[Unit-4] Central Processing Unit

❖ Introduction of CPU

- The central processing unit is made up of three major parts.
- The **register set** *store intermediate data* used during the execution of the instructions.
- The **arithmetic logic unit** (ALU) performs *the required micro operations* for executing the instructions.
- The **control unit** supervises the transfer of *information among the register and instructs the ALU* as to which operation to perform.

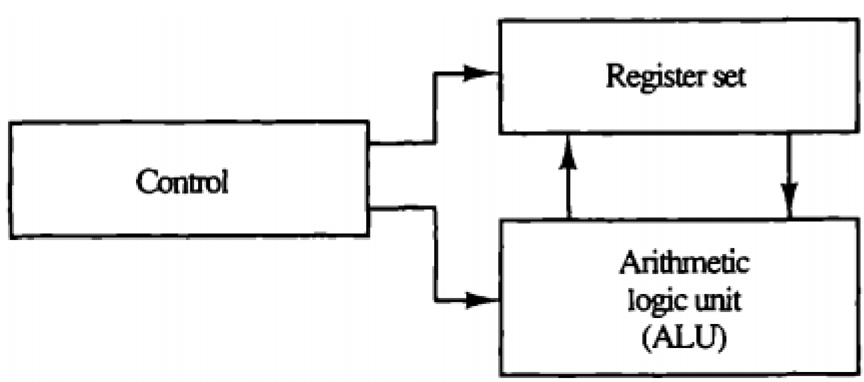
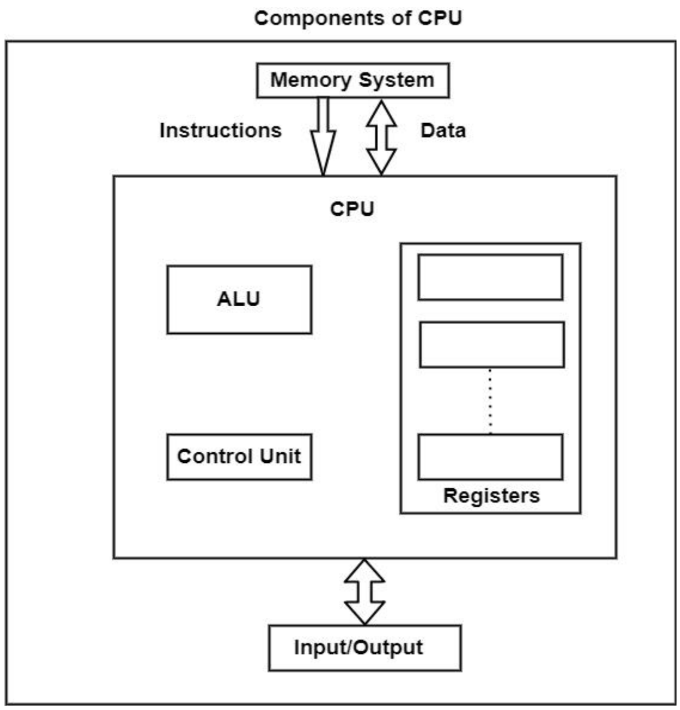


Figure 1 Major components of CPU.

❖ Major component of CPU

Components of CPU

A CPU includes three major components that are as follows −



1. Register Set

→The register set contrasts from one system to another. The register set includes several registers which *contain general-purpose registers and special-purpose registers*. The ***general-purpose*** registers *do not implement any particular function*. They save the temporary information that is needed by a program. The ***special-purpose*** registers execute various *functions for the CPU*.

2. ALU

→The ALU implements all the *arithmetic, logical, and shift operations* by supporting important circuitry that provides these evaluations.

