

IRQs

by **Ralph E. Griffin**

What is an IRQ line:

Some adapter cards which are designed to be installed in an IBM PC, PC/XT, PC/AT, or compatible computer require an Interrupt Request (IRQ) line. These cards usually give the user a narrow selection of IRQ lines and the accompanying documentation gives little advice on which IRQ line to use. If you choose the wrong line, it will interfere with the operation of some other hardware on your system such as the COM ports or printer ports. This document explains how to use IRQ lines.

It will be helpful to review the function of the IRQ lines. The IBM PC, and PC/XT have 8 IRQ lines (numbered IRQ0 through IRQ7). The IBM PC/AT and the non-IBM 386/ATs have 16 IRQ lines (numbered IRQ0 through IRQ15). The IRQ lines are physical connections in the computer. When a hardware device such as an adapter card activates the IRQ line it is detected by the programmable interrupt controller (PIC). The PIC then activates the interrupt pin on the processor. The processor responds by stopping whatever it is doing and then asks the PIC which interrupt should be executed. The PIC responds by telling the processor which interrupt to execute depending on which IRQ line was activated. The processor then gets the vector for that interrupt by looking in the interrupt vector table in memory. The processor then starts executing the procedure at the address that is pointed to by the vector. When the procedure is finished, the processor resumes doing whatever it was doing before it was interrupted.

Every IRQ line has a designated interrupt, and many IRQ lines have designated functions. Some of these functional designations are a little flexible. The following list shows the interrupt number and function of all the IRQ lines:

line	interrupt	function
IRQ0	08	system timer
IRQ1	09	keyboard
IRQ2	0A	PC/XT: EGA vertical retrace or maybe available PC/AT: see explanation below
IRQ3	0B	COM2 or maybe available
IRQ4	0C	COM1
IRQ5	0D	PC/XT: hard disk drive PC/AT: LPT2 or maybe available
IRQ6	0E	floppy disk drive
IRQ7	0F	LPT1
IRQ8	70	PC/AT: CMOS Real Time Clock
IRQ9	71	PC/AT: see explanation below
IRQ10	72	PC/AT: probably available
IRQ11	73	PC/AT: probably available
IRQ12	74	PC/AT: probably available PS/2: mouse
IRQ13	75	PC/AT: numeric coprocessor
IRQ14	76	PC/AT: hard disk drive
IRQ15	77	PC/AT: probably available

As you can see from the above table, it appears that all of the lower 8 IRQ lines are all reserved for something, and that makes it hard to add anything. But you may not actually have all the equipment that uses all those lines which means that the lines are free to be used for something else.

IRQ5:

On PC/XT's, the IRQ5 line is reserved for the hard disk drive. On PC/AT's, it is reserved for the second parallel printer port (LPT2), but most PC/AT's have only one parallel printer port (LPT1), so the IRQ5 line is in fact available for other uses. If you do have a second parallel port, you may be able to disable it and the IRQ5 line, which would make the IRQ5 line available for other uses.

IRQ3:

If a computer has only one serial port, or uses only one serial port, then IRQ3 may be available. If the computer has two serial ports but only one of them is being used, it may be possible to disable the IRQ3 line of the second serial port (COM2). If the IRQ3 line is unused or can be made available, then it is available for other uses.

IRQ2:

The IRQ2 line has no predetermined function, but it is commonly used by EGA and VGA adaptors, network adaptors, and bus mouse adaptors. The IRQ2 line can be used for any one of these purposes or for any other purpose, as long as there is no conflict with other adaptors. If the IRQ2 line is already being used by an EGA or VGA adaptor, you may be able to disable it for reasons explained below, and that would free it up for some other use. On a PC/AT the IRQ9 line may be considered the same as the IRQ2 line (more on that later). So if one adaptor uses the IRQ2 line and another uses the IRQ9 line, then there is a conflict.

Many of the old style of EGA adaptor cards have the problem that snow may appear on the display if you right directly to the display memory in graphics mode. To get around the snow problem, the EGA card generates an interrupt every time the display goes into a vertical retrace. Any software that uses the EGA display in graphics mode can set up an interrupt handler to write to the display only while the display is in vertical retrace, and that eliminates the snow problem. The EGA adaptor uses IRQ2 for this purposes. If your EGA adaptor does not have a jumper that enables or disables the IRQ2 line, then chances are that the IRQ2 line is enabled (and there is nothing you can do about it). If your EGA adaptor has a jumper that enables or disables the IRQ2 line, then you could disable it, and you may not notice any change in performance, especially if you do not have any software that utilizes it. There is also a chance that your EGA adaptor does not have the snow problem anyway, and the IRQ2 jumper is there only for the remote possibility that you may be running some software that won't work properly without the IRQ2.

