INTEL 8051 Microcontroller

AIM

- To learn the overview of microcontroller and its applications.

- To understand the impact of microcontroller in engineering applications.

OBJECTIVE

- Provide an overview of difference between microprocessor and micro controller.
- Provide background knowledge and core expertise in 8051 microcontroller.
- Provide an overview of architecture and the pin configuration of Intel 8051 microcontroller.
- Provide an overview about special function registers
- Discuss about application in 8051 microcontroller

PRE TEST

1)The binary number 11111010 is equivalent to hexadecimal number is ……..

a) FA b)AF c)2A d)F1

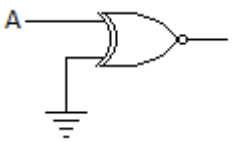
2) 2's complement of binary number 0101 is ……..

a) 1011 b) 1111 c) 1101 d)1110

3) A device which converts BCD to seven segments is called ……..

a) Encoder b) Decoder c) Multiplexer d)None of these

4) For the gate in the given figure the output will be ……..



a) 0 b) 1 c) A d) $\bar{A}$

4) The basic storage element in a digital system is …….
a) Flipflop b) counter c) multiplexer d)encoder

5) Which device has one input and many outputs?
a) Multiplexer b) Demultiplexer c) Counter d) Flip flop

6) The hexadecimal number $(3E8)_{16}$ is equal to decimal number ……
a) 1000 b) 982 c)768 d)323

7) A three state switch has three outputs. These are …….. , …….. , …….
a) low, low and high b) low, high, high c)low. floating, low d) low, high, floating

8) 1's complement of 11100110 is …….
a) 00011001 b)10000001 c)00011010 d)00000000

9) The hexadecimal number $(3E8)_{16}$ is equal to decimal number ……
a) 1000 b)982 c) 768 d)323

10) A counter type A/D converter contains a 4 bit binary ladder and a counter driven by a 2 MHz clock. Then conversion time is ……..
a) 8 μ sec b)10 μ sec c)2 μ sec d) 5 μ sec

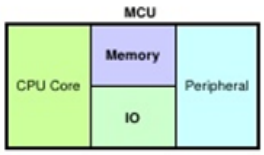
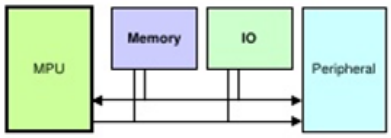
Answer

1) a 2) a 3) b 4) d 5) a 6) a 7) d 8) a 9) a 10) a

Introduction to Microcontroller

A **microcontroller** is a small and low-cost microcomputer, which is designed to perform the Specific tasks of embedded systems like displaying microwave's information, receiving remote signals, etc. The general microcontroller consists of the processor, the memory (RAM, ROM, and EPROM), Serial ports, peripherals (timers, counters), etc.

The following table highlights the differences between a microprocessor and a microcontroller

Classification	MCU	MPU
Chip	Embedded A CPU core, memory, peripherals, IO ... into a single chip.	Contain only the main processor (CPU core)
Block Diagram of a system		
General Application Area	- Self contained to complete a task. - Targeted for small, compact, and low cost system	-Need external memory, peripheral to accomplish a task - Targeted for complex, high performance and expandable system
Processor (CPU) Core	4, 8, 16 bit	32 bit or above
Examples	8051,pic16f887a,M16, H8, SH1/2	SH3/4,8085
Application	Washing machine, car side mirror, air con	Handphone, PDA

Types of Microcontrollers

Microcontrollers are divided into various categories based on memory, architecture, bits and Instruction sets.

Following is the list of their types –

A) Bit

Based on bit configuration, the microcontroller is further divided into three categories.

8-bit microcontroller − this type of microcontroller is used to execute arithmetic and logical operations like addition, subtraction, multiplication division, etc. For example, Intel 8031 and 8051 are 8 bits microcontroller.

16-bit microcontroller − this type of microcontroller is used to perform arithmetic and logical operations where higher accuracy and performance is required. For example, Intel 8096 is a 16-bit microcontroller.

32-bit microcontroller − this type of microcontroller is generally used in automatically controlled appliances like automatic operational machines, medical appliances, etc.

b) Memory Based on the memory configuration, the microcontroller is further divided into two categories.

External memory microcontroller − This type of microcontroller is designed in such a way that they do not have a program memory on the chip. Hence, it is named as external memory microcontroller. For example: Intel 8031 microcontroller.

Embedded memory microcontroller − this type of microcontroller is designed in such a way that the microcontroller has all programs and data memory, counters and timers, interrupts, I/O ports are embedded on the chip. For example: Intel 8051 microcontroller.

c) Instruction Set

Based on the instruction set configuration, the microcontroller is further divided into two Categories.

CISC − CISC stands for complex instruction set computer. It allows the user to insert a single instruction as an alternative to many simple instructions.

RISC − RISC stands for Reduced Instruction Set Computers. It reduces the operational time by shortening the clock cycle per instruction.

Applications of Microcontrollers

Microcontrollers are widely used in various different devices such as −

Light sensing and controlling devices like LED.

Temperature sensing and controlling devices like microwave oven, chimneys.

Fire detection and safety devices like Fire alarm.

Measuring devices like Volt Meter.

