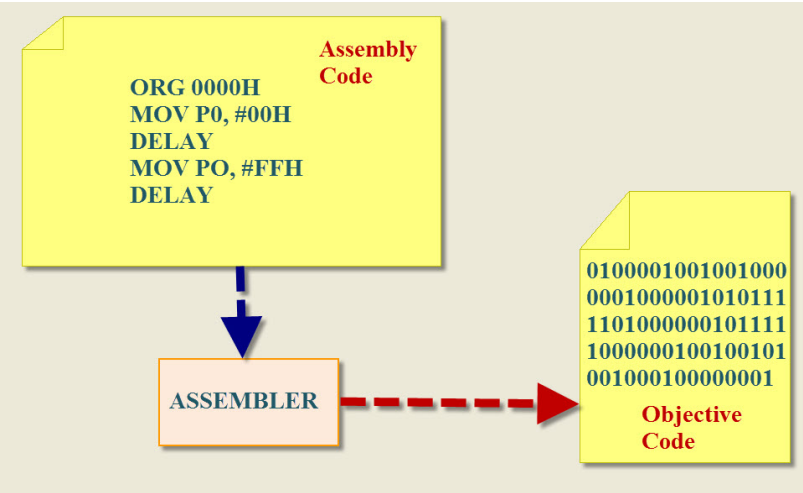
Introduction to 8051 Programming in As Language

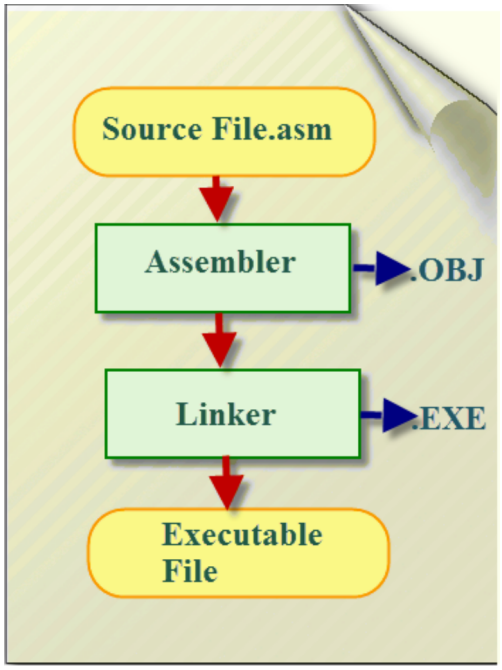
The assembly language is a low-level programming language used to write program code in terms of mne there are many high-levellanguages that are currently in demand, assembly programming language is pc applications.It can be used for direct hardware manipulations. It is also used to write the 8051 program with less number of clock cycles by consuming less memory compared to the other high-level languages.



8051 Programming

8051 Programming in Assembly Language

The assembly language is a fully hardware related programming language. The embedded designers knowledge on hardware of particular processor or controllers before writing the program. The assembly l by mnemonics; therefore, users cannot understand it easily to modify the program.

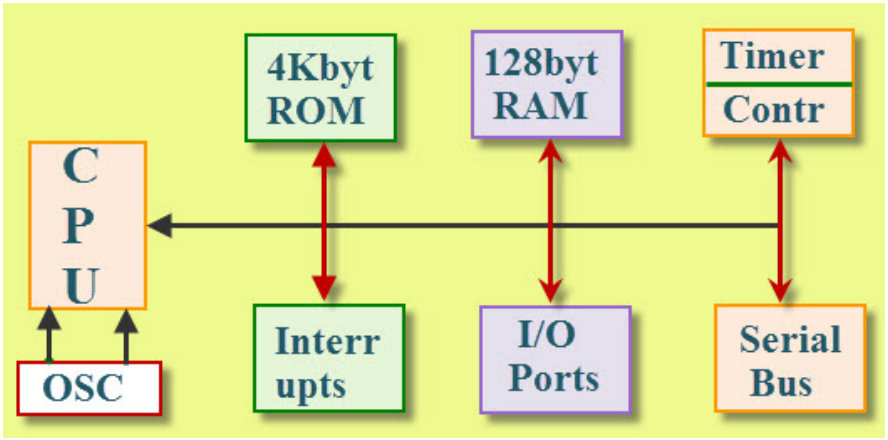


8051 Programming in Assembly Language

Assembly programming language is developed by various compilers and the "keiluvison" is best suitabl programming development. Microcontrollers or processors can understand only binary language in the assembler converts the assembly language to binary language, and then stores it in the microcontroller m specific task.

