Q.1 With diagram, explain the operation of ports in 8051 ?

→ The 8051 has 32 I/O pins configured as four 8-bit parallel ports named P0, P1, P2 and P3.

1) Port 0 (P0)

    (a) Port 0 can be used as an input/output or as a bidirectional data bus and low-order address for external memory.

Port 0 structure

    (b) Input Operation

      • When '1' is written to the latch, the port becomes an input port by turning the FET's off.

      • Since the port line goes into a "float" state (neither 0 nor 1) it is a "true bidirectional" port.

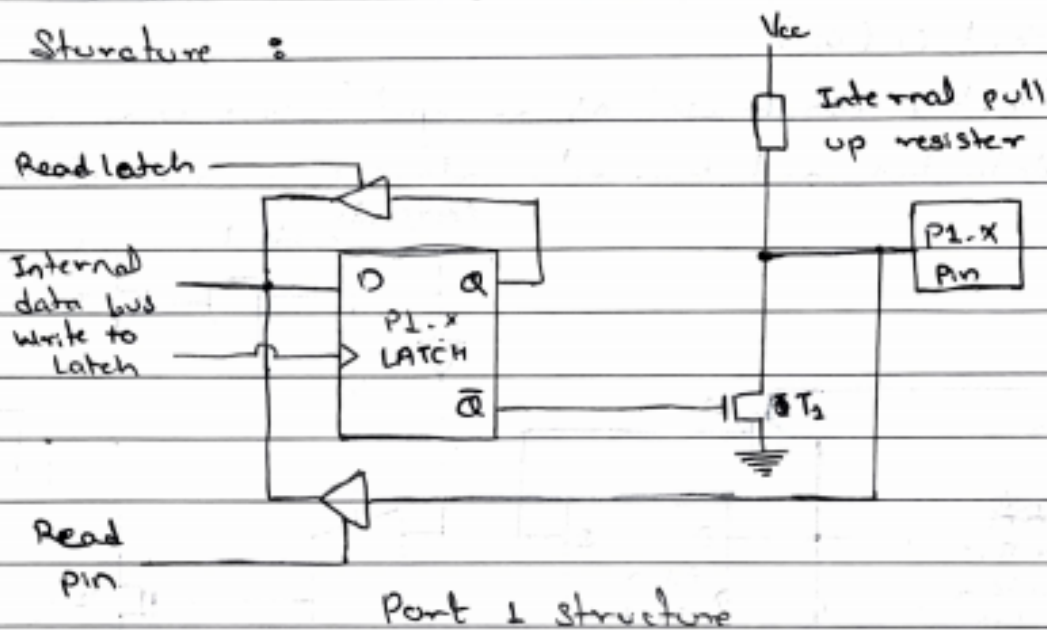   • We can read the value of the port pin by enabling the read pin.

    (c) Output Operation

      • To send a "0", write 0 on the latch. This will turn on the FET and port pin gets grounded, so the port pin contains logic "0".

    (d) Port 0 can also be used as the multiplexed bus AD7-AD0 and can carry address or data.

    The control signal directs the address line to the gate of the FET.

2) Port 1 (P1)

- Port 1 is a true I/O port because it has no alternate function.
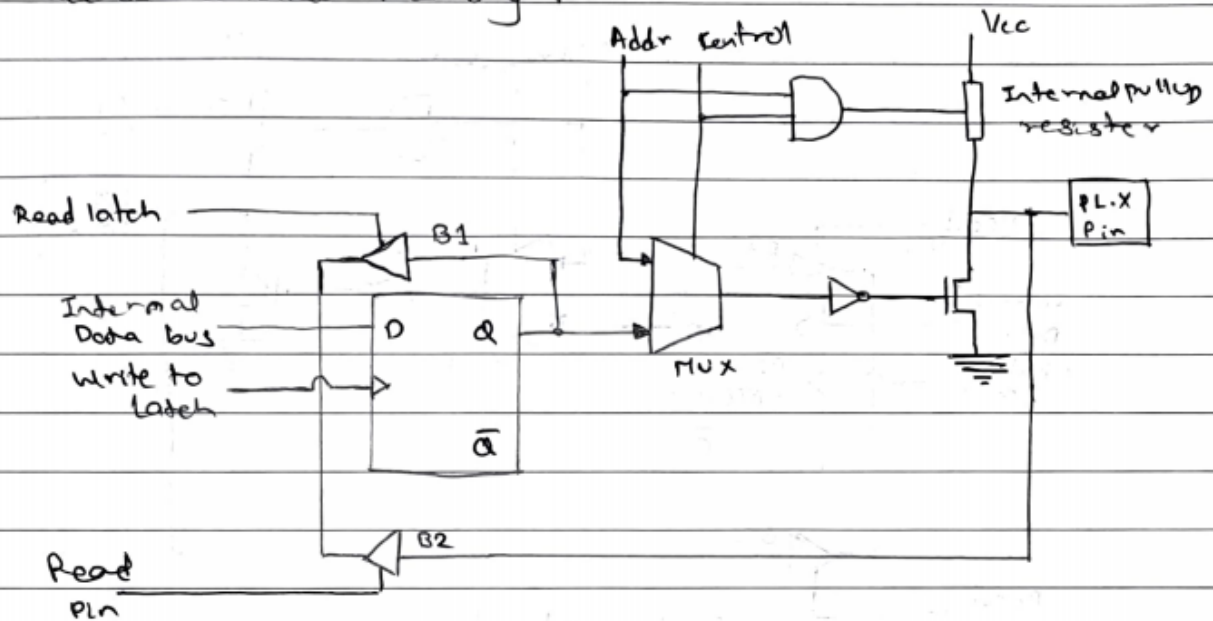
Structure :

