

Embedded System Assignment: Unit 3.

1) What are the features of 8051 Microcontroller?

A) The following are the features of 8051 Microcontroller:

- ① 4KB bytes on-chip program memory (ROM).
- ② 128 bytes on-chip data memory (RAM).
- ③ Four Register Banks.
- ④ 128 user defined software flags.
- ⑤ 8-bit Directional Data Bus.
- ⑥ 16-bit Unidirectional Address Bus.
- ⑦ 32 general purpose registers each of 8-bit.
- ⑧ 16 bit Timers (usually 2, but may have more or less).
- ⑨ Three internal and two external interrupts.
- ⑩ Four 8-bit ports. (Some model have two 8 bit ports.)

⑪ 16 bit program counter and data pointer.

⑫ 8051 may also have a number of special features such as USARTs, ADC, etc.

⑬ Program Counter - 16 bit and DPTR (Data Pointer)

⑭ I/O pins - 32 which are arranged like four ports such as P0, P1, P2 & P3.

⑮ Stack Pointer (SP) - 8 bit & PSW (Processor Status Word)

⑯ Serial Data TX & RX for full-duplex operation.

(2) Write the function of following SFR in 8051.

A) (a) PSW

- The PSW or Program Status Word Register is also called as Flag Register and is one of the important SFRs. The PSW Registers consists of Flag Bits, which help the programmer in checking the condition of result and also make decisions.

(b) TCON

- Timer control or TCON Register is used to start or stop the Timers of 8051 Microcontroller. It also contains bits to indicate if Timers has overflowed. The TCON SFR also consists of Interrupt related bits.

(c) TMOD

- The TMOD or Timer Mode register or SFR is used to set the operating modes of the Timers T0 & T1. The lower four bits are used to configure Timer0 and higher four bits are used to configure Timer1.

(D) DPTR: The DPTR is a 16-bit Register and is physically the combination of DPL (Data Pointer Low) & DPH (Data Pointer High) SFRs. The Data Pointer can be used as a single 16-bit register (as DPTR) or two 8-bit registers (as DPL & DPH).

(E) Stack Pointer: The SP points out to the top of the stack and it indicates the next data to be accessed. Stack Pointer can be accessed using PUSH, POP, CALL & RET, etc.

(F) Program Counter (PC): It is a 16-bit register. It is used to hold the address of the memory location from where the next instruction to be fetched.

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(Q) P0, P1, P2, P3 :

8051 Microcontroller four ports which can be used as Input or Output. These four ports can be used as Input and/or Output. These four ports are P0, P1, P2 & P3. Each port has a corresponding register with same names. The address of ports are as : P0 - 80H, P1 - 90H, P2 - A0H, P3 - BOH.

(3) What is meant by bit addressable Register? Which of the 8051 register is bit addressable?

- A) ① A bit addressable register is one which has each bit addressed sequentially (serially) and thus is bit addressable.
- ② The hardware for parallel byte addressing is more complex but the addressing is faster.
- ③ A register is said to be bit addressable if its individual bits can be set or reset. e.g. let us suppose we have a 8 bit register named D, then it is said to be addressable if it can set or reset bit Dx using instruction.
- ④ 8051 has 4 selectable banks of 8 addressable 8-bit registers ; R0 to R7. This means that there are essentially 32 available general purpose registers, although only 8 (one bank) can be directly accessed at a time.
- ⑤ To access the other banks, we need to change the current bank number in flag Register.

(4) what are the different modes in which 8051 timers can be used?

A)= ① In 8051, there are two 16-bit timer registers. These registers are known as Timer 0 & Timer 1.

② The timer register can be used in two modes. These modes are Timer Mode & Counter Mode.

③ The only difference between two modes is the source for incrementing timers i.e. registers.

④ Timer Mode: In Timer Mode, internal machine cycles are counted. So this register is incremented in each machine cycle. So the clock frequency at 12MHz is reached timer register is incremented in milliseconds.