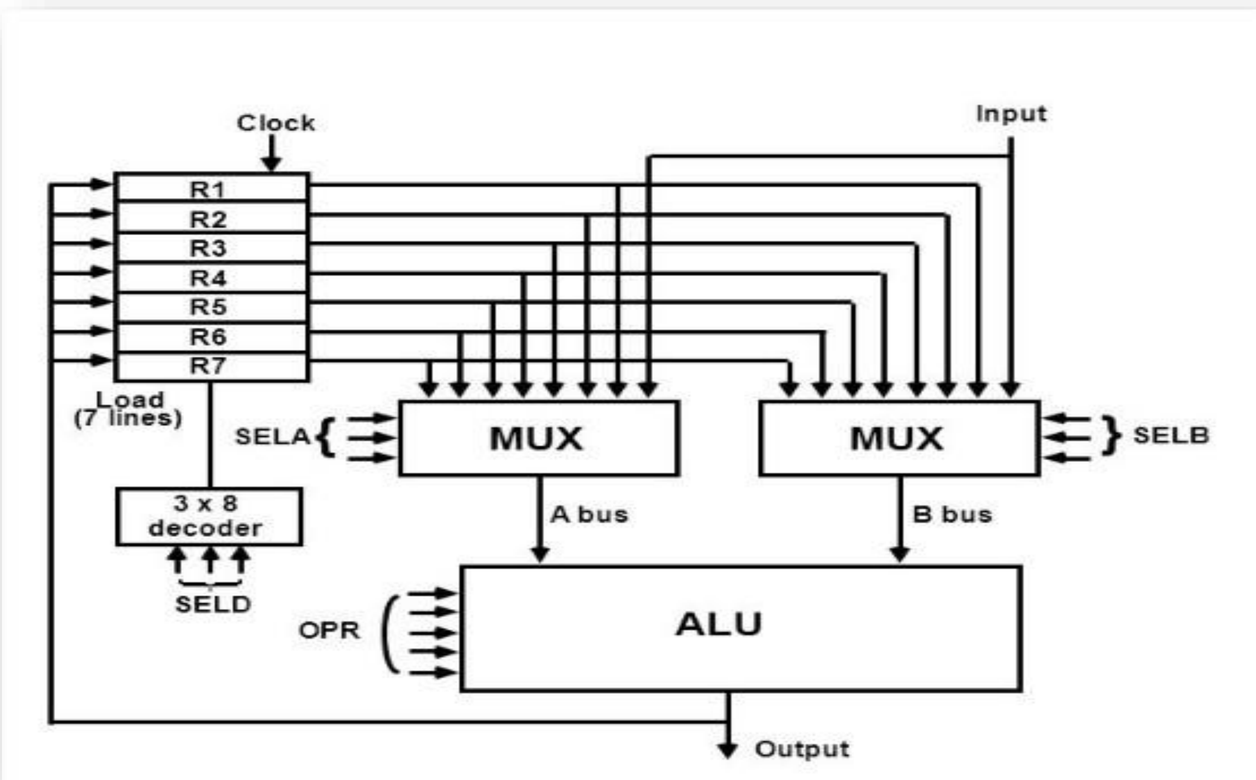
3. Control Unit

→The control unit fetches the instructions from the *main memory, decodes the instructions, and then executes them*.

The CPU interacts with the *main memory and input/output devices*. The CPU *reads* and *writes* data to and from the memory system and transfers data to and from the I/O devices.

❖ General Register Organization

- Generally CPU has ***seven*** general registers.
- Register organization show *how registers are selected* and *how data flow between register and ALU*.
- A decoder is used to *select a particular register*.
- The output of each register is connected to *two multiplexers to form the two buses A and B.*
- The selection lines in each multiplexer select the input data for the particular bus.
- The A and B buses form the two inputs of an ALU.
- The operation select lines decide the micro operation to be performed by ALU.
- The result of the micro operation is available at the output bus.
- The output bus connected to the inputs of all registers, thus by selecting a destination register it is possible to store the result in it.



❖ CONTROL WORD

- There 14 binary selection input in the units, and their combined values specifies control word. The 14 bit control word is display in above circuit.
- It consists of 4 fields. The first 3 fields contain 3 bits each, while the last field contains 5 bits.

SEL A	SEL B	SELREG OR SEL D	SEL OPR
3	3	3	5

FORMATE OF CONTROL WORD

- The three bit of SEL A select a source registers of the A input of the ALU.
- The three bits of SEL B select a source registers of the B input of the ALU.
- The three bits of SELE D or SELREG select a destination register using the decoder.
- The four bits of SELOPR select the operation to be performed by ALU.

