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Unit 5---Microcontroller Basics
Topic name----- Microcontroller Basics
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4.2 Comparison between microcontrollers and microprocessors
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Introduction:-----

A microcontroller is a computer with most of the necessary support chips onboard. All computers have several things in common, namely: . A central processing unit (CPU) that 'executes' programs. . Some random-access memory (RAM) where it can store data that is variable. . Some read only memory (ROM) where programs to be executed can be stored. . Input and output (I/O) devices that enable communication to be established with the outside world i.e. connection to devices such as keyboard, mouse, monitors and other peripherals. There are a number of other common characteristics that define microcontrollers. If a computer matches a majority of these characteristics, then it can be classified as a 'microcontroller'. Microcontrollers may be: . 'Embedded' inside some other device (often a consumer product) so that they can control the features or actions of the product. Another name for a microcontroller is therefore an 'embedded controller'. . Dedicated to one task and run one specific program. The program is stored in ROM and generally does not change. . A low-power device.

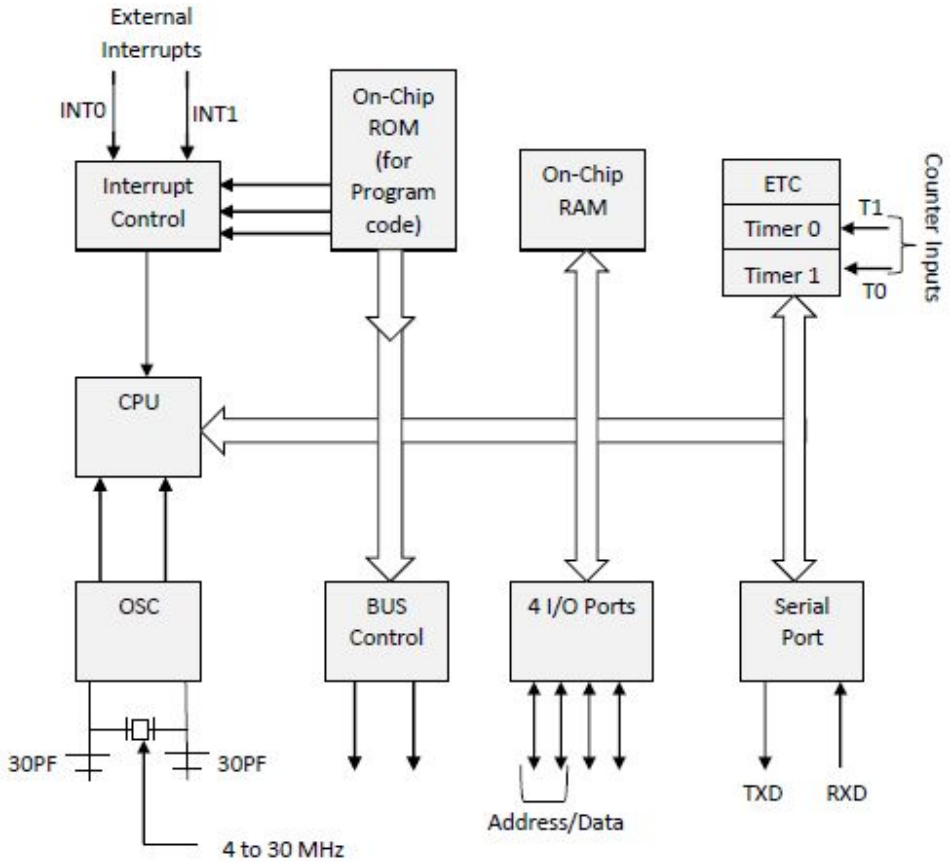
Comparison between Microprocessor and Microcontroller :----

a) Microprocessor contains ALU, General purpose registers, stack pointer, program counter, clock timing circuit, interrupt circuit
   Microcontroller contains the circuitry of microprocessor, and in addition it has built in ROM, RAM, I/O Devices, Timers/Counters etc.
b) Microprocessor has many instructions to move data between memory and CPU.
   Microcontroller has few instructions to move data between memory and CPU.
c) Few bit handling instruction for Microprocessor, Microcontroller has many bit handling instructions
d) Less number of pins are multifunctional for Microprocessor , More number of pins are multifunctional for Microcontroller.
e) Microprocessor based system requires additional hardware but Microcontroller requires less additional hardwares
f) Microprocessor is general purpose but Microcontroller is special purpose.

