse
PNP0F1F	Reserved by Microsoft Input Device Group
PNP0F20	Reserved by Microsoft Input Device Group
PNP0F21	Reserved by Microsoft Input Device Group

PNP0F22	Reserved by Microsoft Input Device Group
PNP0F23	Reserved by Microsoft Input Device Group
PNP0FFF	Reserved by Microsoft Systems

[1] The system BIOS should report the PS/2 port, not which type of mouse is connected to that port.

Network Adapters

Device ID	Description
PNP8001	Novell/Anthem NE3200
PNP8004	Compaq NE3200
PNP8006	Intel EtherExpress/32
PNP8008	HP Ethertwist EISA LAN Adapter/32 (HP27248A)
PNP8065	Ungermann-Bass NIUps or NIUps/EOTP
PNP8072	DEC (DE211) Etherworks MC/TP
PNP8073	DEC (DE212) Etherworks MC/TP_BNC
PNP8078	DCA 10-MB MCA
PNP8074	HP MC LAN Adapter/16 TP (PC27246)
PNP80C9	IBM Token Ring
PNP80CA	IBM Token Ring II
PNP80CB	IBM Token Ring II/Short
PNP80CC	IBM Token Ring 4/16-MB
PNP80D3	Novell/Anthem NE1000
PNP80D4	Novell/Anthem NE2000
PNP80D5	NE1000 compatible
PNP80D6	NE2000 compatible
PNP80D7	Novell/Anthem NE1500T
PNP80D8	Novell/Anthem NE2100
PNP80DD	SMC ARCNETPC
PNP80DE	SMC ARCNET PC100, PC200
PNP80DF	SMC ARCNET PC110, PC210, PC250
PNP80E0	SMC ARCNET PC130/E
PNP80E1	SMC ARCNET PC120, PC220, PC260
PNP80E2	SMC ARCNET PC270/E
PNP80E5	SMC ARCNET PC600W, PC650W
PNP80E7	DEC DEPCA
PNP80E8	DEC (DE100) EtherWorks LC
PNP80E9	DEC (DE200) EtherWorks Turbo

PNP80EA	DEC (DE101) EtherWorks LC/TP
PNP80EB	DEC (DE201) EtherWorks Turbo/TP
PNP80EC	DEC (DE202) EtherWorks Turbo/TP_BNC
PNP80ED	DEC (DE102) EtherWorks LC/TP_BNC
PNP80EE	DEC EE101 (built-in)
PNP80EF	DECpc 433 WS (built-in)
PNP80F1	3Com EtherLink Plus
PNP80F3	3Com EtherLink II or IITP (8-bit or 16-bit)
PNP80F4	3Com TokenLink
PNP80F6	3Com EtherLink 16
PNP80F7	3Com EtherLink III
PNP80F8	3Com generic EtherLink Plug and Play device
PNP80FB	Thomas-Conrad TC6045
PNP80FC	Thomas-Conrad TC6042
PNP80FD	Thomas-Conrad TC6142
PNP80FE	Thomas-Conrad TC6145
PNP80FF	Thomas-Conrad TC6242
PNP8100	Thomas-Conrad TC6245
PNP8105	DCA 10-MB
PNP8106	DCA 10-MB Fiber Optic
PNP8107	DCA 10-MB Twisted Pair
PNP8113	Racal NI6510
PNP811C	Ungermann-Bass NIUpc
PNP8120	Ungermann-Bass NIUpc/EOTP
PNP8123	SMC StarCard PLUS (WD/8003S)
PNP8124	SMC StarCard PLUS with on-board hub (WD/8003SH)
PNP8125	SMC EtherCard PLUS (WD/8003E)
PNP8126	SMC EtherCard PLUS with boot ROM socket (WD/8003EBT)
PNP8127	SMC EtherCard PLUS with boot ROM socket (WD/8003EB)
PNP8128	SMC EtherCard PLUS TP (WD/8003WT)
PNP812A	SMC EtherCard PLUS 16 with boot ROM socket (WD/8013EBT)
PNP812D	Intel EtherExpress 16 or 16TP
PNP812F	Intel TokenExpress 16/4
PNP8130	Intel TokenExpress MCA 16/4
PNP8132	Intel EtherExpress 16 (MCA)
PNP8137	Artisoft AE-1
PNP8138	Artisoft AE-2 or AE-3