8051 Microcontroller Architecuture

The 8051 microcontroller is the CISC based Harvard architecture, and it has peripherals like 32 I/O, ti communication and memories. The microcontroller requires a program to perform the operations that saving and to read the functions. The 8051 microcontroller consists of RAM and ROM memories to store ins



8051 Microcontroller Architecuture

A Register is the main part in the processors and microcontrollers which is contained in the memory that

of collecting and storing the data. The 8051 assembly language programming is based on the memory re manipulate data to a processor or controller by performing subtraction, addition, etc., we cannot d memory, but it needs registers to process and to store the data. Microcontrollers contain several types o classified according to their instructions or content that operate in them.

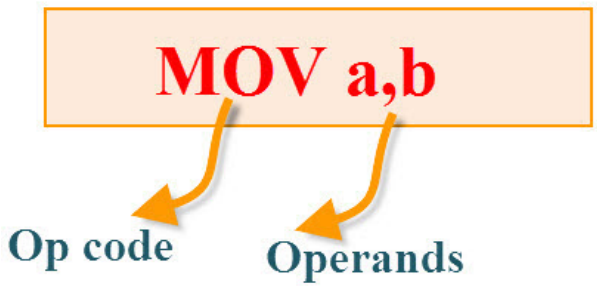
8051 Microcontroller Programs in Assembly Language

The assembly language is made up of elements which all are used to write the program in sequential ma rules to write programming in assembly language.

Rules of Assembly Language

- The assembly code must be written in upper case letters
- The labels must be followed by a colon (label:)
- All symbols and labels must begin with a letter
- All comments are typed in lower case
- The last line of the program must be the END directive

The assembly language mnemonics are in the form of op-code, such as MOV, ADD, JMP, and so on, whic the operations.



Op-code: The op-code is a single instruction that can be executed by the CPU. Here the op-code is a MOV ir

Operands: The operands are a single piece of data that can be operated by the op-code. Example, multi performed by the operands that are multiplied by the operand.

Syntax: MUL a,b;

The Elements of an Assembly Language Programming:

- Assembler Directives
- Instruction Set
- Addressing Modes

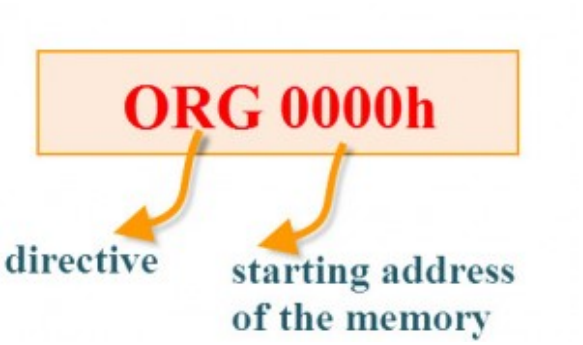
Assembler Directives:

The assembling directives give the directions to the CPU. The 8051 microcontroller consists of variou directives to give the direction to the control unit. The most useful directives are 8051 programming, such a

- ORG
- DB
- EQU
- END

ORG(origin): This directive indicates the start of the program. This is used to set the register address example; ORG 0000h tells the compiler all subsequent code starting at address 0000h.

Syntax: ORG 0000h



DB(define byte): The define byte is used to allow a string of bytes. For example, print the "EDGEFX" whe taken by the address and finally prints the "string" by the DB directly with double quotes.