Introduction to 8051 microcontroller

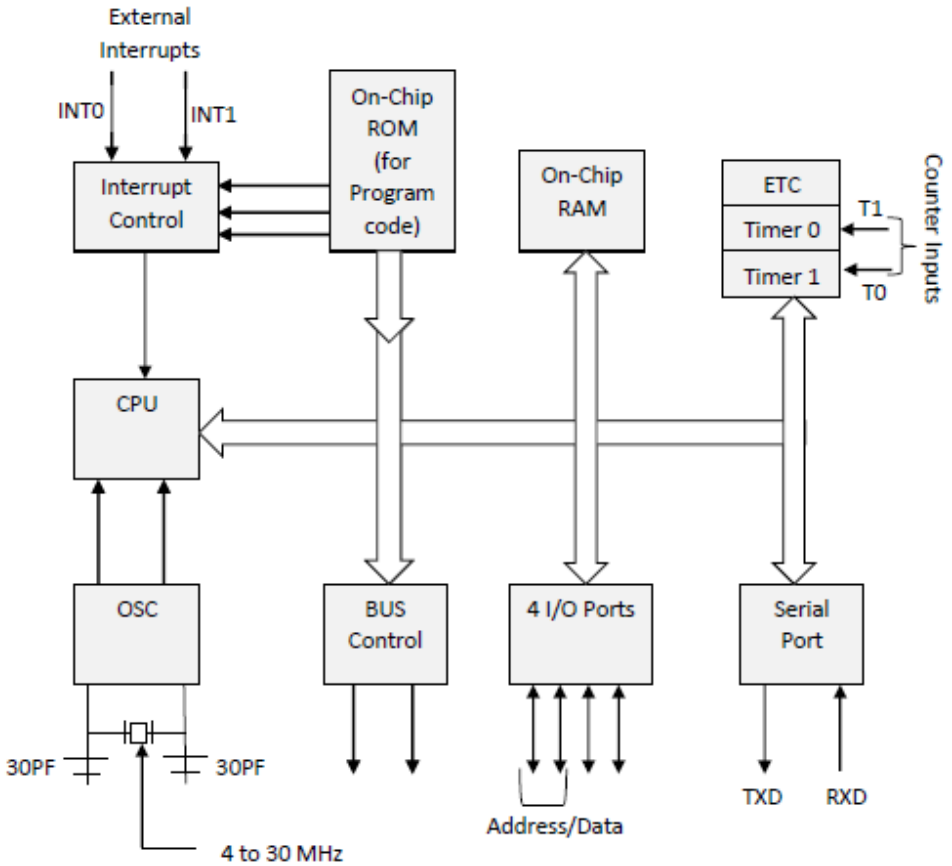
8051 microcontroller is designed by Intel in 1981. It is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, 2 16-bit timers. It consists of are four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the microcontroller having crystal frequency of 12 MHz.

Features of 8051 MC

- 4K bytes internal ROM
- 128 bytes internal RAM
- Four 8-bit I/O ports (P0 - P3).
- Two 16-bit timers/counters
- One serial interface
- only 1 On chip oscillator (external crystal)
- 6 interrupt sources (2 external , 3 internal, Reset)
- 64K external code (program) memory(only read)PSEN
- 64K external data memory(can be read and write) by RD,WR
- Code memory is selectable by EA (internal or external)

Let us now discuss the **architecture of 8051 Microcontroller**.

In the following diagram, the system bus connects all the support devices to the CPU. The system bus consists of an 8-bit data bus, a 16-bit address bus and bus control signals. All other devices like program memory, ports, data memory, serial interface, interrupt control, timers, and the CPU are all interfaced together through the system bus.



The **pin diagram of 8051 microcontroller** looks as follows –

Pins 1 to 8 − these pins are known as Port 1. This port doesn't serve any other functions. It is internally pulled up, bi-directional I/O port.

Pin 9 − It is a RESET pin, which is used to reset the microcontroller to its initial values.

Pins 10 to 17 − these pins are known as Port 3. This port serves some functions like interrupts, timer input, control signals, serial communication signals RxD and TxD, etc.

Port Pin	Alternate Function
P3.0	RXD (serial input port)
P3.1	TXD (serial output port)
P3.2	$\overline{\text{INT0}}$ (external interrupt 0)
P3.3	$\overline{\text{INT1}}$ (external interrupt 1)
P3.4	T0 (Timer 0 external input)
P3.5	T1 (Timer 1 external input)
P3.6	$\overline{\text{WR}}$ (external data memory write strobe)
P3.7	$\overline{\text{RD}}$ (external data memory read strobe)

Pins 18 & 19 − these pins are used for interfacing an external crystal to get the system clock.

Pin 20 − this pin provides the power supply to the circuit.

Pins 21 to 28 − these pins are known as Port 2. It serves as I/O port. Higher order address bus signals are also multiplexed using this port.

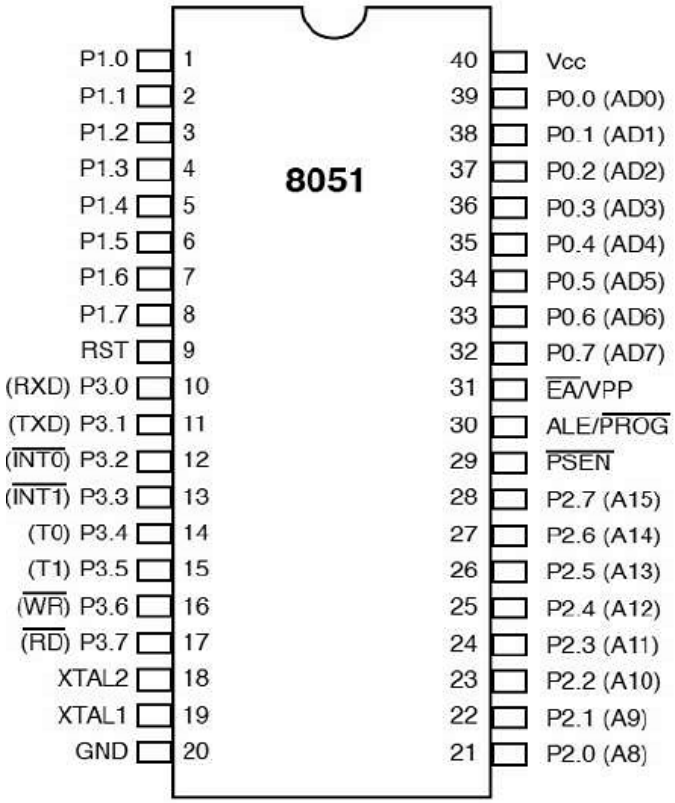
Pin 29 − this is PSEN pin which stands for Program Store Enable. It is used to read a signal from the external program memory.

