

## Chapter 4

### I/O Port Programming



# I/O PORT PROGRAMMING

## Chapter Objectives

- List the 4 ports of the 8051
- Describe the dual role of port 0 in the both data and addresses
- Code Assembly language to use the ports for input or output
- Explain the dual role of port 0 and port 2
- Code 8051 instructions for I/O handling
- Code I/O bit-manipulation programs for the 8051

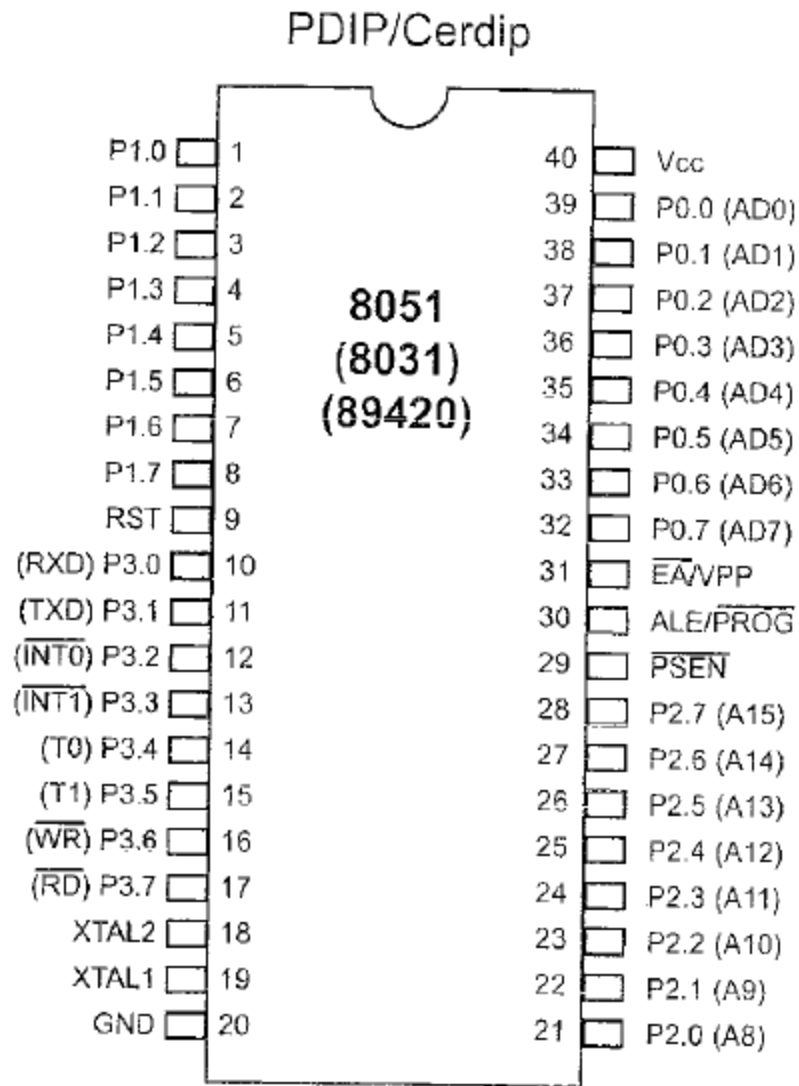


# I/O PORT PROGRAMMING

## 8051 I/O

- There are a total of 4 ports for I/O operations (See **Figure 4.1**)
- 32 pins are set aside for the 4 ports: P0, P1, P2 and P3
- Each port takes 8 pins
- The rest of the pins are designated as  $V_{CC}$ , GND, XTAL1 & XTAL2, RST, EA', ALE/PROG' and PSEN' (Pins will be discussed in Chapter 8)

Figure 4.1: 8051 Pin Out



## I/O port pins and their functions

- The 4 ports P0, P1, P2 and P3 each use 8 pins, making them 8-bit ports.
- All the ports upon RESET are configured as inputs, ready to be used as input ports.
- When the 1<sup>st</sup> “0”,it becomes an output.
- To reconfigure it as an input, a “1” must be sent to the port.