Syntax:

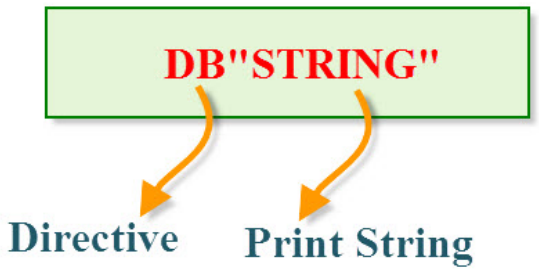
ORG 0000h

MOV a, #00h

————-

————-

DB”EDGEFX”



EQU (equivalent): The equivalent directive is used to equate address of the variable.

Syntax:

reg equ,09h

————–

————–

MOV reg,#2h

END: The END directive is used to indicate the end of the program.

Syntax:

reg equ,09h

————–

————–

MOV reg,#2h

END

Addressing Modes:

The way of accessing data is called addressing mode. The CPU can access the data in different ways by usi

The 8051 microcontroller consists of five addressing modes such as:

- Immediate Addressing Mode
- Register Addressing Mode

- Direct Addressing Mode
- Indirect Addressing Mode
- Base Index Addressing Mode

Immediate Addressing Mode:

In this addressing mode, the source must be a value that can be followed by the '#' and destination m general purpose registers and address. It is used for immediately storing the value in the memory registers.

Syntax:

```
MOV A, #20h   //A is an accumulator register, 20 is stored in the A//
MOV R0,#15      // R0 is a general purpose register; 15 is stored in the R0 register//
MOV P0, #07h    //P0 is a SFR register;07 is stored in the P0//
MOV 20h,#05h   //20h is the address of the register; 05 stored in the 20h//
```

Ex:

```
MOV R0, #1
MOV R0, #20      //R0 <—R0[15]+20, the final value is stored in R0//
```

Register Addressing Mode:

In this addressing mode, the source and destination must be a register, but not general purpose registers. S moved within the general purpose bank registers.

Syntax:

```
MOV A, B;       // A is a SFR register, B is a general purpose register//
MOV R0, R1   //Invalid instruction, GPR to GPR not possible//
```

EX:

MOV R0, #02h
MOV A, #30h
ADD R0, A //R0<—R0+A, the final value is stored in the R0 register//

Direct Addressing Mode

In this addressing mode, the source or destination (or both source and destination) must be an address, bu

Syntax:

MOV A,20h // 20h is an address; A is a register//
MOV 00h, 07h // both are addressed of the GPS registers//

Ex:

MOV 07h,#01h
MOV A, #08h
ADD A,07h //A<—A+07h the final value is stored in A//

Indirect Addressing Mode:

In this addressing mode, the source or destination (or destination or source) must be a indirect address, addressing mode supports the pointer concept. The pointer is a variable that is used to store the address This pointer concept is only used for R0 and R1 registers.

Syntax:

MOVR0, #01h //01 value is stored in the R0 register, R0 address is 08h//
MOV R1, #08h//R1 is the pointer variable that stores address (08h) of R0 //
MOV 20h,@R1 //01 value is stored in the 20h address of the GP register//

Indirect Addressing Mode

Base Index Addressing Mode:

This addressing mode is used to read the data from the external memory or ROM memory. All addressin the data from the code memory. The code must read through the DPTR register. The DPTR is used to poir or external memory.

Syntax:

MOVC A, @A+DPTR //C indicates code memory//
MOCX A, @A+DPTR // X indicate external memory//
EX: MOV A, #00H //00H is stored in the A register//
MOV DPTR, #0500H //DPTR points 0500h address in the memory//
MOVC A, @A+DPTR //send the value to the A register//
MOV P0, A //date of A send to the PO registrar//

Instruction Set:

The instruction set is the structure of the controller or processor that provides commands to the co controller for processing data. The instruction set consists of instructions, native data types, address registers, exceptional handling and memory architecture. The 8051 microcontroller can follow CISC instr architecture. In case of the 8051 programming different types of CISC instructions include:

- Data Transfer Instruction set
- Sequential Instruction Set
- Arithmetic Instruction set
- Branching Instruction set
- Loop Instrcution Set
- Conditional Instruction set
- Unconditional Instruction set
- Logical Instruction set
- Boolean Instruction set