Pin 30 − this is EA pin which stands for External Access input. It is used to enable/disable the external memory interfacing.

Pin 31 − this is ALE pin which stands for Address Latch Enable. It is used to demultiplex the address-data signal of port.

Pins 32 to 39 − these pins are known as Port 0. It serves as I/O port. Lower order address and data bus signals are multiplexed using this port.

Pin 40 − this pin is used to provide power supply to the circuit.

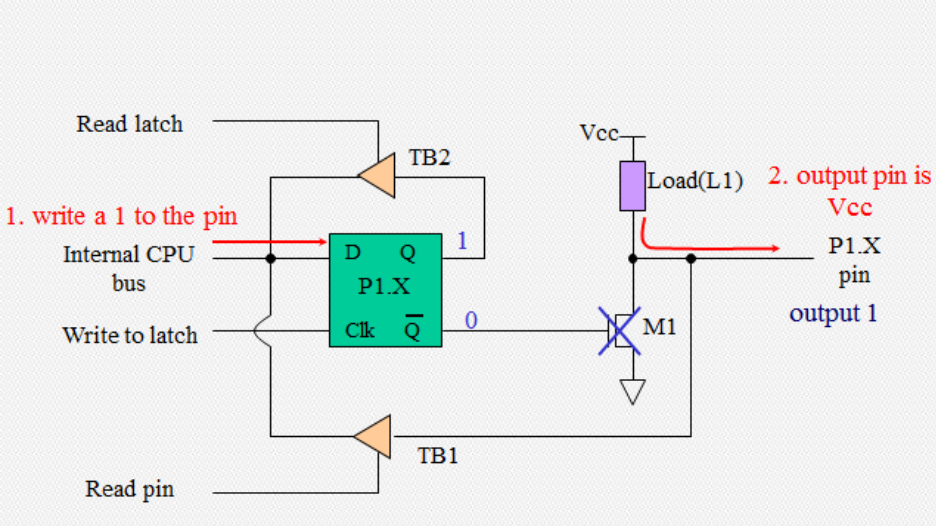


8051 microcontrollers have 4 I/O ports each of 8-bit, which can be configured as input or output. Hence, total 32 input/output pins allow the microcontroller to be connected with the peripheral devices.

Pin configuration, i.e. the pin can be configured as 1 for input and 0 for output as per the logic state.

Input/Output (I/O) pin − All the circuits within the microcontroller must be connected to one of its pins except P0 port because it does not have pull-up resistors built-in.

Input pin − Logic 1 is applied to a bit of the D register. The output of transistor is turned off and the other pin remains connected to the power supply voltage over a pull-up resistor of high resistance.



Port 0 − The P0 (zero) port is characterized by two functions −

When the external memory is used then the lower address byte (addresses A0A7) is applied on it, else all bits of this port are configured as input/output.

When P0 port is configured as an output then other ports consisting of pins with built-in pull-up resistor connected by its end to 5V power supply, the pins of this port have this resistor left out.

Input Configuration

If any pin of this port is configured as an input, then it acts as if it "floats", i.e. the input has unlimited input resistance and in-determined potential.

Output Configuration

When the pin is configured as an output, then it acts as an "open drain". By applying logic 0 to a port bit, the appropriate pin will be connected to ground (0V), and applying logic 1, the external output will keep on "floating". In order to apply logic 1 (5V) on this output pin, it is necessary to build an external pullup resistor.

Port 1

P1 is a true I/O port as it doesn't have any alternative functions as in P0, but this port can be configured as general I/O only. It has a built-in pull-up resistor and is completely compatible with TTL circuits.

Port 2

P2 is similar to P0 when the external memory is used. Pins of this port occupy addresses intended for the external memory chip. This port can be used for higher address byte with addresses A8-A15. When no memory is added then this port can be used as a general input/output port similar to Port 1.

Port 3

In this port, functions are similar to other ports except that the logic 1 must be applied to appropriate bit of the P3 register.

Pins Current Limitations

When pins are configured as an output (i.e. logic 0), then the single port pins can receive a current of 10mA.

When these pins are configured as inputs (i.e. logic 1), then built-in pull-up resistors provide very weak current, but can activate up to 4 TTL inputs of LS series.

If all 8 bits of a port are active, then the total current must be limited to 15mA (port P0: 26mA).

If all ports (32 bits) are active, then the total maximum current must be limited to 71mA.

Interrupt of 8051 microcontroller

Interrupts are the events that temporarily suspend the main program, pass the control to the external sources and execute their task. It then passes the control to the main program where it had left off.

8051 has 5 interrupt signals, i.e. INT0, TFO, INT1, TF1, RI/TI. Each interrupt can be enabled or disabled by setting bits of the IE register and the whole interrupt system can be disabled by clearing the EA bit of the same register.