Some VGA adaptor cards also have a jumper that allows you to enable or disable the IRQ2 line. VGA adaptors are not supposed to have the snow problem even when the IRQ2 line is disabled, so it is very unlikely that you need to enable it. The IRQ2 jumper is there only for the remote possibility that you may be running some software that won't work properly without the IRQ2. Most software that uses the IRQ2 can automatically detect it and adjust its operations to work with or without it. Some software that uses the IRQ2 selects the mode of operation during installation, so you may have to reinstall or resetup after disabling the IRQ2 line of the EGA or VGA adaptor. If the VGA adaptor has a 16 bit interface instead of an 8 bit interface, then the jumper will be referred to as IRQ9 enable instead of IRQ2 enable. It is really the same line as explained below.

IRQ2 and IRQ9 Working Together:

On PC/AT's and 386/AT's the IRQ2 and IRQ9 lines are used in mysterious ways which require lengthy explanation. Most technical references provide confusing, scant and contradictory information about this line and its

interrupt. The following is an attempt to clear up the confusion.

A comparison of the pinout diagrams for the adapter interface of the PC/XT and PC/AT shows that the IRQ9 terminal on the PC/AT is in the same location as the IRQ2 terminal on the PC/XT. Furthermore, the PC/AT does not even have an IRQ2 terminal. If a card is designed to work in the PC/XT, it has an 8 bit interface and it may use the IRQ2 line. If the card is plugged into a PC/XT system and if it activates its IRQ2 line, then it will activate the IRQ2 line on the computer mother board and that will cause the computer to execute interrupt 0A. If the same card is plugged into a PC/AT and if it activates (what it thinks is) the IRQ2 line, then it will actually be activating the IRQ9 line on the computer motherboard (the IRQ2 terminal of the card contacts the IRQ9 terminal of the interface connector) and that will cause the computer to execute interrupt 71. The procedure for interrupt 71 is set up by the BOIS and it includes a software call to interrupt 0A (the interrupt for IRQ2).

In other words, the PC/AT computer uses hardware to redirect the IRQ2 line of an adaptor card onto the IRQ9 line of the motherboard, and it uses software to redirect interrupt 71 (the procedure for IRQ9) back to interrupt 0A (the procedure for IRQ2). Thus the real IRQ2 line on the motherboard is uninvolved, except for an indirect way (cascading) which is discussed below. You can install an 8 bit card in a PC/AT computer and enable IRQ2. It is possible to run software which is specifically designed to work with that card (it expects to see interrupt 0A executed every time the card activates the IRQ2 line) and it should work (provided that there are no conflicts with other adaptor cards).

Many technical references state that the PC/AT computer uses the IRQ2 line as a cascade for IRQ8 through IRQ15. That is true. It means that whenever any one of the IRQ8 through IRQ15 lines is activated, it triggers a slave PIC which then activates the IRQ2 line going into the master PIC. The master PIC then activates the interrupt pin of the processor. However, that IRQ2 line is not accessible by the adaptor interface, so it is not interfered with by using the IRQ2 line of an 8 bit adaptor card. Furthermore, the cascading process is based on hardware protocol and it does not involve the use of interrupt 0A.

Many technical references state that the IRQ2 line or int 0A is reserved. That is not true. It may be that IBM wanted to reserve IRQ2 for its own use, but the only things that IBM ever commonly used it for are listed above. Currently, IBM has abandoned the AT architecture in favor of the PS/2. It may be that the technical references are referring to the IRQ2 line which is used for cascade and which is not even accessible to the adapter cards of the PC/AT. But that is misleading because it leaves the reader with the untrue impression that it would be hazardous to enable the IRQ2 line on an 8 bit adaptor card which is plugged into a PC/AT.

Printing without an IRQ line:

It is possible to operate a printer port without an IRQ line. By disabling the IRQ7 line of LPT1, or the IRQ5 line of LPT2, you can make that IRQ line available for other uses. The parallel printer port needs an IRQ line only if it is performing true bidirectional data transfer. If you disable the IRQ line of the parallel printer port, your programs can still send data to the printer and it will be printed. The parallel interface still has status lines which enables your programs to avoid overflowing the printers input buffer and detect basic errors such as "Out of Paper" and "Device not Ready".

Sharing an IRQ line:

It is also possible for more than one device to share an IRQ line. For example, you could have a scanner and a modem both using the IRQ3 line. As long as you don't try to run the scanner program and the modem program at the same time, you may be able to make it work. The most likely problem that may arise here is a software incompatibility. For example,

you may need to load a driver for the scanner in the CONFIG.SYS file, and that may conflict with the modem program even when you are not running the scanner program. It may be that you will have to change the configuration and reboot in order to switch between the scanner and the modem. You may find that you can run the scanner just fine, and then run the modem just fine, but you can't run the scanner after running the modem because the modem program does not restore the state of the interrupt vectors and the state of the PIC enable/disable masking bit for that IRQ line. Such an incompatibility can be overcome without rebooting, but it requires that the modem program be run from a batch file. The batch file would contain commands to run the modem program and then a custom program that restores the interrupt vectors and PIC mask to the proper values for compatibility with the scanner (this solution is most elegant once you get it working but it is not for novices).