THE 8051 ARCHITECTURE

Salient features of 8051 microcontroller are given below.
1)Eight bit CPU.
2) On chip clock oscillator
3) 4Kbytes of internal program memory (code memory) [ROM]
4) 128 bytes of internal data memory [RAM]
5) 64 Kbytes of external program memory address space.
6) 64 Kbytes of external data memory address space.
7) 32 bi directional I/O lines (can be used as four 8 bit ports or 32 individually addressable I/O lines)

8) Two 16 Bit Timer/Counter :T0, T1
9) Full Duplex serial data receiver/transmitter
10) Four Register banks with 8 registers in each bank.
11) Sixteen bit Program counter (PC) and a data pointer (DPTR)
12) 8 Bit Program Status Word (PSW)
13) 8 Bit Stack Pointer
14) Five vector interrupt structure (RESET not considered as an interrupt.)
15) 8051 CPU consists of 8 bit ALU with associated registers like accumulator 'A' , B register, PSW, SP, 16 bit program counter, stack pointer.
16) ALU can perform arithmetic and logic functions on 8 bit variables.
8051 has 128 bytes of internal RAM which is divided into
o Working registers [00 – 1F]
o Bit addressable memory area [20 – 2F]
o General purpose memory area (Scratch pad memory) [30-7F]

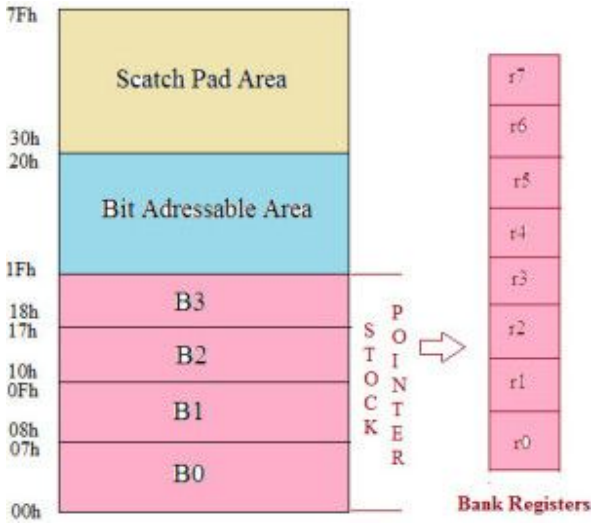


Types of Registers

The 8051 microcontroller contains mainly two types of registers:

- General-purpose registers (Byte addressable registers)
- Special function registers (Bit addressable registers)

General Purpose Registers



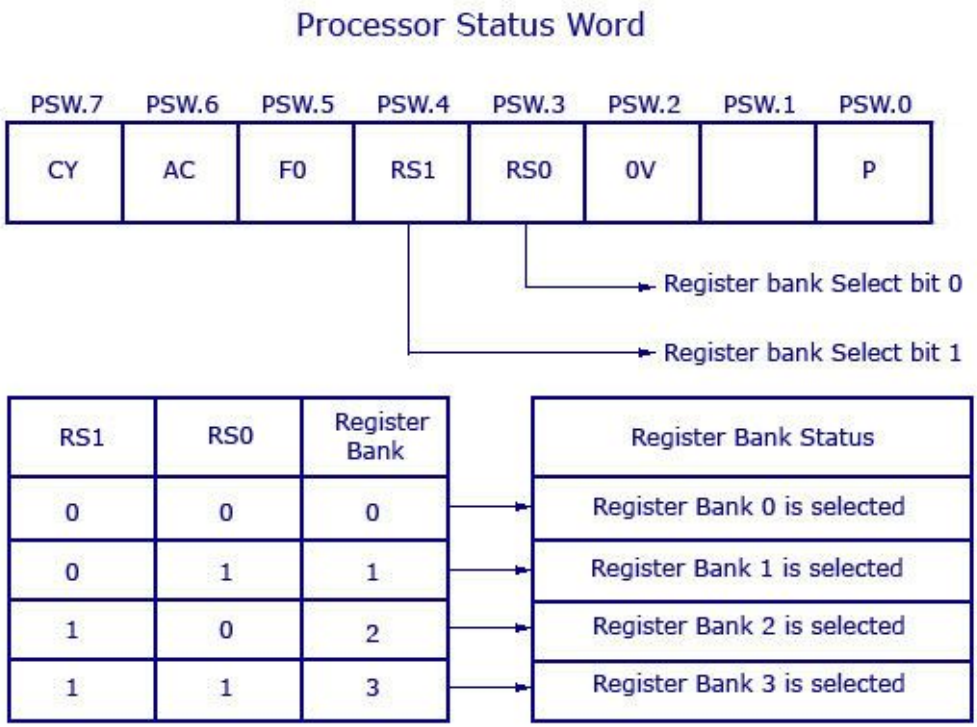
The general-purpose memory is called as the RAM of the 8051 microcontrollers, which is divided into 3 areas such as banks, bit-addressable area, and scratch-pad area. The banks contain different general-purpose registers such as R0-R7, and all such registers are byte-addressable registers that store or remove only 1-byte of data.