Steps in executing an interrupt

- Upon receiving the interrupt signal the Microcontroller , finish current instruction and saves the PC on stack
- Jumps to a fixed location in memory depending on type of interrupt
- Starts to execute the interrupt service routine until RETI (return from interrupt)

- Upon executing the RETI the microcontroller returns to the place where it was interrupted. Get pop PC from stack
- Each interrupt has a specific place in code memory where program execution (interrupt service routine) begins.
- External Interrupt 0: 0003h
- Timer 0 overflow: 000Bh
- External Interrupt 1: 0013h
- Timer 1 overflow: 001Bh
- Serial : 0023h
- Timer 2 overflow(8052+) 002bh

IE (Interrupt Enable) Register

This register is responsible for enabling and disabling the interrupt. EA register is set to one for enabling interrupts and set to 0 for disabling the interrupts. Its bit sequence and their meanings are shown in the following figure.

EA	-	-	ES	ET1	EX1	ET0	EX0

EA - It disables all interrupts. When EA = 0 no interrupt will be acknowledged and EA = 1 enables the interrupt individually.

ES - Enables/disables serial port interrupt.

ET1 - Enables/disables timer1 overflow interrupt.

EX1 - Enables/disables external interrupt1.

ET0 - Enables/disables timer0 overflow interrupt.

EX0 - Enables/disables external interrupt0.

IP (Interrupt Priority) Register

We can change the priority levels of the interrupts by changing the corresponding bit in the Interrupt Priority (IP) register as shown in the following figure.

A low priority interrupt can only be interrupted by the high priority interrupt, but not interrupted by another low priority interrupt.

If two interrupts of different priority levels are received simultaneously, the request of higher priority level is served.

If the requests of the same priority levels are received simultaneously, then the internal polling sequence determines which request is to be serviced.

-	-	PT2	PS	PT1	PX1	PT0	PX0
bit7	bit6	bit5	bit4	bit3	bit2	bit1	

PS - It defines the serial port interrupt priority level.

PT1 - It defines the timer interrupt of 1 priority.

PX1 - It defines the external interrupt priority level.

PT0 - It defines the timer0 interrupt priority level.

PX0 - It defines the external interrupt of 0 priority level.

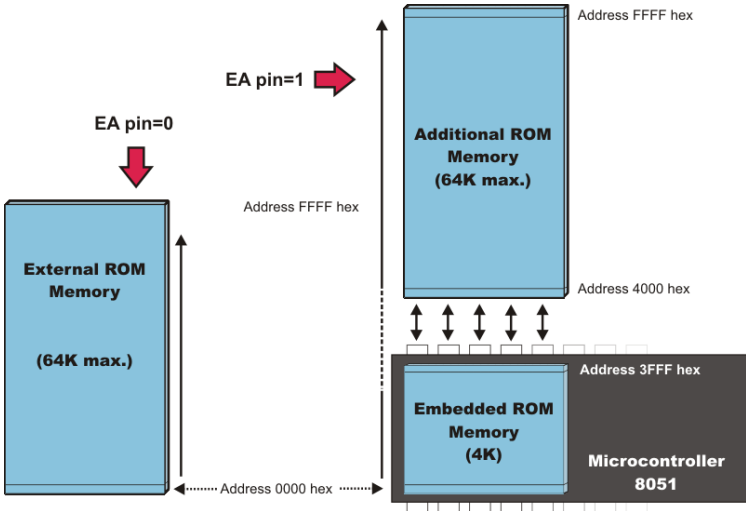
TCON register specifies the type of external interrupt to the microcontroller.

8051 Memory Organization

The 8051 microcontroller's memory is divided into Program Memory and Data Memory. Program Memory (ROM) is used for permanent saving program being executed, while Data Memory (RAM) is used for temporarily storing and keeping intermediate results and variables.

Program Memory (ROM)

Program Memory (ROM) is used for permanent saving program (CODE) being executed. The memory is read only. Depending on the settings made in compiler, program memory may also use to store constant variables. The 8051 executes programs stored in program memory only. code memory type specified is used to refer to program memory. 8051 memory organization allows external program memory to be added.

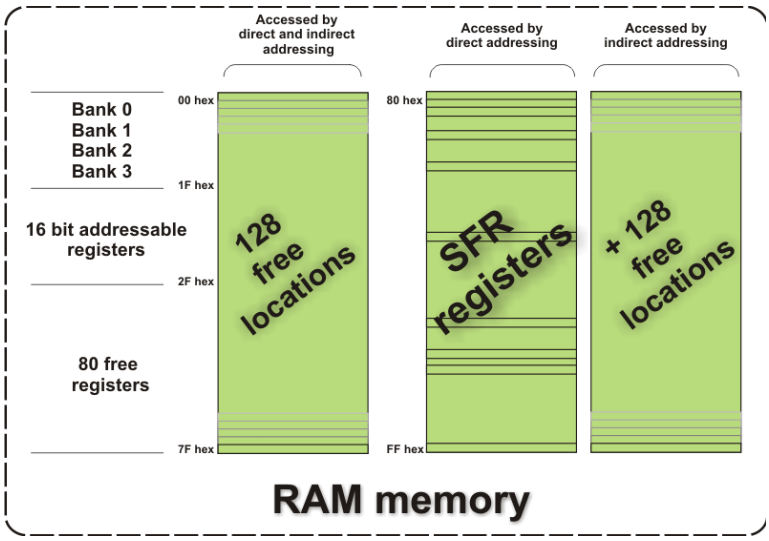


Internal Data Memory

Up to 256 bytes of internal data memory are available depending on the 8051 derivative. Locations available to the user occupy addressing space from 0 to 7Fh, i.e. first 128 registers and this part of RAM is divided in several blocks. The first 128 bytes of internal data memory are both directly and indirectly addressable. The upper 128 bytes of data memory (from 0x80 to0xFF) can be addressed only indirectly. Since internal data memory is used for CALL stack also and there is only 256 bytes splited over few different memory areas fine utilizing of this memory is crucial for fast and compact code.