Arithmetic Instruction Set:

The arithmetic instructions perform the basic operations such as:

- Addition
- Multiplication
- Subtraction
- Division

Addition:

```
ORG 0000h
MOV R0, #03H    // move the value 3 to the register R0//
MOV A, #05H    // move the value 5 to accumulator A//
Add A, 00H      // addA value with R0  value and stores the result inA//
END
```

Multiplication:

```
ORG 0000h
MOV R0, #03H    // move the value 3 to the register R0//
MOV A, #05H    // move the value 5 to accumulator A//
MUL A, 03H      // Multiplied result is  stored in the Accumulator A //
```

```
END
```

Subtraction:

```
ORG 0000h
MOV R0, #03H    // move the value 3 to register R0//
MOV A, #05H     // move the value 5 to accumulator A//
SUBB A, 03H     // Result value is stored in the Accumulator A //
END
```

Division:

```
ORG 0000h
MOV R0, #03H    // move the value 3 to register R0//
MOV A, #15H     // move the value 5 to accumulator A//
DIV A, 03H      // final value is stored in the Accumulator A //
END
```

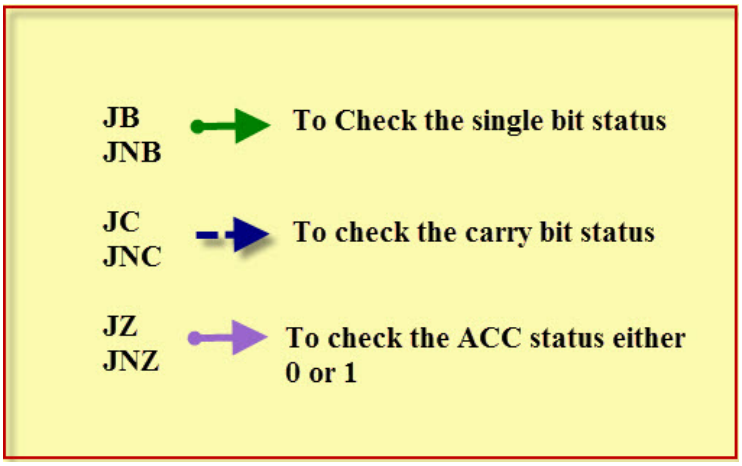
MNEMONICS	DESCRIPTION	BYTES
ADD A,Rr	A+Rr-->A	1
ADD A,@Rp	A+(Rp)-->A	2
ADD A, #N	A+N-->A	1
SUB A,Rr	A-Rr-->A	2
SUB A,@Rp	A-(Rp)-->A	1
SUB A, #N	A-N-->A	2
DEC A	A-1-->A	1
DEC Rr	Rr-1-->	2
DEC ADD	(ADD)-1-->ADD	1
INC A	A+1-->A	2
INC Rr	Rr+1-->	1
INC ADD	(ADD)+1-->ADD	2
DIV AB	A/B-->AB	1
MUL AB	A*B-->AB	2

Conditional Instructions

The CPU executes the instructions based on the condition by checking the single bit status or b

microcontroller consists of various conditional instructions such as:

- JB —>Jump below
- JNB —> Jump if not below
- JC —> Jump if Carry
- JNC —>Jump if not Carry
- JZ —>Jump if Zero
- JNZ —> Jump if not Zero



Conditional Instructions

1. Syntax:

```
JB P1.0, label
- - - - - - - -
- - - - - - - -
Label:  - - - - - - - -
- - - - - - - -
END
```

2. Syntax:

```
JNB P1.0, label
- - - - - - - -
- - - - - - - -
Label:  - - - - - - - -
- - - - - - - -
END
```

3. Syntax:

JC, label

– – – – – – – –

– – – – – – – –

Label: – – – – – – – –

– – – – – – – –

END

4. Syntax:

JNC, label

– – – – – – – –

– – – – – – – –

Label: – – – – – – – –

– – – – – – – –

END

5. Syntax:

JZ, label

– – – – – – – –

– – – – – – – –

Label: – – – – – – – –

– – – – – – – –

END

6. Syntax:

JNZ, label

– – – – – – – –

– – – – – – – –

Label: – – – – – – – –

– – – – – – – –

END

Call and Jump Instructions:

The call and jump instructions are used to avoid the code replication of the program. When some specific

once in different places in the program, if we mention specific name to code then we could use that n program without entering a code for every time. This reduces the complexity of the program. The 8051 prc call and jump instructions such as LCALL, SJMP.