Port 1 structure

Input Operation

- When a "1" is written to the latch, the port becomes an input port by turning the FET off.
- The port line will not go into a float state.
- Instead, the internal pull up resistor will maintain a logic 1 (V_{cc}) on the port line.
- We can read (input) the value of the port pin be enabling read pin output operation.

* Output Operation

- To send a "0": Write a "0" on the latch.
  This turns on the FET and the port pin gets grounded, so the port pin contains logic "0".
- To send a "1": Write a "1" on the latch. This turns OFF the FET. The internal Vcc pull up provides a logic "1" on the port line.

3) Port 2 (P2)

Port 2 can be used as I/O port exactly similar by port 1. It can also be used to provide high-order address byte to access external memory.
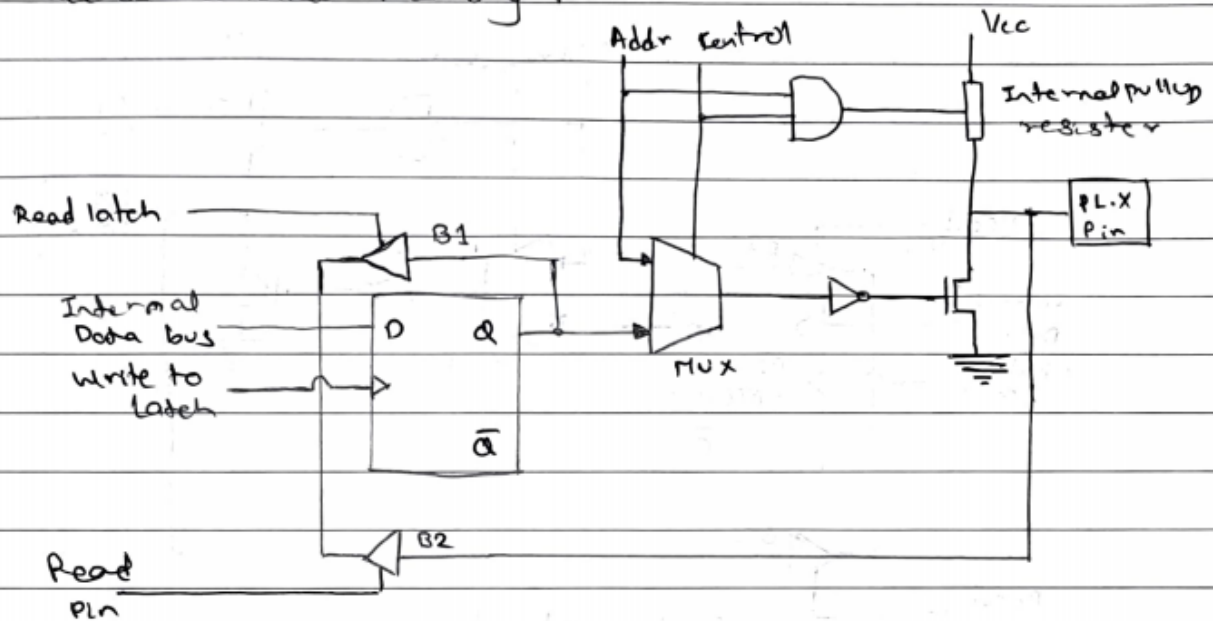

Port 2 structure

Input Operation
- When a "1" is written to the latch, the port becomes an input port by turning the FET off.
- The port line will not go into a float state.
- Instead, the internal pull up resistor will maintain a logic 1 (Vcc) on the port line.
- We can read (input) the value of the port pin be enabling read pin output operation.

