

# Investigating IO Interrupts

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## Introduction

At the end of this lab you should be able to:

- Describe what interrupt vectors are and explain how they are used
  - Describe two main methods of IO interrupt handling
  - Explain the difference between the two main methods of IO interrupt handling
  - Compare the merits of the two main methods of IO interrupt handling
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## Basic Theory

Computer systems use the interrupt mechanism as a means of responding to external events such as input and output operations. The CPU is momentarily interrupted just before executing the next instruction and is forced to execute the instructions of an interrupt handler. Once the interrupt handling is completed the CPU is returned back to executing the instruction it was about to execute before it was interrupted. The stack is used to store the CPU state such as the contents of registers and the return address when interrupted. These are then restored once the interrupt handler is exited.

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## Lab Exercises - Investigate and Explore

The lab investigations are a series of exercises that are designed to demonstrate the various aspects of IO interrupt handling.

### Exercise 1 – Describe what interrupt vectors are and explain how they are used

In the compiler window, check only the boxes **Generate code**, **Enable optimizer** and **Redundant Code**. Enter the following source code and compile it:

```
program Vectors
  sub IntVect1 intr 1
    writeln("This is intr 1")
  end sub

  sub IntVect2 intr 2
    writeln("This is intr 2")
  end sub

  sub IntVect5 intr 5
    writeln("This is intr 5")
  end sub

  while true
    wend
end
```

In the compiled code window locate the subroutines *IntVect1*, *IntVect2* and *IntVect5*. Make a note of the starting addresses of these subroutines below:

Subroutine	Starting address
IntVect1	0000
IntVect2	0020
IntVect5	0040

Next, do the following:

1. Load the code generated in CPU memory.
2. Click on the **INTERRUPTS...** button to view the **INTERRUPT VECTORS** window.
3. Make a note of the numbers displayed in text boxes next to **INT1**, **INT2** and **INT5**.

**Note:** The **INTERRUPT VECTORS** window in the simulator represents that part of the CPU hardware that stores the various interrupt routine addresses.

Interrupt	
INT1	0
INT2	20
INT5	40

Compare the two tables above and enter a brief comment on your observation in the space below:

The are the same....

Now, follow the instructions below:

1. Click on the **INPUT OUTPUT...** button to view the console window.
2. Select **Stay on top** boxes both in the console and the interrupt vectors windows.
3. Reset the **Vectors** program and run it at the fastest speed.
4. While the program is running, click **TRIGGER** buttons in the interrupts window against **INT1**, **INT2** and **INT5** one after the other.
5. Observe the messages displayed on the console. Comment on your observations:

**Tip:** If you run the program at a slow pace (speed slider down), you should be able to see the effects of clicking on the **TRIGGER** buttons.

Comment on your observations in the space below:

The interrupts are executed.  
All the Registers are stored on the stack, furthermore the return address is stored on the stack.  
When IRET is called the register values before the interrupt are restored and the program continues.

## Exercise 2 – Describe two main methods of interrupt handling

Enter the following source code in a new source editor and compile it.

```
program PolledInt
  var v integer

  v = 0
  writeln("Program Starting")
  while true
    read(nowait, v)
    for i = 1 to 100
      if v > 0 then
        break *
      end if
      write(".")
    next
  wend
  writeln("Program Ending")
end
```

### Notes:

- The **nowait** keyword in the read statement makes sure the program is not suspended while waiting for an input.
- If there is no input, the value of the variable **v** will remain unchanged.
- The **break \*** statement takes the program out of the outermost loop which in this case is the while loop.

So, now, briefly explain what the above program is doing:

Every 100 loops of the for loop, the value of v is polled. When this value changes the program is halted.

Next, follow the instructions below:

1. Load the code generated in CPU memory.
2. Set the speed of simulation to maximum.
3. Bring the console window up (use the **INPUT OUTPUT...** button).
4. Check the **Stay on top** check box on the Console.
5. Click in the **INPUT** box on the Console.
6. Start the simulation by clicking the CPU Simulator's **RUN** button. As soon as the **Program Starting** message is displayed on the Console, type any single character in the **INPUT** box of the Console. Wait until the program terminates.

Next, enter the following source code in a new source editor and compile it.

```
program VectoredInt
  var v integer

  sub InputInt intr 1
    read(nowait, v)
  end sub

  v = 0
  writeln("Program Starting")
  while true
    for i = 1 to 100
      if v > 0 then
        break *
      end if
      write(".")
    next
  wend
  writeln("Program Ending")
end
```

Briefly explain what the above program is doing (note where the read statement is in this case)

The input is now read in an interrupt. This interrupt is called when something is entered in the console.

Load the code generated in CPU memory. Reset and run this code at the fastest speed. As soon as the **Program Starting** message is displayed on the Console, type any single character in the **INPUT** box of the Console. Wait until the program terminates.

### Exercise 3 – Explain the difference between polled and vectored interrupts

Based on your observation in the previous exercise, briefly explain the difference in the behaviours of the two programs, *PolledInt* and *VectoredInt*, with respect to the speed of response to input. Explain why this difference.

PolledInt keeps checking for the input to be changed. VectoredInt just calls an interrupt. VectoredInt is faster since the input is handled directly. In PolledInt the input is only checked once in so much clock cycles.

Based on your observations in exercises 2, and looking at the table below, which interrupt handling method listed in the table, is more efficient (put an **X** against it):

Interrupt method	Select the most efficient one
Polled Interrupt	
Vectored Interrupt	x

### Exercise 4 – Compare the merits of the two main methods of interrupt handling

1. Based on your observations above, suggest and briefly describe a reason where you would use the Polled Interrupt method in preference to the Vectored Interrupt method?

Because the amount of interrupts in a processor is limited it is sometimes necessary to use polling. Furthermore, when using polling the cpu can define the amount of times it has to pol. This makes sure the rest of the processes have enough processing time. With interrupts it is possible that the the rest of the program is starved.

2. Very briefly describe where you would use the Vectored Interrupt method in preference to the Polled Interrupt?

It uses far less clock cycles. The cpu can do other things in stead of waiting for a slow device.