- LCALL
- ACALL
- SJMP
- LJMP

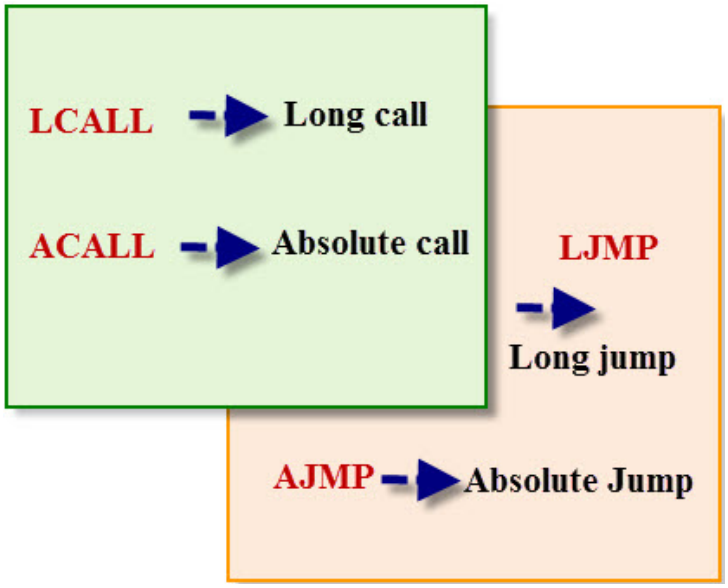
1. Syntax:

```
ORG 0000h
– – – – – – – –
– – – – – – – –
ACALL, label
– – – – – – – –
– – – – – – – –
SJMP STOP
Label: – – – – – – – –
– – – – – – – –
– – – – – – – –
ret
STOP:NOP
```

2. Syntax:

```
ORG 0000h
– – – – – – – –
– – – – – – – –
LCALL, label
– – – – – – – –
– – – – – – – –
SJMP STOP
Label: – – – – – – – –
– – – – – – – –
– – – – – – – –
ret
```

STOP:NOP



Call and Jump Instructions

Loop Instructions:

The loop instructions are used to repeat the block each time while performing the increment and decrer 8051 microcontroller consist two types of loop instructions:

- CJNE —> compare and jump if not equal
- DJNZ —> decrement and jump if not zero

1. Syntax:

of CJNE

MOV A, #00H

MOV B, #10H

Label:INC A

– – – – – –

– – – – – –

CJNE A, label

2. Syntax:

of DJNE

MOV R0, #10H

Label:– – – – – –

– – – – – –

DJNE R0, label

– – – – – –

– – – – – –

END

Logical Instruction Set:

The 8051 microcontroller instruction set provides the AND, OR, XOR, TEST, NOT and Boolean logic instruct the bits based on the need in the program.

Mnemonics	Description	Bytes
ANL A, Rr	A AND Rr-->A	1
ANL A, ADD	A AND(ADD)-->A	2
ORL A, Rr	A OR Rr-->A	1
ORL A, ADD	A OR(ADD)-->A	2
XRL A, Rr	A XOR Rr-->A	1
XRL A, ADD	A XOR(ADD)-->A	2
CLR A	00-->A	1
CPL A	A bar-->A	2

Logical Instruction Set

1. Syntax:

MOV A, #20H /00100000/

MOV R0, #03H /00000101/

ORL A, R0 //00100000/00000101=00000000//

2. Syntax:

MOV A, #20H /00100000/

MOV R0, #03H /00000101/

ANL A, R0

3. Syntax:

MOV A, #20H /00100000/

MOV R0, #03H /00000101/

XRL A, R0

Shifting Operators

The shift operators are used for sending and receiving the data efficiently. The 8051 microcontroller consist