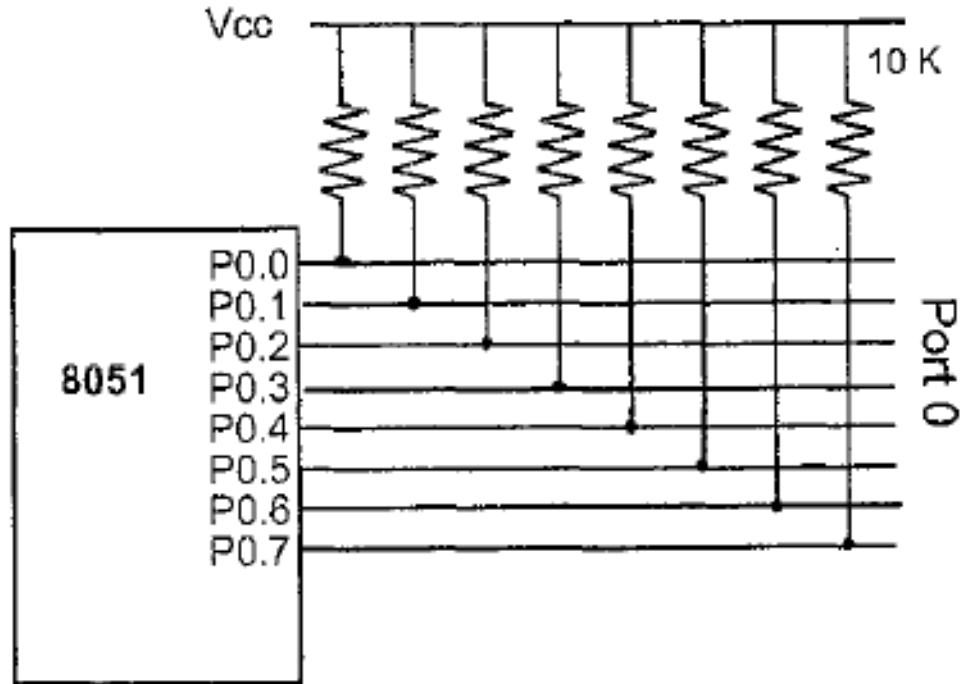


## I/O port pins and their functions

### Port 0

- Port 0 occupies a total of 8 pins (pins 32 -39)
- It can be used for input or output.
- To use the pins of port 0 as both input and output ports, each pin must be connected externally to a 10K –ohm pullup resistor. (See **Figure 4-2**).
- The pullup resistor is required because Port P0 has an open drain pin wired to it.
- Ports P1-P3 required external pullup resistors for proper electrical operation of the 8051 uC.
- ***Open drain*** is a term used for MOS chips in the same way that ***open collector*** is used for TTL chips.

**Figure 4.2:** External Pullup Resistors wired to PO port





## I/O port pins and their functions

### Port 0...

- By using the external resistors, Port 0 can easily be used as an Input or Output functions.

The following code illustrates PO as being configured as an output.

```
; Toggle all bits of PO  
BACK: MOV     A, #55H  
      MOV     P0, A  
      ACALL  DELAY  
      MOV     A, #0AAH  
      MOV     P0, A  
      ACALL  DELAY  
      SJMP   BACK
```



## Port 0 as an input

With resistors connected to port 0, in order to make it an input, the port must be programmed by writing 1 to all the bits. The following code illustrates configuring port 0 as input port by writing “1s” to it and then data is received from that port and sent to P1.

; Get a byte from P0 and send it to P1

```
        MOV    A, #0FFH    ;A = FF hex
        MOV    P0, A      ; make P0 an input port
                               ; by writing all 1s to it
BACK;   MOV    A, P0      ; get data from P0
        MOV    P1, A      ; send it to port 1
        SJMP   BACK       ; keep doing it
```



## Dual role of port 0

- Figure 4-1 shows port 0 also designated as AD0 – AD7, allowing it be used for both address and data.
- When connecting to external memory, port 0 provides both address and data.
- The 8051 multiplexes address and data through port 0 to save pins.



## Port 1

- Port 1 occupies a total of 8 pins (pins 1 through 8).
- It can be used as input or output
- This port doesn't require external pullup resistors like port 0 because they're internal to the microcontroller.
- Upon reset, port 1 is configured as an input port.
- The code on the following slide illustrates the port being used as an output.