⑤ Counter Mode: In Counter Mode: In Counter Mode, external events are counted. In this mode, timer registers is incremented for each 1 to 0 transition of external input pin.

⑥ There are 4 different Modes of Timer or Counter. The Mode 0 to Mode 2 are for both of the Timer/Counter. Mode 3 has a different meaning for each timer register.

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(5) with neat labelled diagram explain function of each pin of 8051 Microcontroller.

(A) =

P1.0	F	1	40	VCC
P1.1	F	2	39	P0.0 (AD0)
P1.2	F	3	38	P0.1 (AD1)
P1.3	F	4	37	P0.2 (AD2)
P1.4	F	5	36	P0.3 (AD3)
P1.5	F	6	35	P0.4 (AD4)
P1.6	F	7	34	P0.5 (AD5)
P1.7	F	8	33	P0.6 (AD6)
RST	F	9	32	P0.7 (AD7)
RxD (P3.0)	I	10	31	P0. EA / VPP
TxD (P3.1)	F	11	30	ALE / PROG
INT0 (P3.2)	I	12	29	PSEN
INT1 (P3.3)	F	13	28	P2.7 (A15)
T0 (P3.4)	I	14	21	P2.6 (A14)
T1 (P3.5)	I	15	26	P2.5 (A13)
(WR) (P3.6)	I	16	25	P2.4 (A12)
(RD) (P3.7)	I	17	24	P2.3 (A11)
XTAL 2	I	18	23	P2.2 (A10)
XTAL 1	I	19	22	P2.1 (A9)
GND	I	20	21	P2.0 (A8)

- Pin 1 to 8 (Port1) :-

Pin 1 to 8 are assigned to Port1 for simple I/O operations. They can be configured as input or output pins depending on the logic control.

- Pin 9 (RST) :-

Reset pin. It is an active high, input pin. Therefore if RST pin is high for a min. of 2 machine cycles, the microcontroller will reset i.e. it will close and terminate all activities.

- Pin 10 to Pin17 (Port3) :-

Pin 10 to Pin17 are port 3 pins which are also referred to as P3.0 to P3.7. These pins are similar to Port1 and can be used as universal inputs.

- P3.0 (RXD) : Serial Data Receive

- P3.1 (TXD) : Serial Data Transmit

- P3.2 & P3.3 External Hardware Interrupt 0 & 1

- P3.4 & P3.5 Timer 0 & Timer 1

- P3.6 : WR : Writing to ext. memory

- P3.7 (RP) : Reading from ext. memory

- Pin 18 & 19 : Provide clock frequency

- Pin 20 : Ground

- Pin 21 to 28 : High order address bytes (Bidirectional).

