
IRQ – the unsolved mystery, or not?

Basics

IRQ stands for "Interrupt Request", IRQs communicate to the processor when a device wants to carry out a specific command. This is called the interrupt request, which is capable of stopping the processor and directing it to perform a specific function.

Since the introduction of PIC (Programmable Interrupt Controller) 16 Interrupt conductors are available in a PC, Most of these, as demonstrated in the diagram below, are already allocated, More Modern mainboards usually utilize the APIC (Advanced Programmable Interrupt Controller) standard, which can manage more than 32 IRQs.

IRQ	Device Assignment
0	System Timer
1	Keyboard
2	Link to second IRQ controller (IRQ 8 to 15); since AT replaced by IRQ 9
3	Serial port 2 (COM2)
4	Serial port 1 (COM1)
5	Available
6	Floppy Disk Controller
7	Parallel Port 1 (LPT1)
8	Real-time Clock
9	Available
10	Available
11	Available
12	PS/2 Mouse
13	Math Coprocessor
14	Primary IDE Controller
15	Secondary IDE Controller

Unfortunately the PC isn't yet ready to be used as no graphic card IRQ reservation has been provided for. Additionally almost every modern PC has a USB controller, often a Network controller or Raid Controller and eventually even „Sound on Board“ (AC '97). As you can see, it quickly becomes problematic to secure an IRQ, particularly when an additional PCI card is to be installed.

All unnecessary devices (i.e. the COM Ports are seldom used anymore) should be deactivated in the PC's BIOS. Consult your mainboard manual for further details. The freed IRQ's then become available to the system for reassignment.

PCI Bus

The PCI Bus usually has only 4 interrupt inputs, whereas modern mainboards with APIC have 8 „real“ interrupt inputs. This means that even if the mainboard has 6 PCI Slots it must make due with 4, respectively 8, IRQs, whereby the AGP Port, USB and eventually the Raid Controller all have to use these same IRQs. Newer mainboards may additionally have Onboard LAN, 1394 (FireWire), and SATA (Serial ATA – a newer disk controller standard). This of course leads to PCI slots sharing IRQs. There are no general rules governing this and the mainboard documentation proves to be the savior in such cases. Every mainboard has an IRQ table for the PCI bus. Using the „ABIT KT7A-Raid“ and the „ASUS A7V8X“ as examples, let us take a closer look:

ABIT KT7A-Raid

Device	A	B	C	D
PCI Slot 1	shared	-	-	-
PCI Slot 2	-	shared	-	-
PCI Slot 3	-	shared	-	-
PCI Slot 4	-	-	-	shared
PCI Slot 5	-	-	shared	
PCI Slot 6				shared
AGP Slot	shared	-	-	-
USB Controller	-	-	-	shared
Raid Controller			shared	

A through D represent the 4 available IRQs belonging to the PCI bus.

- A represents PCI slot 1 and the AGP slot.
- B represents PCI slots 2 and 3.
- C represents PCI slot 5 and the Raid controller.
- D represents PCI slots 4, 6, and the USB controller.

This means:

- PCI slot 1 and the AGP slot share an IRQ
- PCI slots 2 and 3 share an IRQ
- PCI slot 4, 6, and the USB controller share an IRQ
- PCI slot 5 and the Raid controller share an IRQ

ASUS A7V8X

Device	A	B	C	D	E	F	G	H
PCI slot 1	-	-	-	shared	-	-	-	-
PCI slot 2	shared	-	-	-	-	-	-	-
PCI slot 3	-	shared	-	-	-	-	-	-
PCI slot 4	-	-	shared	-	-	-	-	-
PCI slot 5	-	-	-	shared	-	-	-	-
PCI slot 6	shared	-	-	-	-	-	-	-
AGP slot	shared	-	-	-	-	-	-	-
USB 1.1 UHCI 1	-	-	-	-	-	shared	-	-
USB 1.1 UHCI 2	-	-	-	-	-	shared	-	-
USB 1.1 UHCI 3	-	-	-	-	-	shared	-	-
USB 2.0 EHCI	-	-	-	-	-	shared	-	-
AC '97 (Sound)	-	-	-	-	-	-	used	-
Onboard LAN	-	-	shared	-	-	-	-	-
Onboard 1394	-	shared	-	-	-	-	-	-
Onboard SATA	-	shared	-	-	-	-	-	-
Onboard IDE	-	-	-	-	used	-	-	-

A through H represent the 8 available IRQs belonging to the PCI bus.

- A represents PCI slots 2, 6, and the AGP slot.
- B represents PCI slot 3, Onboard 1394 (FireWire), and SATA.
- C represents PCI slot 4 and Onboard LAN.
- D represents PCI slots 1 and 5.
- E represents the IDE controller.
- F represents the USB controller(s).
- G represents the Onboard AC '97(Sound).
- H is not used

This means:

- PCI slot 2, 6, and the AGP port share an IRQ.
- PCI slot 3, Onboard 1394 (FireWire) and SATA share an IRQ.
- PCI slot 4 and Onboard LAN share an IRQ.
- PCI slots 1 and 5 share an IRQ.
- The IDE controller has its own IRQ.

- The USB controller has its own IRQ.
- The AC '97 soundchip has its own IRQ.

As you see, the slot choice has a very large influence on the systems IRQ assignment and to insure a device receives its own IRQ one can, using the board from ABIT as an example, use the 2nd PCI slot - but the 3rd must then remain unused. On the ASUS board this correlates to slots 1 and 5.

In order to control the systems IRQ assignments under Windows 98 and ME go to the Windows Control Panel and double click on the System icon, where the IRQ list can be viewed. Under Windows 2000 and XP the Device Manager does not correctly reflect the IRQ assignments because of the virtual ACPI IRQ layer. When using these operating systems the PCI Device List must be consulted- this is displayed briefly during the boot phase. There the „real“(physical) IRQ assignment is shown, but most modern PCs boot so fast that this is displayed very briefly. Tip: Use the floppy drive as first boot device (in BIOS) and boot the PC with a blank diskette. When the error message comes saying no operating system could be located, the PCI Device List should be visible on the screen ;-).

Exclusive or shared IRQ ?

Categorically stated, all modern PCI cards with WDM drivers support IRQ sharing, although in certain circumstances problems may still arise. When, for example, the soundcard requests an interrupt during playback or recording and the IRQ is shared with another device like an ISDN card, the request cannot be fulfilled immediately because the IRQ controller must first determine which device has made the request, leading to possible distortion like popping and snapping due to dropped samples.

Our hearing is (luckily) a very sensitive organ, capable of immediately recognizing playback errors caused by such a sample drop. The eyes don't mind when a tiny hesitation delays the display of an internet page because the ISDN controller reacted slowly, but the ears are an entirely different story.

And so for soundcards: Give them their own IRQ and your ears will be pleased!