PNP8141	Amplicard AC 210/XT
PNP8142	Amplicard AC 210/AT
PNP814B	Everex SpeedLink /PC16 (EV2027)
PNP8155	HP PC LAN Adapter/8 TP (HP27245)
PNP8156	HP PC LAN Adapter/16 TP (HP27247A)
PNP8157	HP PC LAN Adapter/8 TL (HP27250)
PNP8158	HP PC LAN Adapter/16 TP Plus (HP27247B)
PNP8159	HP PC LAN Adapter/16 TL Plus (HP27252)
PNP815F	National Semiconductor Ethernode *16AT
PNP8160	National Semiconductor AT/LANTIC Ethernode 16-AT3
PNP816A	NCR Token-Ring 4-MB ISA
PNP816D	NCR Token-Ring 16/4-MB ISA
PNP8191	Olicom 16/4 Token Ring Adapter
PNP81C3	SMC EtherCard PLUS Elite (WD/8003EP)
PNP81C4	SMC EtherCard PLUS 10T (WD/8003W)
PNP81C5	SMC EtherCard PLUS Elite 16 (WD/8013EP)
PNP81C6	SMC EtherCard PLUS Elite 16T (WD/8013W)
PNP81C7	SMC EtherCard PLUS Elite 16 Combo (WD/8013EW or 8013EWC)
PNP81C8	SMC EtherElite Ultra 16
PNP81E4	Pure Data PDI9025-32 (Token Ring)
PNP81E6	Pure Data PDI508+ (ArcNet)
PNP81E7	Pure Data PDI516+ (ArcNet)
PNP81EB	Proteon Token Ring (P1390)
PNP81EC	Proteon Token Ring (P1392)
PNP81ED	Proteon ISA Token Ring (1340)
PNP81EE	Proteon ISA Token Ring (1342)
PNP81EF	Proteon ISA Token Ring (1346)
PNP81F0	Proteon ISA Token Ring (1347)
PNP81FF	Cabletron E2000 Series DNI
PNP8200	Cabletron E2100 Series DNI
PNP8209	Zenith Data Systems Z-Note
PNP820A	Zenith Data Systems NE2000-compatible
PNP8213	Xircom Pocket Ethernet II
PNP8214	Xircom Pocket Ethernet I
PNP821D	RadiSys EXM-10
PNP8227	SMC 3000 Series
PNP8228	SMC 91C2 controller

PNP8231	Advanced Micro Devices AM2100/AM1500T
PNP8263	Tulip NCC-16
PNP8277	Exos 105
PNP828A	Intel 595-based Ethernet
PNP828B	TI2000-style Token Ring
PNP828C	AMD PCNet Family cards
PNP828D	AMD PCNet32 (VL-bus version)
PNP8294	IrDA Infrared NDIS driver (Microsoft-supplied)
PNP82BD	IBM PCMCIA-NIC
PNP82C2	Xircom CE10
PNP82C3	Xircom CEM2
PNP8321	DEC Ethernet (all types)
PNP8323	SMC EtherCard (all types except 8013/A)
PNP8324	ARCNET-compatible
PNP8326	Thomas Conrad (all ARCNET types)
PNP8327	IBM Token Ring (all types)
PNP8385	Remote network access (RNA) driver
PNP8387	RNA point-to-point protocol (PPP) driver
PNP8388	Reserved for Microsoft networking components
PNP8389	Peer IrLAN IR driver (Microsoft-supplied)
PNP8390	Generic network adapter

SCSI and Proprietary CD-ROM Adapters

Device ID	Description
PNPA002	Future Domain 16-700–compatible controller
PNPA003	Panasonic proprietary CD-ROM adapter (SBPro/SB16)
PNPA01B	Trantor 128 SCSI controller
PNPA01D	Trantor T160 SCSI controller
PNPA01E	Trantor T338 Parallel SCSI controller
PNPA01F	Trantor T348 Parallel SCSI controller
PNPA020	Trantor Media Vision SCSI controller
PNPA022	Always IN-2000 SCSI controller
PNPA02B	Sony proprietary CD-ROM controller
PNPA02D	Trantor T13b 8-bit SCSI controller
PNPA02F	Trantor T358 Parallel SCSI controller
PNPA030	Mitsumi LU-005 Single Speed CD-ROM controller + drive

PNPA031	Mitsumi FX-001 Single Speed CD-ROM controller + drive
PNPA032	Mitsumi FX-001 Double Speed CD-ROM controller + drive

Sound, Video Capture, and Multimedia

Device ID	Description
PNPB000	Sound Blaster 1.5 sound device
PNPB001	Sound Blaster 2.0 sound device
PNPB002	Sound Blaster Pro sound device
PNPB003	Sound Blaster 16 sound device
PNPB004	Thunderboard-compatible sound device
PNPB005	Adlib-compatible frequency modulation (FM) synthesizer device
PNPB006	MPU401 compatible
PNPB007	Microsoft Windows Sound System-compatible sound device
PNPB008	Compaq Business Audio
PNPB009	Plug and Play Microsoft Windows Sound System device
PNPB00A	MediaVision Pro Audio Spectrum (Trantor SCSI-enabled, Thunder Chip-disabled)
PNPB00B	MediaVision Pro Audio 3-D
PNPB00C	MusicQuest MQX-32M
PNPB00D	MediaVision Pro Audio Spectrum Basic (no Trantor SCSI, Thunder Chip-enabled)
PNPB00E	MediaVision Pro Audio Spectrum (Trantor SCSI-enabled, Thunder Chip-enabled)
PNPB00F	MediaVision Jazz-16 chip set (OEM versions)
PNPB010	Auravision VxP500 chip set–Orchid Videola
PNPB018	MediaVision Pro Audio Spectrum 8-bit
PNPB019	MediaVision Pro Audio Spectrum Basic (no Trantor SCSI, Thunder chip-disabled)
PNPB020	Yamaha OPL3-compatible FM synthesizer device
PNPB02F	Joystick/gameport

Modems

Device ID	Description
PNPC000	Compaq 14400 modem (TBD)
PNPC001	Compaq 2400/9600 modem (TBD)