- Pin 29 (PSEN) : Program store Enable

- Pin 30 (ALE) : Address Latch Enable

- Pin 31 : External Access

- Pin 32 to 39 : Bidirectional input/output pins

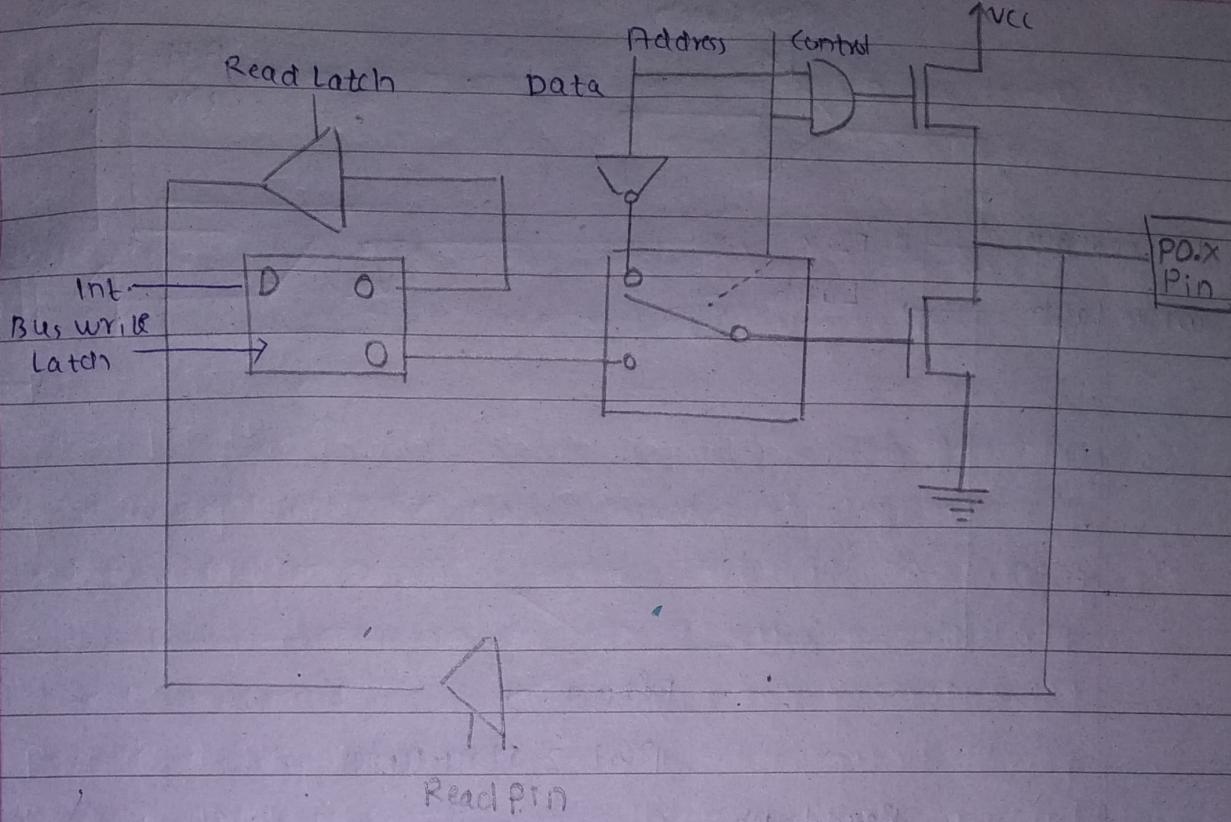
- Pin 40 (VCC)

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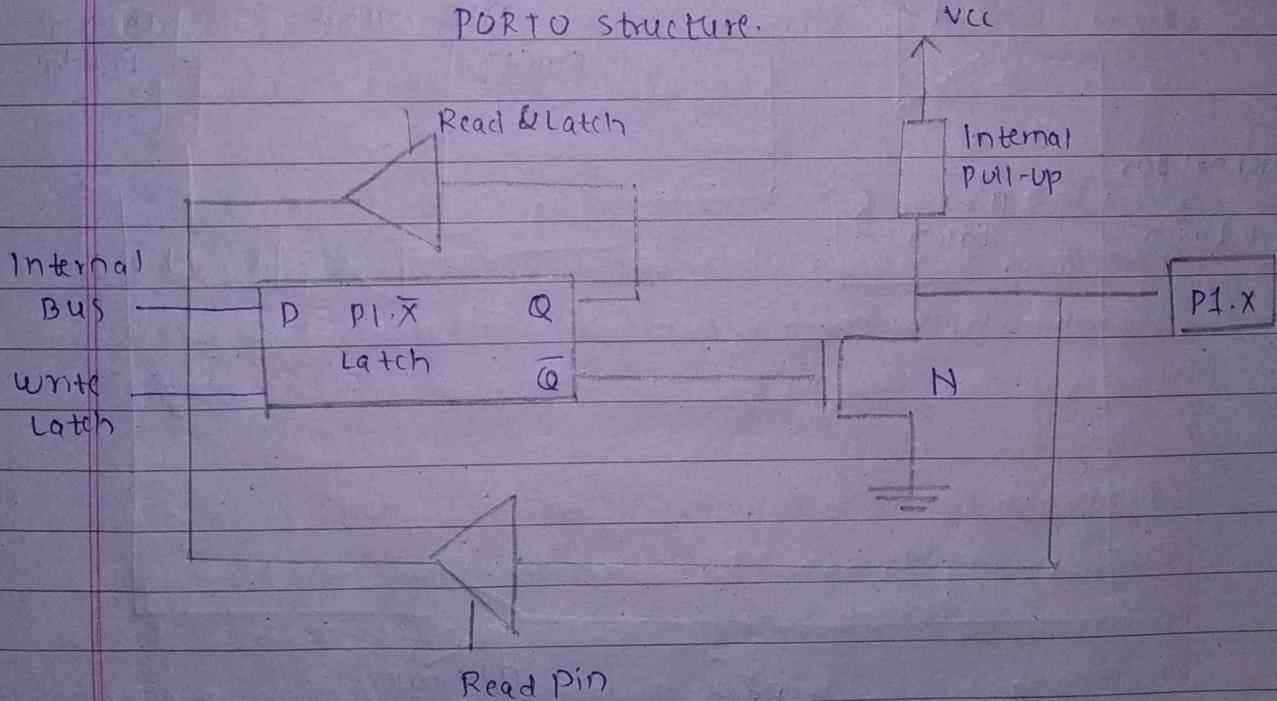
(G) (b)