## Port 1 ...

; Toggle all bits of P1 continuously

```
BACK: MOV    A, #55H
```

```
      MOV    P1, A
```

```
      ACALL  DELAY
```

```
      CPL    A           ; complement (invert) reg. A
```

```
      SJMP   BACK
```



## Port 1 as an input

- Port 1 is configured as an input by writing “1” to all its bits.
- The code on the following slide illustrates configuring Port 1 as an input.



## Port 1 as an input...

```
MOV    A, #0FFH    ; A=FF hex
MOV    P1, A       ; make P1 an input port
                          ; by writing all 1s to it
MOV    A, P1       ; get data from P1
MOV    R7, A       ; save it in reg R7
ACALL  DELAY       ; wait
MOV    A, P1       ; get another data from P1
MOV    R6, A       ; save it in reg R6
ACALL  DELAY       ; wait
MOV    A, P1       ; get another data from P1
MOV    R5, A       ; save it in reg R5
```



## Port 2

- Port 1 occupies a total of 8 pins (pins 21 through 28).
- It can be used as input or output.
- Just like P1, Port 2 does not require any external pullup resistors since they're internal to the microcontroller.
- Upon reset, Port 2 is configured as an input port.
- The code on the following slide will illustrate using Port 2 as an output.



## Port 2 ...

; Toggle all bits of P2 continuously

```
BACK: MOV    A, #55H
```

```
      MOV    P2, A
```

```
      ACALL  DELAY
```

```
      CPL    A           ; complement (invert) reg. A
```

```
      SJMP  BACK
```



## Port 2 as an input

- Port 2 is configured as an input by writing “1” to all its bits.
- The code on the following slide illustrates configuring Port 1 as an input. The data is received from that port and is sent to P1 continuously.



## Port 2 as an input. . .

; Get a byte from P2 and send it to P1

```
MOV    A, #0FFH    ;A = FF hex
```

```
MOV    P2, A      ; make P0 an input port
```

```
        ; by writing all 1s to it
```

```
BACK;    MOV    A, P2      ; get data from P0
```

```
MOV    P1, A      ; send it to port 1
```

```
SJMP   BACK      ; keep doing it
```



## Dual role of port 2

- In many 8051 based embedded systems, P2 is used as simple I/O.
- However, in an 8031 based embedded system, Port 2 must be used along with P0 to provide the 16bit address for external memory.
- As shown in Figure 4-1, port 2 is also designated as A8-A15, indicating its dual function.
- Since an 8051/31 is capable of accessing 64kbytes of external memory, it need a path for the 16 bits of the address.
- While P0 provides the lower 8 bits via A0-A7, it is the job of P2 to provide bits A8 –A16 of the address.
- P2 is used for the upper 8bits of the 16bit address and it cannot be used for I/O.



## Port 2 Conclusion

- Embedded systems based on 8751, 89C51, or DS589C4x) microcontrollers, 3 ports , P0, P1, and P2 can be used for I/O operation.
- The 3 ports should be enough for most microcontroller applications.
- Port 3 is generally used for interrupts as well as other signals.



## Port 3

- Port 3 occupies a total of 8 pins, (pins 10 through 17).
- It can be used as input or output.
- P3 doesn't need any pullup resistors, just as P1 and P2 did not.
- Although Port 3 is configured as an input port upon reset, this not the common way it is used.
- Port 3 has the additional function of providing some extremely important signals as interrupts
- Table 4-1 provides a summary of alternate functions of P3.
- This information applies to both 8051 and 8031 chips.



## Port 3 Summary

**Table 4-1:Port 3 Alternate Functions**

<b>P3 Bit</b>	<b>Function</b>	<b>Pin</b>
P3.0	RxD	10
P3.1	TxD	11
P3.2	$\overline{\text{INT0}}$	12
P3.3	$\overline{\text{INT1}}$	13
P3.4	T0	14
P3.5	T1	15
P3.6	$\overline{\text{WR}}$	16
P3.7	$\overline{\text{RD}}$	17