Memory block in the range of 20h to 2Fh is bit-addressable, which means that each bit being there has its own address from 0 to 7Fh. Since there are 16 such registers, this block contains in total of 128 bits with separate addresses (Bit 0 of byte 20h has the bit address 0, and bit 7 of byte 2Fh has the bit address 7Fh).

Three memory types specifies can be used to refer to the internal data memory: **data**, **idata**, and **bdata**.



External Data Memory

Access to external memory is slower than access to internal data memory. There may be up to 64K Bytes of external data memory. Several 8051 devices provide on-chip XRAM space that is accessed with the same instructions as the traditional external data space. This XRAM space is typically enabled via proper setting of SFR register and overlaps the external memory space. Setting of that register must be manually done in code, before any access to external memory or XRAM space is made.

The mikroC PRO for 8051 has two memory types specifies that refers to external memory space: **xdata** and **pdata**.

SFR Memory

The 8051 provides 128 bytes of memory for Special Function Registers (SFRs). SFRs are bit, byte, or word-sized registers that are used to control timers, counters, serial I/O, port I/O, and peripherals.

8051 Timer/Counter:

8051 Timer/Counter Two internal Timers/Counters 16-bit timer/counter Timer uses system clock as source of input pulses Counter uses external input pulses from port 3 (T0,T1) If associated interrupt is enabled, when count overflow an interrupt is generated Registers TH0, TL0 : timer/counter register of timer 0 TH1, TL1 : timer/counter register of timer 1

TMOD: Mode Select register, TCON: Control Register

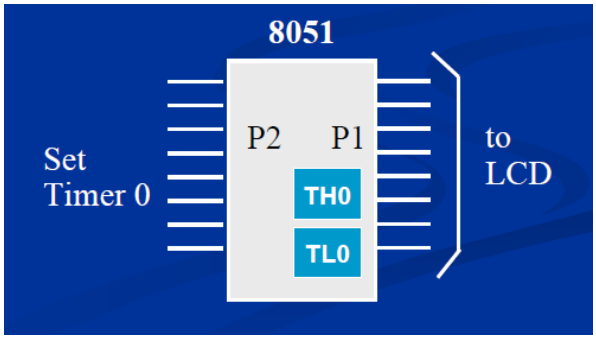
Timer

Set the initial value of registers

Start the timer and then the 8051 counts up.

Input from internal system clock (machine cycle)

When the registers equal to 0 and the 8051 sets a bit to denote time out



Counter

- Count the number of events

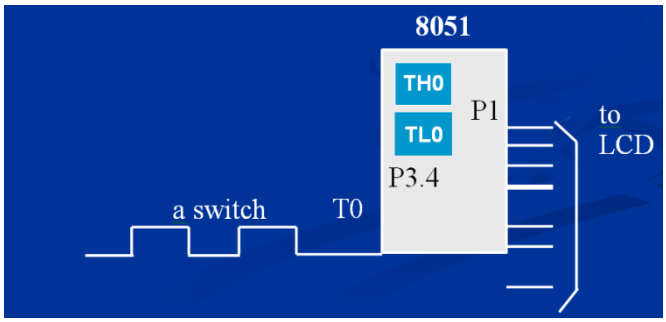
Show the number of events on registers

External input from T0 input pin (P3.4) for Counter 0

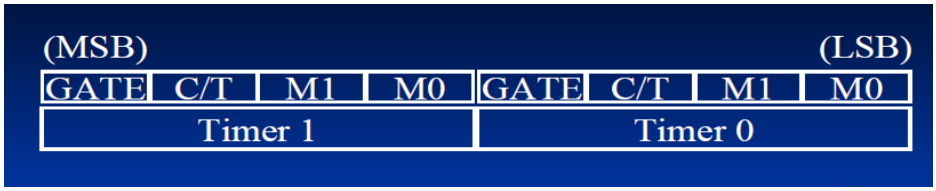
External input from T1 input pin (P3.5) for Counter 1

External input from Tx input pin.

We use Tx to denote T0 or T1.



TMOD Register



- Both Timer 0 &Timer 1 use the same Mode register TMOD
- ❑ It is an-8-bit register .The lower 4-bits are meant for
- ❑ Timer 0 &the upper 4-bits are meant for Timer 1
- ❑ It is not bit addressable.
- ❑ It is used similar to any other register of 8051. For ex:

  MOV TMOD, #21H

- Every timer has a mean of starting and stopping.

GATE=0

Internal control

The start and stop of the timer are controlled by way of software

Set/clear the TR for start/stop timer

SETB TR0

CLR TR0

GATE=1

External control

The hardware way of starting and stopping the timer by software and an external source.

Timer/counter is enabled only while the INT pin is high and the TR control pin is set (TR).

- C/T: Timer or counter selected cleared for timer operation (input from internal system clock). Set for counter operation (input from Tx input pin).
- M1, M0: Used for mode selection, because the Timers of 8051 can be set in 4-different modes.

M1	M0	Mode	Operation
0	0	0	13-bit timer mode 8-bit THx + 5-bit TLx (x= 0 or 1)
0	1	1	16-bit timer mode 8-bit THx + 8-bit TLx
1	0	2	8-bit auto reload 8-bit auto reload timer/counter; THx holds

			a value which is to be reloaded into TLx each time it overflows.
1	1	3	Split timer mode

TCON Register

- Timer control register TMOD is a 8-bit register which is bit addressable and in which Upper nibble is for timer/counter,
- lower nibble is for interrupts
- TR (Timer run control bit)

  TR0 for Timer/counter 0; TR1 for Timer/counter 1.

  TR is set by programmer to turn timer/counter on/off.

  TR=0 : off (stop)

  TR=1 : on (start)
- TF (timer flag, control flag)

  TF0 for timer/counter 0; TF1 for timer/counter 1.