Discuss the circuit and function of each Parallel port in Microcontroller.

- A) = ① A Parallel port is another type of computer port to connect a peripheral device to the computer system.
- ② As its name implies ; a parallel port can transmit multiple bits of data all together at same time.
- ③ Therefore in case of parallel ports , the rate of data transmission is relatively high as compared to series ports.
- ④ Parallel ports are mainly used to connect to those computer peripheral devices that require high bandwidth.
- ⑤ Parallel ports provide an interface to connect multiple lines to prepare a parallel communication to send large data at a time.
- ⑥ Parallel ports are used in connecting printers , hard-drives , CD-drives , etc. All line's speed should be same to avoid error & cross-talk issues. To avoid such issues , the wires are kept small in length.
- ⑦ A Parallel port uses a D-25 connector , a 25 pin D-shaped connector that connects to transmission wires.

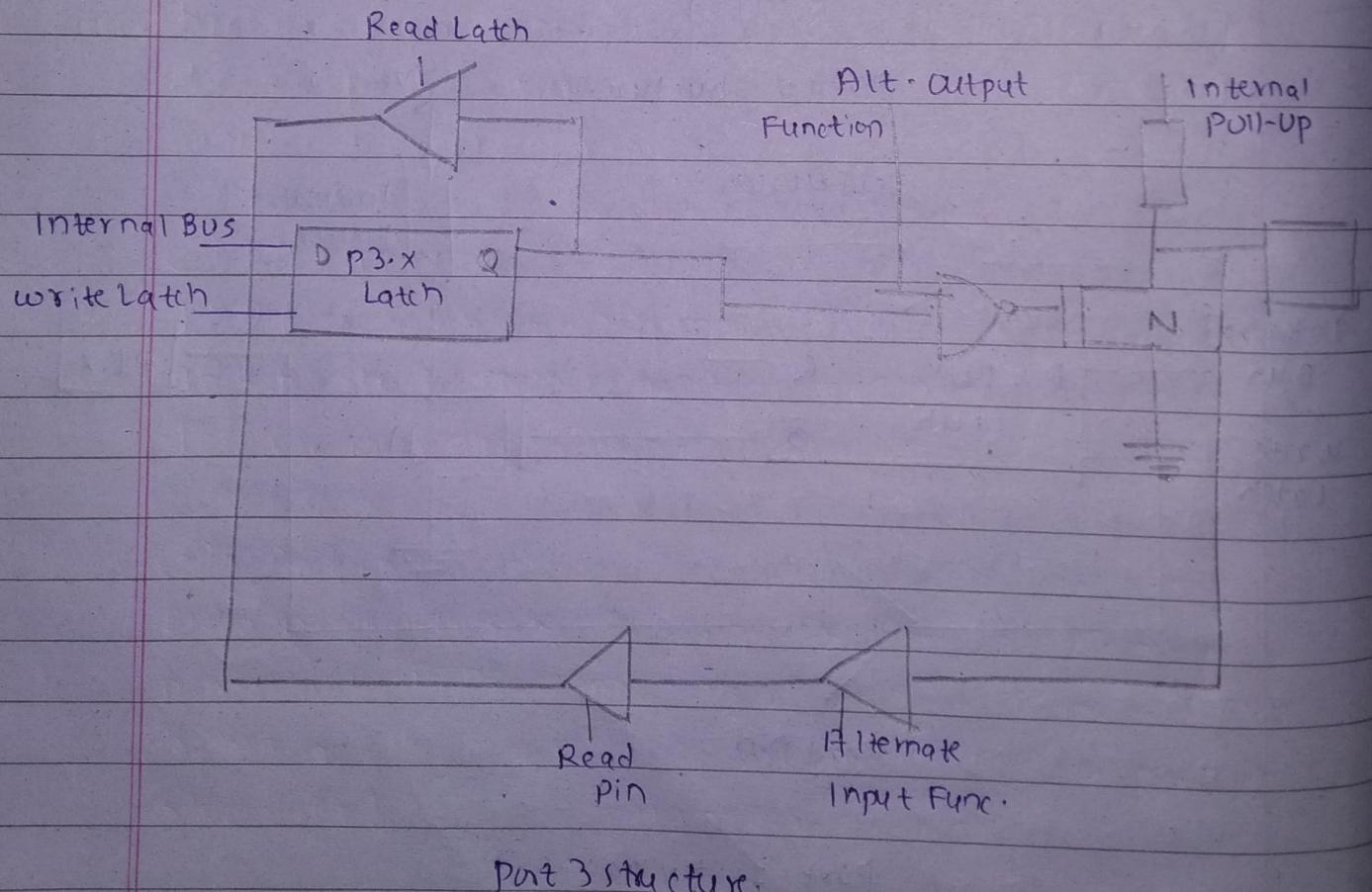
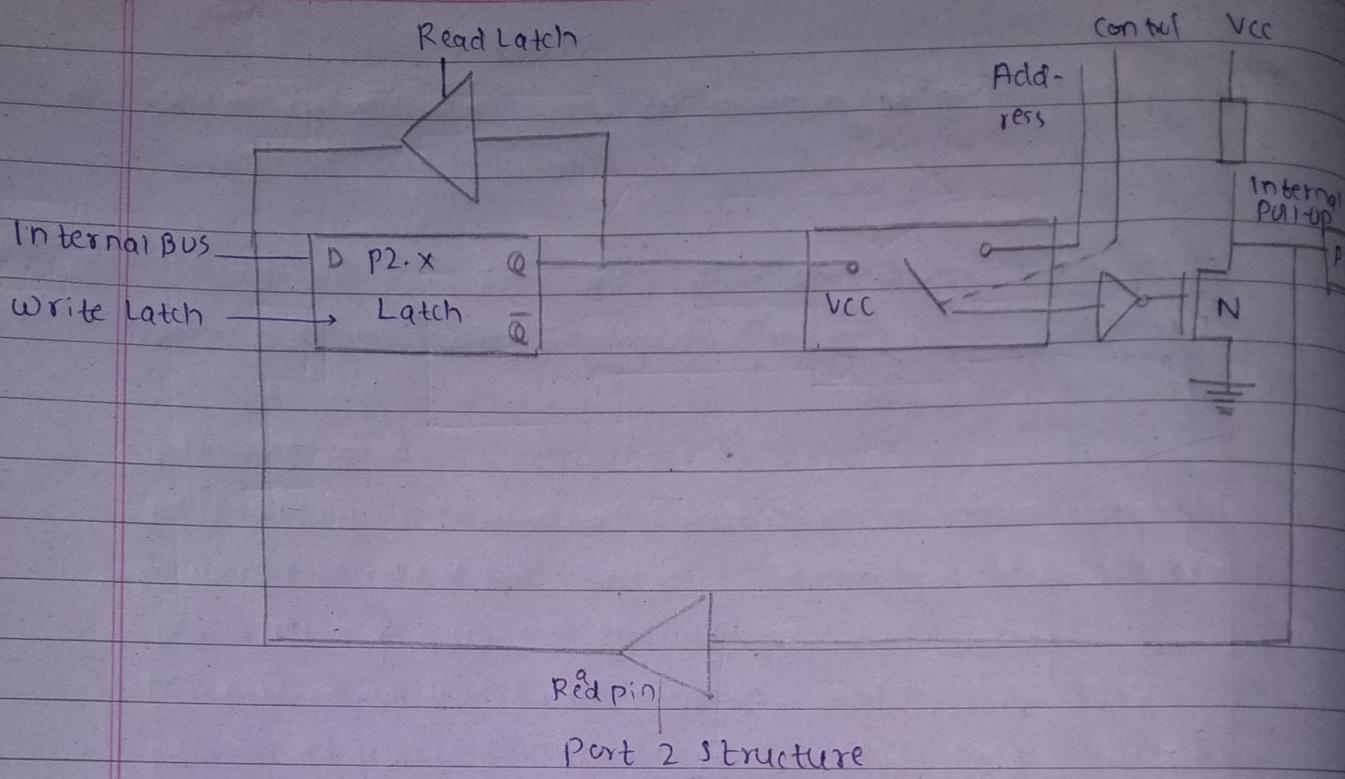