Banks and Registers

The B0, B1, B2, and B3 stand for banks, and each bank contains eight general-purpose registers ranging from ‘R0’ to ‘R7’. All these registers are byte-addressable. Data transfer

between general-purpose registers to general-purpose registers is not possible. These banks are selected by the Program Status Word (PSW) register.

At one time, one bank is available and the bank is chosen by setting the bit pattern of program status word.



PSW (Program Status Word). This is an 8 bit register which contains the arithmetic status of ALU and the bank select bits of register banks.

CY - carry flag,AC - auxiliary carry flag,F0 - available to the user for general purpose,RS1,RS0 - register bank select bits,OV - overflow,P - parity

Stack Pointer (SP) – it contains the address of the data item on the top of the stack. Stack may reside anywhere on the internal RAM. On reset, SP is initialized to 07 so that the default stack will start from address 08 onwards.

Data Pointer (DPTR) – DPH (Data pointer higher byte), DPL (Data pointer lower byte). This is a 16 bit register which is used to furnish address information for internal and external program memory and for external data memory.

Program Counter (PC) – 16 bit PC contains the address of next instruction to be executed. On reset PC will set to 0000. After fetching every instruction PC will increment by one.

8051 Microcontroller Special Function Registers (SFRs)The 8051 Microcontroller Special Function Registers act as a control table that monitor and control the operation of the 8051 Microcontroller. If you observe in Internal RAM Structure, the Address Space from 80H to FFH is allocated to SFRs.

Out of these 128 Memory Locations (80H to FFH), there are only 21 locations that are actually assigned to SFRs. Each SFR has one Byte Address and also a unique name which specifies its purpose.

Name of the Register	*Function*	*Internal RAM Address (HEX)*
ACC	Accumulator	E0H
B	B Register (for Arithmetic)	F0H
DPH	Addressing External Memory	83H
DPL	Addressing External Memory	82H
IE	Interrupt Enable Control	A8H
IP	Interrupt Priority	B8H
P0	PORT 0 Latch	80H
P1	PORT 1 Latch	90H
P2	PORT 2 Latch	A0H
P3	PORT 3 Latch	B0H
PCON	Power Control	87H
PSW	Program Status Word	D0H
SCON	Serial Port Control	98H
SBUF	Serial Port Data Buffer	99H
SP	Stack Pointer	81H
TMOD	Timer / Counter Mode Control	89H
TCON	Timer / Counter Control	88H
TL0	Timer 0 LOW Byte	8AH
TH0	Timer 0 HIGH Byte	8CH
TL1	Timer 1 LOW Byte	8BH
TH1	Timer 1 HIGH Byte	8DH

Math or CPU Registers: A and B

Status Register: PSW (Program Status Word)

Pointer Registers: DPTR (Data Pointer – DPL, DPH) and SP (Stack Pointer)

I/O Port Latches: P0 (Port 0), P1 (Port 1), P2 (Port 2) and P3 (Port 3)

Peripheral Control Registers: PCON, SCON, TCON, TMOD, IE and IP

Peripheral Data Registers: TL0, TH0, TL1, TH1 and SBUF

Data Pointer (DPTR – DPL and DPH)

The Data Pointer is a 16-bit Register and is physically the combination of DPL (Data Pointer Low) and 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 and DPH).

DPTR doesn't have a physical Memory Address but the DPL (Lower Byte of DPTR) and DPH (Higher Byte of DPTR) have separate addresses in the SFR Memory Space. DPL = 82H and DPH = 83H.

The DPTR Register is used by the programmer addressing external memory (Program – ROM or Data – RAM).

I/O Port Registers (P0, P1, P2 and P3)

The 8051 Microcontroller four Ports which can be used as Input and/or Output. These four ports are P0, P1, P2 and P3. Each Port has a corresponding register with same names (the Port Registers are also P0, P1, P2 and P3). The addresses of the Port Registers are as follows: P0 – 80H, P1 – 90H, P2 – A0H and P2 – B0H.

TCON (Timer Control)

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

TMOD (Timer Mode)

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

PCON (Power Control)

The PCON or Power Control register, as the name suggests is used to control the 8051 Microcontroller's Power Modes and is located at 87H of the SFR Memory Space. Using two bits in the PCON Register, the microcontroller can be set to Idle Mode and Power Down Mode.

SCON (Serial Control)

The Serial Control or SCON SFR is used to control the 8051 Microcontroller's Serial Port. It is located as an address of 98H. Using SCON, you can control the Operation Modes of the Serial Port, Baud Rate of the Serial Port and Send or Receive Data using Serial Port.

References:-------Microprocessor & microcontroller by Senthil kumar, electronicshub.org, nptel.ac.in