❖Accumulator Register

→Some processor unit separate one register from all others and call it an Accumulator Register.

→This register is abbreviated as AC or A register.

→The name of this register is derived from the arithmetic addition process.

→

The accumulator register is a multipurpose register capable of performing not only add micro operation but many other micro operation as well. The fig-5.5 shows the block diagram of a processor unit that employs accumulator register. Input B supplies one external source information & this information may come from other processors or directly from the main memory of the computer. The A register supplies the other source information to the A.L.U. at input A. the result of operation is transfer back to the A register and replace it previous contain. The output from the A register may go to an external destination or into the input terminals of other processor register.

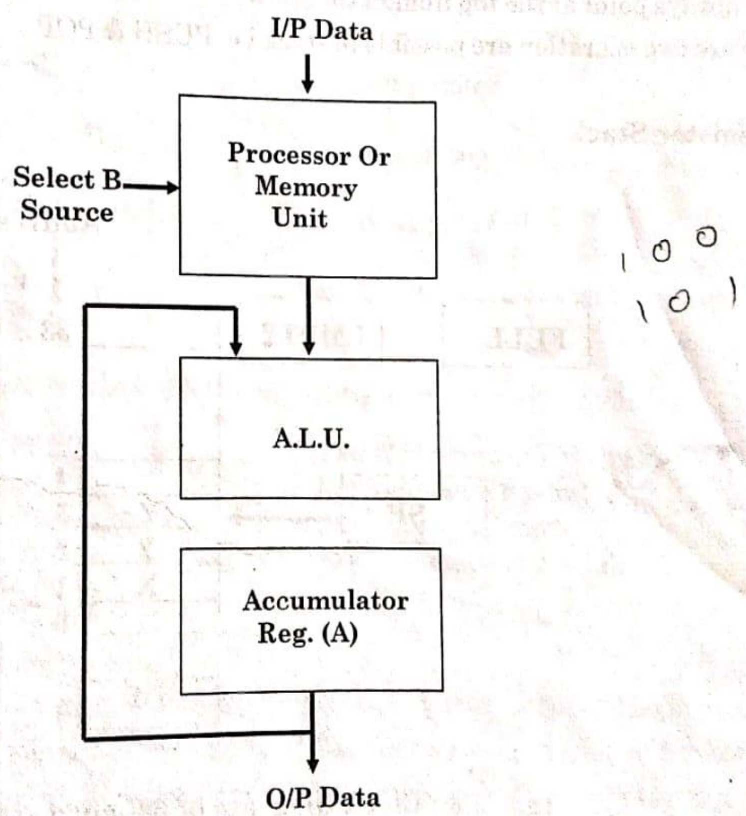


Fig. 5.5 : Processor with an accumulator register

❖ STACK ORGANIZATION

Stack is a storage structure that stores information in such a way that the last item stored is the first item retrieved. It is based on the principle of LIFO (Last-in-first-out). The stack in digital computers is a group of memory locations with a register that holds the address of top of element. This register that holds the address of top of element of the stack is called ***Stack Pointe***

Stack Operations

The two operations of a stack are:

1. **Push:** Inserts an item on top of stack.
2. **Pop:** Deletes an item from top of stack.

Implementation of Stack

In digital computers, stack can be implemented in two ways:

1. Register Stack
2. Memory Stack

Register Stack

A stack can be organized as a collection of finite number of registers that are used to store temporary information during the execution of a program. The stack pointer (SP) is a register that holds the address of top of element of the stack.