* Output Operation
- To send a "0". Write a "0" on the latch. This turns on the FET and the port pin gets grounded, so the port pin contains logic "0".
- To send a "1". Write a "1" on the latch. This turns OFF the FET. The internal Vcc pull up provides a logic "1" on the port line.

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- To send a "0". Write a "0" on the latch. This turns on the FET and the port pin gets grounded, so the port pin contains logic "0".
- To send a "1". Write a "1" on the latch. This turns OFF the FET. The internal Vcc pull up provides a logic "1" on the port line.

Q.2 Write a AIP program to read port 1. If the received data is equal to 20H, send FFH to port 2, otherwise send 00H to port 3.

→ Program :-

```
    org 0000H
    MOV A, P1
    CJNE A, #20H, PASS
    CALL SKIP
PASS: MOV A, #00H
      MOV P3, A
      RET
SKIP: MOV A, #0FFH
      MOV P2, A
      RET
    END
```

Output :-

Port 1	7	6	5	4	3	2	1	0
0×20			✓					
0×20			✓					

Port		7	6	5	4	3	2	1	0
0×30				✓					
0×30				✓					

Port 2	7	6	5	4	3	2	1	0
0×FF	✓	✓	✓	✓	✓	✓	✓	✓
0×FF	✓	✓	✓	✓	✓	✓	✓	✓

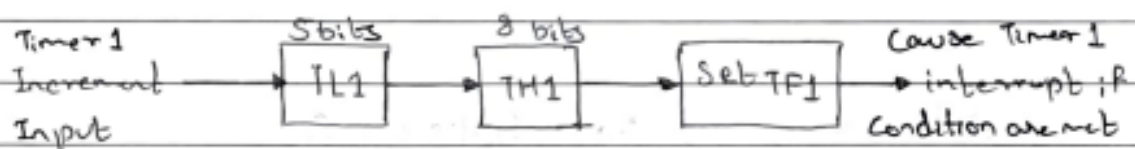| Port 3	7	6	5	4	3	2	1	0
0×00								
0×00								

Q.3 | Discuss the value timer modes supported by 8051

→ Timer Mode

In the timer mode, the internal machine cycles are counted. So this register is incremented in each machine cycle. So when the clock frequency is 12 MHz, then the timer-register is incremented in each millisecond. In this mode it ignores the external timer input pin.

@ Mode 0 of Timer / counter

The Mode 0 operation is the 8-bit timer or counter with a 5-bit pre-scaler. So it is a 13-bit timer/counter. It uses 5 bits of TL0 or TL1 and all of the 8-bits of TH0 or TH1
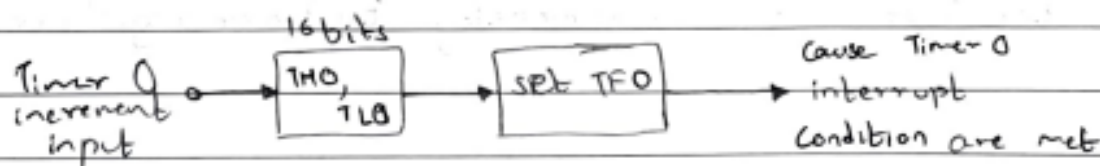
```
Timer 1        5bits    8 bits              Cause Timer 1
Increment  →   TL1   →  TH1   →  Set TF1 →  interrupt if
Input                                       Condition are met
```

```
MOV  TMOD , # 00H
MOV  TH1 , # 0F0H
           IE
MOV  IA , # 88H
SETB TR1
```

@ Mode 1 of Timer/counter

The Mode 1 operation is the 16-bit timer or counter. so we are using mode 1 for timer 0.

```
             16bits                 Cause Timer 0
Timer 0  →   THO,   →  set TF0 →    interrupt
increment    TL0                    Condition are met
input
```

```
MOV    TMOD , #01 H
MOV    TL0 , #0F0H
MOV    THO , #0FFH
MOV    IE , #82H
SETB   TR0
```
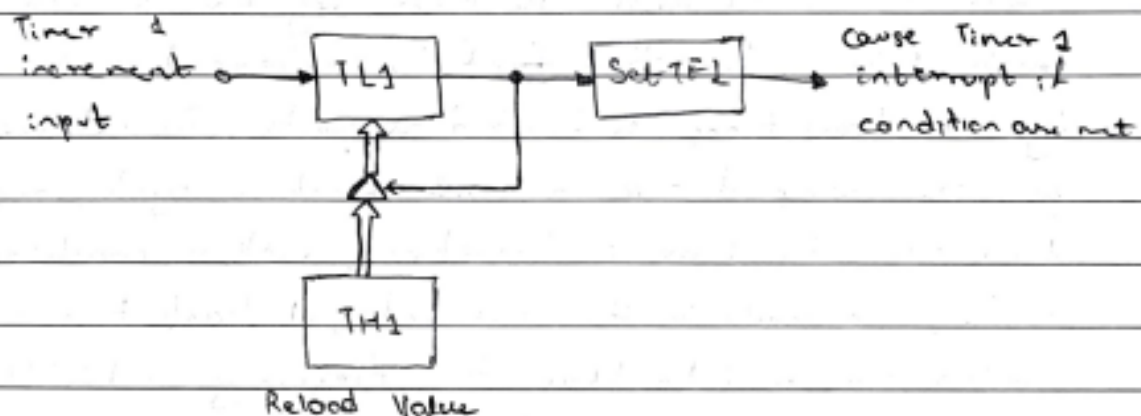
© Mode 2 of Timer / counter