PORTO structure.



Port I structure.

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Port 3 structure.

(7) Why is external memory required for some members of 8051 family?

A) ① For minimal memory applications, the 8051 has internal data and code memory.

②

In such a position, For certain applications the memory will not be adequate.

③ To expand the memory space of the 8051 micro-controller, we must bind external ROM /EPROM and RAM.

④ We also know that ROM serves as program memory and RAM serves as Data Memory.

⑤ The reason for interfacing external Program Memory or ROM is that complex programs written in high-level languages often tend to be larger and occupy more memory.

⑥ Another important reason is that chips like 8031 & 8032, which doesn't have any internal ROM, have to be interfaced with external ROM.

(8) What are different types of memory used externally in 8051?

A)- Microcontrollers / microprocessors are produced essentially and externally with 3 types of memory:

① Flash Memory:

Flash Memory is "non-volatile", which means that when the power is shut off, the contents of the memory are not lost.

Flash Memory is used to store the program.

Flash Memory can be written a lot of times; so it is possible to update the microcontroller program without hardware replacements. However, do not use flash memory to store program variables because lifetime of memory will decrease very very rapidly.

② RAM memory:

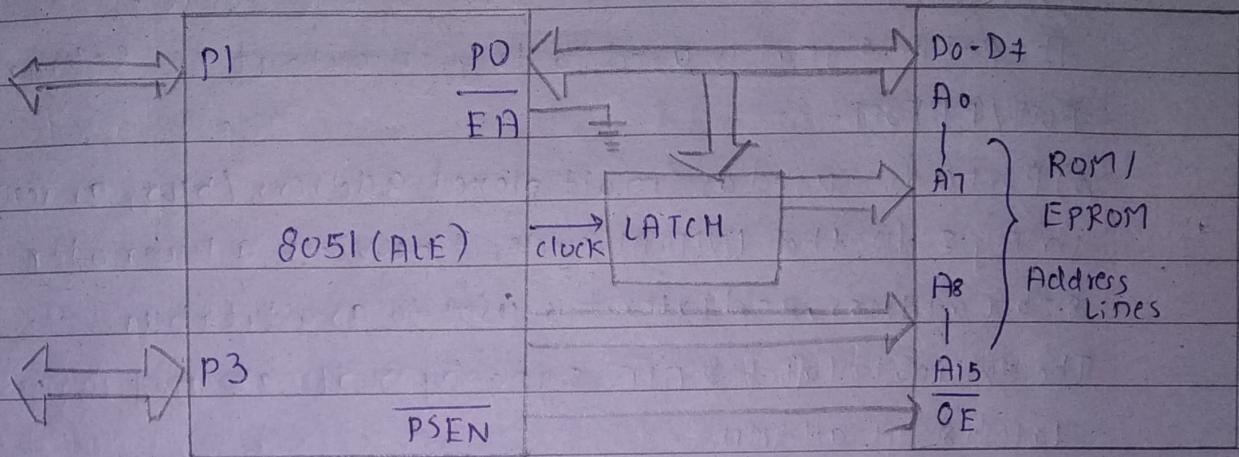
RAM () is volatile, which means, that when power is shut off, the contents of memory are lost. RAM Memory is used to store the variables during program execution.