- RR —> Rotate Right
- RRC —>Rotate Right through carry
- RL —> Rotate Left
- RLC —>Rotate Left through carry

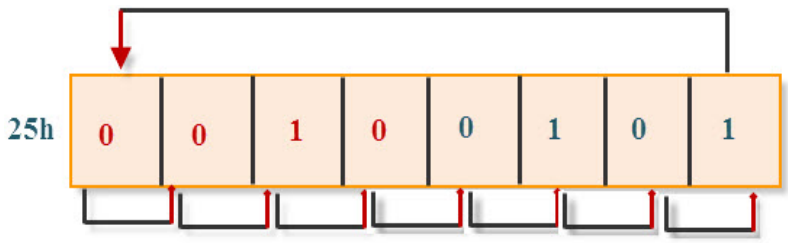
Rotate Right (RR):

In this shifting operation, the MSB becomes LSB and all bits shift towards right side bit-by-bit, serially.

Syntax:

MOV A, #25h

RR A



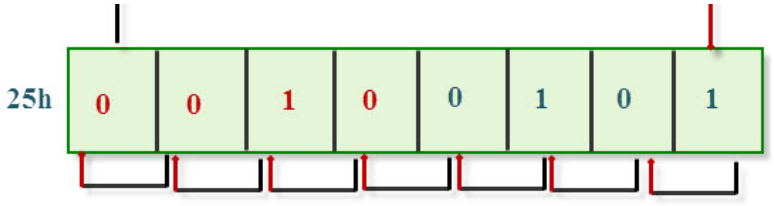
Rotate Left (RL):

In this shifting operation, the MSB becomes LSB and all bits shift towards Left side bit-by-bit, serially.

Syntax:

MOV A, #25h

RL A



RRC Rotate Right through Carry:

In this shifting operation, the LSB moves to carry and the carry becomes MSB, and all the bits are shift towa bit position.

Syntax:

MOV A, #27h
RRC A

RLC Rotate Left through Carry:

In this shifting operation, the MSB moves to carry and the carry becomes LSB and all the bits shift towards l position.

Syntax:

MOV A, #27h
RLC A

Basic Embedded C Programs:

The microcontroller programming differs for each type of operating system. There are many operating sy Windows, RTOS and so on. However, RTOS has several advantages for embedded system development. S level programming examples are given below.

LED blinking using with 8051 microcontroller:

- Number Displaying on 7-segment display using 8051 microcontroller
- Timer/Counter calculations and program using 8051 microcontroller
- Serial Communication calculations and program using 8051 microcontroller

LED programs with 8051 Microcontrller

1. WAP to toggle the PORT1 LEDs

```
ORG 0000H
TOGLE: MOV P1, #01    //move 00000001 to the p1 register//
CALL DELAY    //execute the delay//
MOV A, P1       //move p1 value to the accumulator//
CPL A       //complement A value //
MOV P1, A       //move 11111110 to the port1 register//
CALL DELAY    //execute the delay//
SJMP TOGLE
DELAY: MOV R5, #10H    //load register R5 with 10//
TWO:       MOV R6, #200    //load register R6 with 200//
ONE:      MOV R7, #200    //load register R7 with 200//
DJNZ R7, $    //decrement R7 till it is zero//
DJNZ R6, ONE    //decrement R7 till it is zero//
DJNZ R5, TWO    //decrement R7 till it is zero//
RET          //go back to the main program //
END
```

Timer/Counter Calculations and Program using 8051 Microcontroller:

The delay is the one of the important factors in the application software development. The timers and c components of the microcontroller, that are used in many applications to provide the accurate time del Both the tasks are implemented by the software technique.