The mode 2 operation is the 8-bit auto-reload timer
or counter. In the following diagram, we are using
mode 2 for Timer 1.

Reload Value

```
MOV    TMOD , #20H
MOV    TL1 , #0F0H
MOV    TH1 , #0F0H
MOV    IE , #88H
SETB   TR1
```
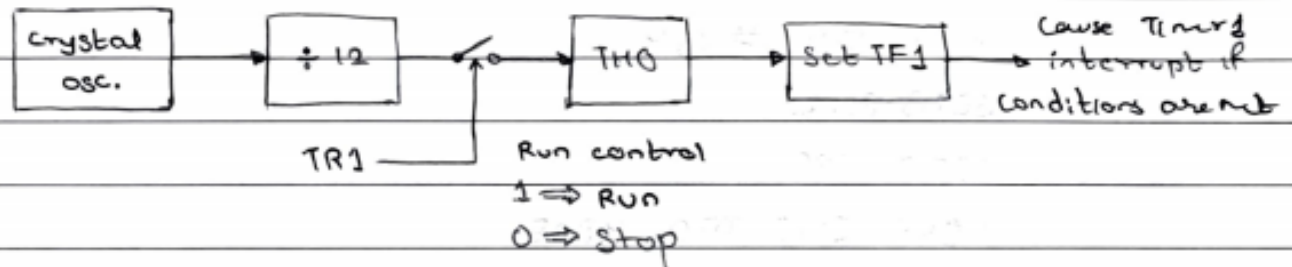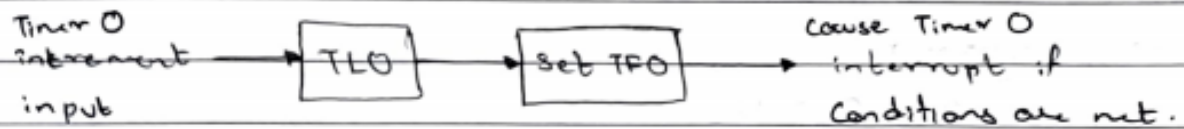
③ Mode 3 of Timer / counter

Mode 3 is different for Timer 0 and Timer 1. When
the Timer 0 is working in mode 3, the TL0 will be used
as an 8-bit timer/counter. It will be controlled by the
standard Timer 0 control bits, T0 and INT0 inputs.

The TH0 is used as an 8-bit timer but not the counter. This is controlled by Timer 1 control bit TR1. When the TH0 overflows from FFH to 00H, the TF1 is set to 1.

Timer 0
increment ────→ [TL0] ──→ [Set TF0] ────→ cause Timer 0
input   interrupt if
                                           conditions are met.

[crystal
osc.] ──→ [÷ 12] ──→ ⟋°──→ [TH0] ──→ [Set TF1] ──→ cause Timer1
                                                    interrupt if
                                                    conditions are met
                 TR1 ──────┘ Run control
                              1 ⇒ Run
                              0 ⇒ Stop

When the timer 1 is working in mode 3, it simply holds the counts but does not run. When Timer 0 is in Mode 3, the Timer 1 is configured in one of the mode 0, 1 and 2. In this case, the timer 1 cannot interrupt the microcontroller. When the TF1 is used by TH0 timer 1 is used as Baud Rate Generator.

Q.4 Assume an oscillator running at 12 MHz controls an 8052 micro controller. Write a program to generate 4 kHz square wave on port 1.2 pin 3 using timer 0 in auto reload mode.

→ Program :

```
        Org  0000H
        MOV  TMOD , # 02H
        MOV  TH0, # 83H
        SETB P1.2
        SETB TR0
HERE:   JNB TF0, HERE
        CPL P1.2
        CLR TF0
        SJMP HERE
```

Output :