③ EEPROM:

Electrically Erasable Programmable Read Only Memory is non-volatile. EEPROM memory offers slow response times both in reading & writing operations. It's used to permanently store data like device parameters, data, etc.

(g) with reg. dig. explain how external memory is interfaced with microcontroller.

a) ① External ROM interfacing:



- ① Port 0 is used as multiplexed data and address lines. It gives lower order (A7-A0) 8 bit address in initial T1 cycle & higher order (A8-A15) used as data bus.
- ② 8 bit address is latched using external latch & ALE Signal from 8051.
- ③ Port 2 provides higher order (A15-A8) 8 bit address.
- ④ PSEN used to activate output enable signal of external ROM / EPROM.

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(10) write a note on the use of following elements in interfacing of 8051 Microcontroller.

A) ① ALE: (Address Latch Enable):

ROM /EPROM that is external to the device.

The PSEN signal is used to trigger output i.e. external ROM /EPROM.

② Port 0 is used as multiplexed address / bus, as seen in Fig 2. In the INITIAL cycle, it provides a lower order 8-bit address, and later it is used as a data bus. The external latch & ALE signal by 8051 are used to latch 8-bit address.

③ P0 & P2 role in providing address:

Since the Program Counter is 16 bit, it is capable of accessing upto 64K bytes of program code. In 8051, port 0 and port 2 provide the 16 bit address to external areas. Of these two ports, P0 provides lower 8 bit address A₀-A₇ and P2 provides upper 8 bit address A₈-A₁₅. More importantly, P0 is used to provide the 8 bit data bus D₀-D₇.

To know the time when P0 is used for data path and when it is used to address path, ALE jobs comes in and it does its working.

(1) write a notes on data types in embedded C.

a) i) Unsigned Char:

- The 8051 is an 8 bit microcontroller
- The character data type is used.
- The unsigned char is an 8-bit data type.
- The range is (0U-FFH)
- ASCII characters.

b) Signed Char:

- The signed char is an 8-bit data type.
- It uses Most Significant Bits (MSB) i.e. D7 of D0-D7 or value.
- The value of bit is -128 to 127.

c) Bit & str:

- The bit data type allows access to single bits of bit addressable memory 20-2FH

d) Time Delay:

- It designed both fields of IC technology and microprocessor architectural design have seen great achievements.

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(12) What are Time Delays? Why are they required in Embedded program?

A1: ① There are 2 (two) ways to create a time delay in 8051 C.

① Using a simple for loop.

② Using the 8051 timers.

② The 8051 Design: In creating a time delay by using a for loop this factor affect accuracy of time delay.

③ The crystal frequency connected to the X1-X2 pins and duration of clock period for machine cycle is a function of crystal frequency.

④ The time delay is compiler used to compile C program. In this C prog. C compiler converts C statements into assembly language instructions.

(13) What are the factors affecting delay size.

A) The delay size in 8051 microcontroller depends on 3 factors:

1. The crystal frequency.

2. The number of clocks per machine.

3. the compiler.