  TF is like a carry. Originally, TF=0. When TH-TL roll over to 0000 from FFFFH, the TF is set to 1.

  TF=0 : not reach

  TF=1: reach

  If we enable interrupt, TF=1 will trigger ISR.

Operation Modes

Mode 0

13-bit counter, an interrupt is generated when counter overflows.

It takes 8192 input pulses to generate the next interrupt.

Mode 1

16-bit counter, similar to mode 0, but take 65536 input pulses

Mode 2

8-bit reload

TL1 operates as timer/counter

TH1 store a number and reload to TL1 when overflows

Mode 3

Timer 1 is inactive, hold count value.

TL0 and TH0 operate as two separate 8-bit timer/counter

TL0 control by timer 0 control bits

TH0 operate as timer driven by system clock, prescaled by 12 and cause timer 1 interrupt Overflows

Working of Timer Mode 1

let us consider timer 0 as an example.

- **16-bit** timer (TH0 and TL0)
- TH0-TL0 is incremented continuously when TR0 is set to 1.
- 8051 stops to increment TH0-TL0 when TR0 is cleared.
- The timer works with the internal system clock. In other words, the timer counts up each machine cycle.
- When the timer (TH0-TL0) reaches its maximum of FFFFH, it rolls over to 0000, and TF0 is raised.
- Programmer should check TF0 and stop the timer 0.
- 1. Choose mode 1 timer 0

  MOV TMOD,#01H

- 2. Set the original value to TH0 and TL0.

  MOV TH0,#FFH

  MOV TL0,#FCH

- 3. You better to clear the TF: TF0=0.

  CLR TF0

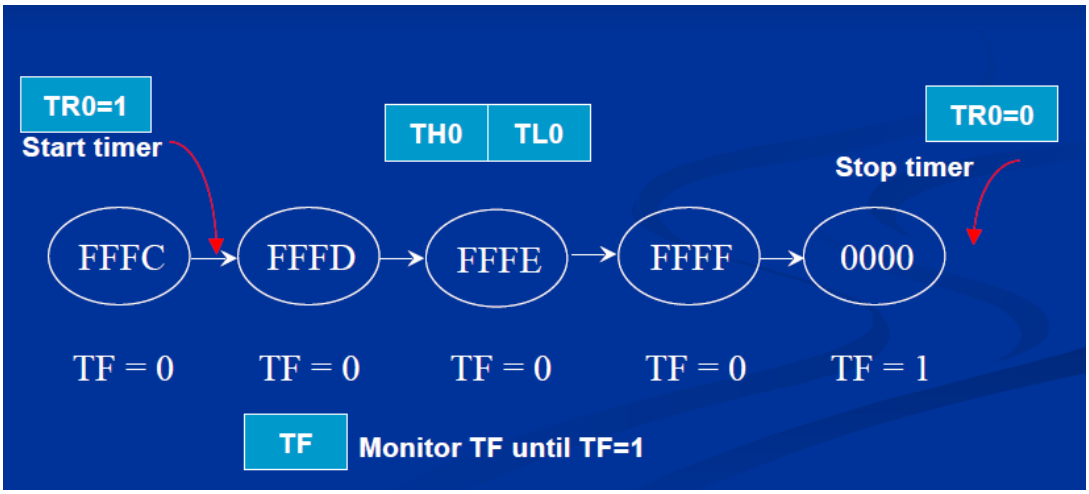
➢ 4. Start the timer.

SETB TR0

Steps of Mode 1

The 8051 starts to count up by incrementing the TH0-TL0

TH0-TL0= FFFCH,FFFDH,FFFEH,FFFFH,0000H



- When TH0-TL0 rolls over from FFFFH to 0000, the 8051 set TF0=1.

  TH0-TL0= FFFE H, FFFF H, 0000 H (Now TF0=1)

- Keep monitoring the timer flag (TF) to see if it is raised.

  AGAIN: JNB TF0, AGAIN

- Clear TR0 to stop the process.

  CLR TR0

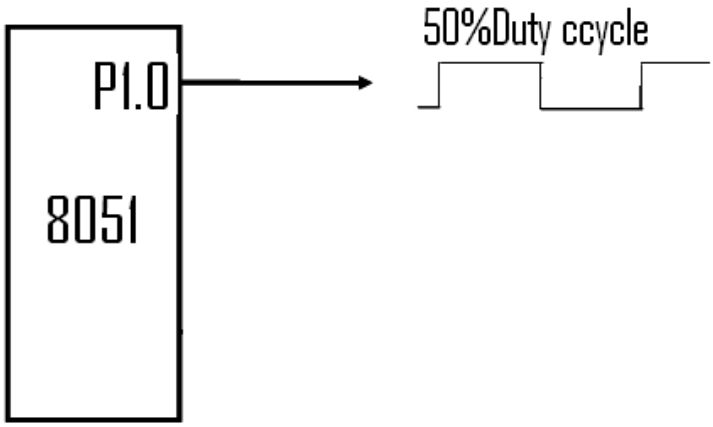
- Clear the TF flag for the next round.