1. WAP to calculate the 500us time delay.

```
MOV TMOD, #10H       //select the timer mode by the registers//
MOV TH1, #0FEH       // store the delay time in higher bit//
MOV TL1, #32H       // store the delay time in low bit//
JNB TF1, $          //decrement the value of the timer till it is zero//
CLR TF1          //clear the timer flag bit//
CLR TR1          //OFF the timer//
```

2. WAP to toggle the LEDs withthe 5 sec time delay

```
ORG 0000H
```

```
RETURN: MOV PO, #00H
ACALL DELAY
MOV P0, #0FFH
ACALL DELAY
SJUMP RETURN
DELAY:   MOV R5, #50H     //load register R5 with 50//
DELAY1: MOV R6, #200    //load register R6 with 200//
DELAY2: MOV R7, #229    //load register R7 with 200//
DJNZ R7, $    //decrement R7 till it is zero//
DJNZ R6, DELAY2//decrement R6 till it is zero//
DJNZ R5, DELAY1//decrement R5 till it is zero//
RET          //go back to the main program //
END
```

3. WAP to count the 250 pulses using mode0 count0

Syntax:

```
ORG 0000H
MOV TMOD, #50H       //select the counter//
MOV TH0, #15       //move the counting pulses higher bit//
MOV TH1, #9FH       //move the counting pulses, lower bit//
SET TR0          //ON the timer//
JNB  $          //decrement the count value till zero//
CLR TF0          //clear the counter, flag bit//
CLR TR0          //stop the timer//
END
```

Serial Communication Programming Using 8051 Microcontroller:

Serial communication is commonly used for transmitting and receiving the data. The 8051 micro UART/USART serial communication and the signals are transmitted and received by Tx and Rx pins. The transfers the data bit-by-bit serially. The UART is a half-duplex protocol that transfers and receives the dat time.

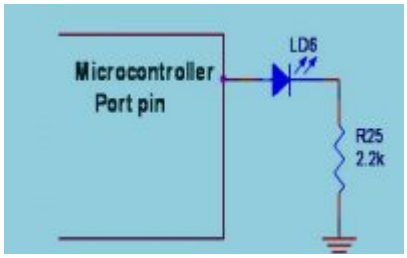
1. WAP to transmit the characters to the Hyper Terminal

```
MOV SCON, #50H       //set the serial communication//
MOV TMOD, #20H       //select the timer mode//
MOV TH1, #-3       //set the baud rate//
SET TR1          //ON the timer//
MOV SBUF, #'S'       //transmit S to the serial window //
JNB TI, $          //decrement value of the timer till it is zero//
CLR RI          // clear receive interrupt //
CLR TR1          //clear timer//
```

2. WAP to transmit the Receive the character by the Hyper Terminal

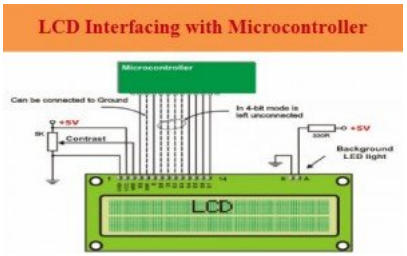
```
MOV SCON, #50H       //set the serial communication//
MOV TMOD, #20H       //select the timer mode//
MOV TH1, #-6       //set the baud rate//
SET TR1          //on the timer//
MOV SBUF, #'S'       //transmit S to the serial window //
JNB RI, $          //decrement value of timer till it is zero//
CLR RI          // clear receive interrupt //
MOV P0, SBUF       //send the SBUF register value to the port0//
CLR TR1          //clear timer//
```

This is all about the 8051 Programming in Assembly language in brief with example-based programs. W information on assembly language will be certainly helpful for the readers and we look forward for their v the comment section below.

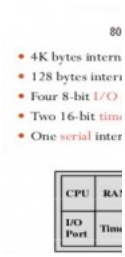


How to Interface an LED With 8051 Microcontroller

Digital Temperature Controller Circuit



LCD Interfacing with 8051 Microcontroller



8051 Micr and Basic

7 Comments

Ajit Kumar Says:
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thank you sir to sharing these important information.

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> Hi Ajith
> Thank you so much for your feedback

Muhammad Siddique Says:
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Excellent , very helpful for a new one like me. Example programs make all the things clear

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