The original 8051 used 1/12 of crystal oscillator frequency as one machine cycle. In other words each machine cycle is equal to 1/12th period of crystal frequency connected to X1-X2 pins of 8051. To speed up 8051, many recent versions of 8051 have reduced the number of clocks per machine cycle from 12 to four, or even 1. The frequency of timer is always 1/12th the frequency of crystal attached to 8051 regardless of 8051 version.

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(14) How can SFR addresses be used to access I/O ports.

A) ① One major feature of a microcontroller is the versatility built into input/output (I/O) circuit that connect the 8051 to outside world. As the design must add additional chips to interface with external circuitry; this ability is built into microcontroller.

② To be commercially viable, the 8051 had to incorporate as many functions as were technically and economically feasible. The main constraint that limits numerous functions is no. of pins available to 8051 circuit designers.

③ Given the pin flexibility, the 8051 may be applied simply as a single component with I/O only, or it may be expanded to include additional memory, parallel ports & serial data communication.

④ Each port has a D type output latch for each pin. The SFR for each port is made up of these eight latches, which can be addressed at SFR address for that port. For instance the eight latches for port 0 are addressed at loc. 80h; Port 0's pin 3 is bit 2 of P0 SFR. The port latches should not be confused with port pins.

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(15) Using logic operators , explain how packed BCD can be converted to unpacked BCD numbers.

A) Prog. for BCD to Unpacked.

```
#include <reg51.h>
Void main()
{
    unsigned char x,y,z;
    unsigned char mybyte=0x29;
    x=mybyte & 0XF0;
    p1= x | 0x30;
    y = mybyte & 0XF0;
    y = y >> 4;
    p2= y | 0x30;
}
```

Bitwise OR operation : ' | '

Bitwise AND operation: ' & '

Complement or negation: ' ~ '

Bitwise shift Left or Right = ' >>' & ' << '.

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- (b) Explain & write code segments for following datatype conversion.

(a) 87BCD to ASCII

```
#include <reg51.h>
void main(void)
{
    unsigned char x, y, z;
    unsigned char mybyte = 0x29;
    x = mybyte & 0x0F;
    P1 = x | 0X30;
    y = mybyte & 0xF0;
    y = y >> 4;
    P2 = y | 0X30;
}
```

(b) ASCII to BCD

```
#include <reg51.h>
void main(void)
{
    unsigned char bcdbyte;
    unsigned char w = '4';
    unsigned char z = '7';
    w = w & 0x0F; // mask 3
    w = w << 4; // shift left
    z = z & 0x0F; // mask 3
    bcdbyte = w | z; // combine
    P1 = bcdbyte;
}
```

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(c) Binary to decimal

```

#include <reg51.h>
void main (void)
{
    unsigned char x, binbyte, d1, d2, d3;
    binbyte = 0xFD;           // bin byte
    x = binbyte / 10;         // div by 10
    d1 = binbyte % 10;        // find remainder
    d2 = x / 10;              // middle
    d3 = x % 10;              // MSB
    P0 = d1;
    P1 = d2;
    P2 = d3;
}

```

(17) Which hardware factors are used in selecting controller?

A) ① A microcontroller has many uses in consumer electronics like toys and appliances; in communication devices like cell phones and computers, and in medical instruments, etc. It is essential to choose a microcontroller that is most appropriate for a project. There are many factors to consider.

② Power Efficiency: There is a trade off between processing performance and power consumption -

③ Temperature Tolerance: Depending on environment in which your microcontrollers operate, you may want devices that withstand such temperature.

④ Security: Hacking which targets IoT devices is rising, a threat that is especially relevant to microcontrollers used in automobiles.

⑤ Hardware Architecture: A Microcontroller's packaging directly influences its size & performance.

⑥ Processing Power: A multicore processor will be faster but would require more energy.

⑦ Memory: Amount of memory depends on program to be run

⑧ Cost: Microcontroller fall within a wide price range.