  CLR TF0

Application

- **Generation of Square wave using ports**

```
HERE : SETB P1.0 (Make bit of Port 0 High)
       LCALL DELAY
       CLR P1.0
       LCALL DELAY
       SJMP HERE : Keep doing it
DELAY:
       MOV A,#FF
  L1   DCR A
       JNZ LI
       RET
```

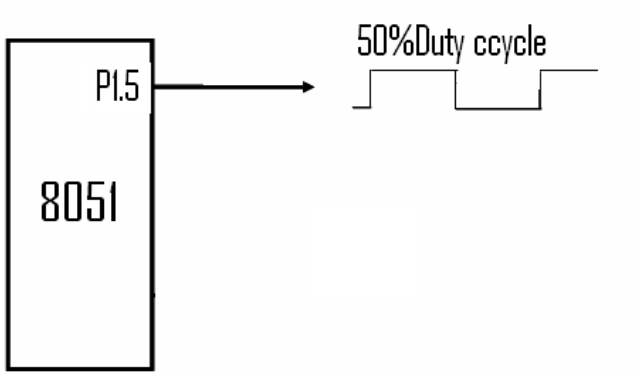


- **Generation of square wave using Timer**

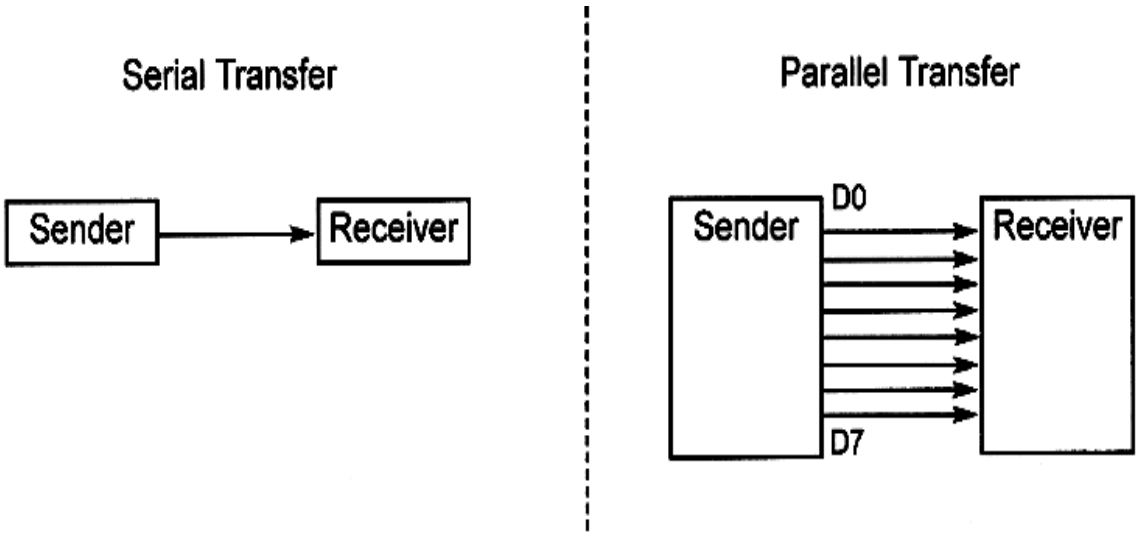
Square wave of 50% duty on P1.5 Timer 0 is used

```
MOV TMOD,#01          Timer 0,mode 1(16-bit)
HERE: MOV TL0,#0F2H   Timer value = FFF2H
MOV TH0,#0FFH
CPL P1.5
```

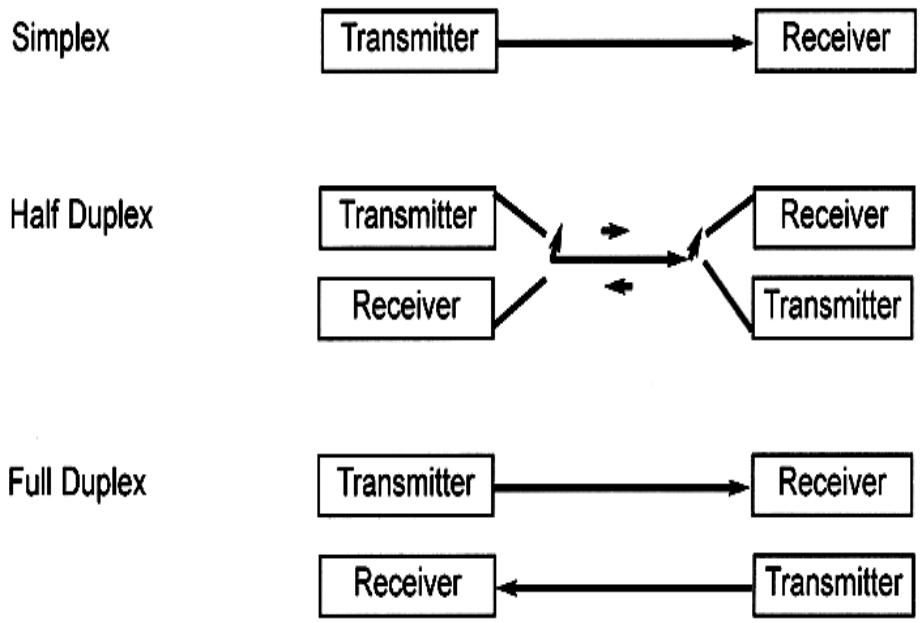
```
    ACALL DELAY
    SJMP HERE
DELAY:
SETB TR0                start the timer 0
AGAIN: JNB TF0,AGAIN
CLR TR0                 stop timer 0
CLR TF0                 clear timer 0 flag
RET
```



8051- SERIAL COMMUNICATION

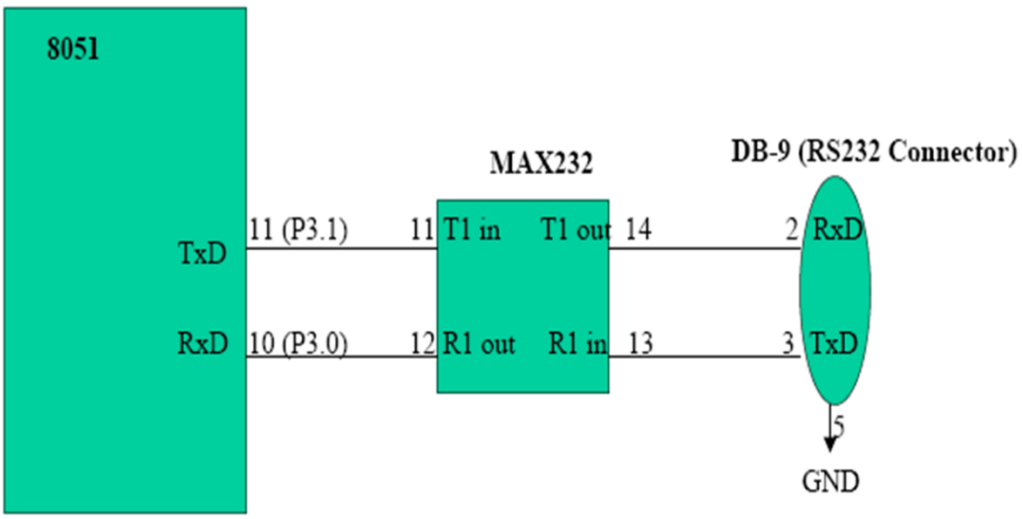


Types of Serial communications



- The 8051 has two pins for transferring and receiving data by serial communication.
- These two pins are part of the Port3(P3.0 &P3.1)
- These pins are TTL compatible and hence they require a line driver to make them RS232 compatible
- Max232 chip is one such line driver in use.
- Serial communication is controlled by an 8-bit register called SCON register; it is a bit addressable register.

Interfacing to PC



SCON (Serial control) register

- These two bits of SCON register determine the framing of data by specifying the number of bits per character and start bit and stop bits. There are 4 serial modes.

SM0	SM1	
0	0	Serial Mode 0
0	1	Serial Mode 1, 8 bit data,1 stop bit, 1 Start bit
1	0	Serial Mode 2
1	1	Serial Mode 3

- **REN** (Receive Enable) also referred as SCON.4.When it is high; it allows the 8051 to receive data on the RxD pin. So to receive and transfer data REN must be set to 1.When REN=0, the receiver is disabled. This is achieved as below

SETB SCON.4

& CLR SCON.4

- **TI** (Transmit interrupt) is the D1 bit of SCON register. When 8051 finishes the transfer of 8-bit character, it raises the TI flag to indicate that it is ready to transfer another byte. The TI bit is raised at the beginning of the stop bit.

- **RI** (Receive interrupt) is the D0 bit of the SCON register. When the 8051 receives data serially, via RxD, it gets rid of the start and stops bits and places the byte in the

SBUF register. Then it raises the RI flag bit to indicate that a byte has been received and should be picked up before it is lost. RI is raised halfway through the stop bit.

SM0	SM1	SM2	REN	TB8	RB8	TI	RI

SM0	SCON.7	Serial port mode specifier
SM1	SCON.6	Serial port mode specifier
SM2	SCON.5	Used for multiprocessor communication. (Make it 0)
REN	SCON.4	Set/cleared by software to enable/disable reception.
TB8	SCON.3	Not widely used.
RB8	SCON.2	Not widely used.
TI	SCON.1	Transmit interrupt flag. Set by hardware at the beginning of the stop bit in mode 1. Must be cleared by software.
RI	SCON.0	Receive interrupt flag. Set by hardware halfway through the stop bit time in mode 1. Must be cleared by software.

Post test

1) 8051 series has how many 16 bit registers?
   a) 2
   b) 3
   c) 1
   d) 0

Ans a

2) What is the bit size of the 8051 microcontroller?
   a) 8-bit
   b) 4-bit
   c) 16-bit
   d) 32-bit

Ans a

3) Number of I/O ports in the 8051 microcontroller?
   a) 3 ports
   b) 4 ports
   c) 5 ports

d) 4 ports with last port having 5 pins

Ans b

4) SCON in serial port is used for which operation?
   a) Transferring data
   b) Receiving data
   c) Controlling
   d) Controlling and transferring

Ans c

5) Program counter stores what?
   a) Address of before instruction
   b) Address of the next instruction
   c) Data of the before execution to be executed
   d) Data of the execution instruction

Ans b

6) External Access is used to permit _____
   a) Peripherals
   b) Power supply
   c) ALE
   d) Memory interfacing

Ans d

7) What is the address range of SFRs?
   a) 80h to feh
   b) 00h to ffh
   c) 80h to ffh
   d) 70h to 80h

Ans c

8) How many interrupts are there in micro controller?
   a) 3
   b) 6
   c) 4
   d) 5

Ans d

9) Timer 0 is a _____ bit register.
   a) 32-bit
   b) 8-bit
   c) 16-bit

d) 10-bit

Ans c

10) Number of pins in 8051 microcontroller with _____ package.
a) 40 pin with LLC
b) 60 Pin with QFP
c) 40 pin with DIP
d) 60 pin with QFP

Ans c

Conclusion

- ✓ Thus the difference between microprocessor and microcontroller has been discussed.
- ✓ Give an understanding about the concepts, basic architecture, pin configuration, special function register and application of 8051 microcontroller.

Reference

1. Kenneth J.Ayala, "The 8051 microcontroller Architecture, Programming and applications" ,Third edition,Cengage Learning India pvt ltd,2009.
2. D.Karunasagar,"The 8051 microcontroller" ,CengageNarosa Publication HousePvt. Ltd, 1st Edition 2011.
3. Mohamed Ali Mazidi,JaniceGillispieMazidi," The 8051 microcontroller and embedded systems using Assembly and C",second edition, Pearson education /Prentice hall of India, 2007.

Assignments

1. Describe briefly about architecture of 8051 microcontroller.
2. Explain the pin configuration of 8051 microcontroller.
3. Explain how to generate square wave form using timer.
4. Describe briefly about special function register.