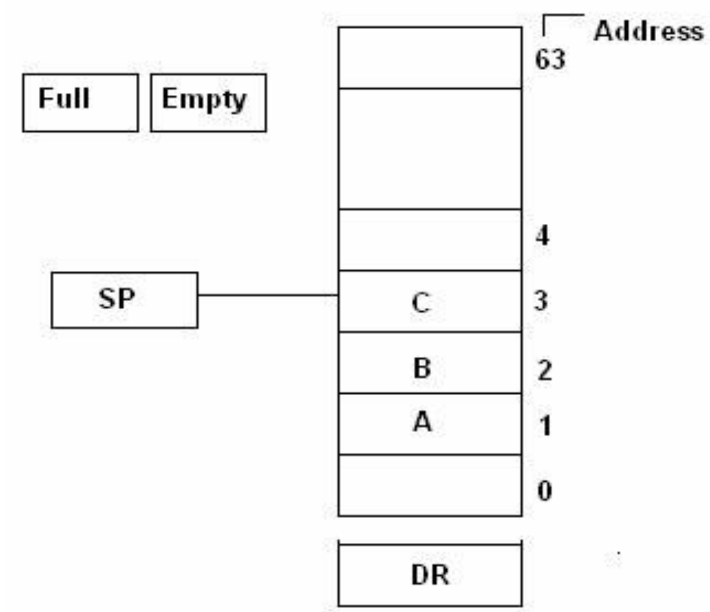


Figure :3 Block Diagram of a 64-word stack

Push Operation in Register Stack

Step1: The stack pointer increments by 1.
SP←SP+1

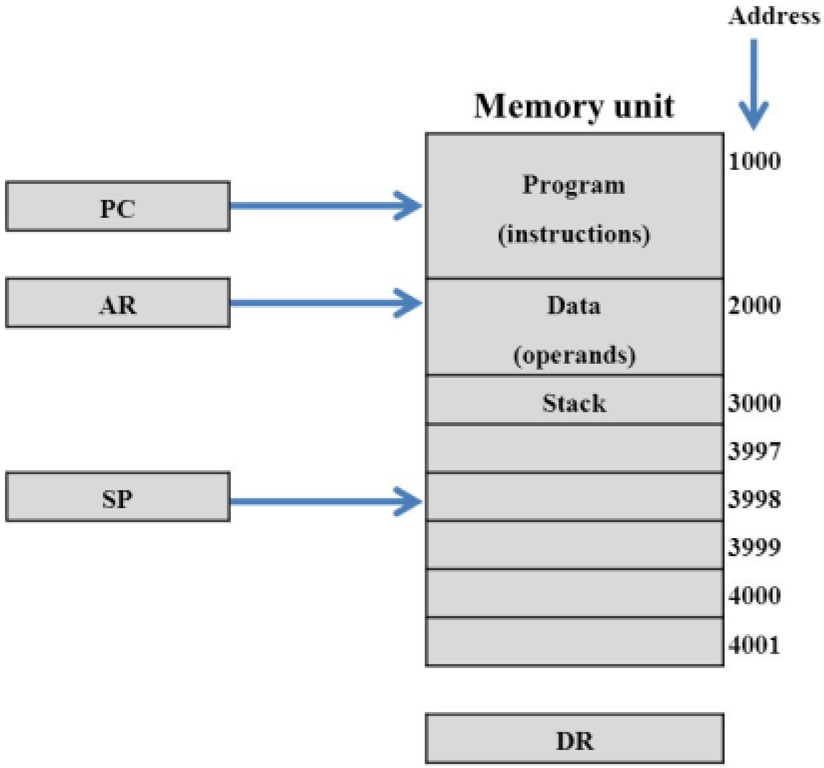
Step2: Enter the data into the stack.
M[SP]←DR [Where DR is the Data Register]

Step3: Check whether the stack is full or not
if (sp=0) then (full←1)

Step4: Mark not empty
empty←0

Memory Stack

A stack can be implemented in a random access memory (RAM) attached to a CPU. The implementation of a stack in the CPU is done by assigning a portion of memory to a stack operation and using a processor register as a stack pointer. The starting memory location of the stack is specified by the processor register as *stack pointer*.



The program instructions always store in the program counter (PC), the data registers are identified by the address register (AR). The address 3000 to 4001 used for the stack and the first item or element is stored at 4001.

Push Operation in Memory Stack

Step1: SP←SP-1
Step2: M[SP]←DR

Pop operation in Memory Stack

Step1: DR←M[SP]
Step2: SP←SP-1

❖ POLOSH NOTATIONS AND REVERSE POLISH NOTATION (RPN)

In this **notation**, operator is prefixed to operands, i.e. operator is written ahead of operands.

For **example**, +ab.

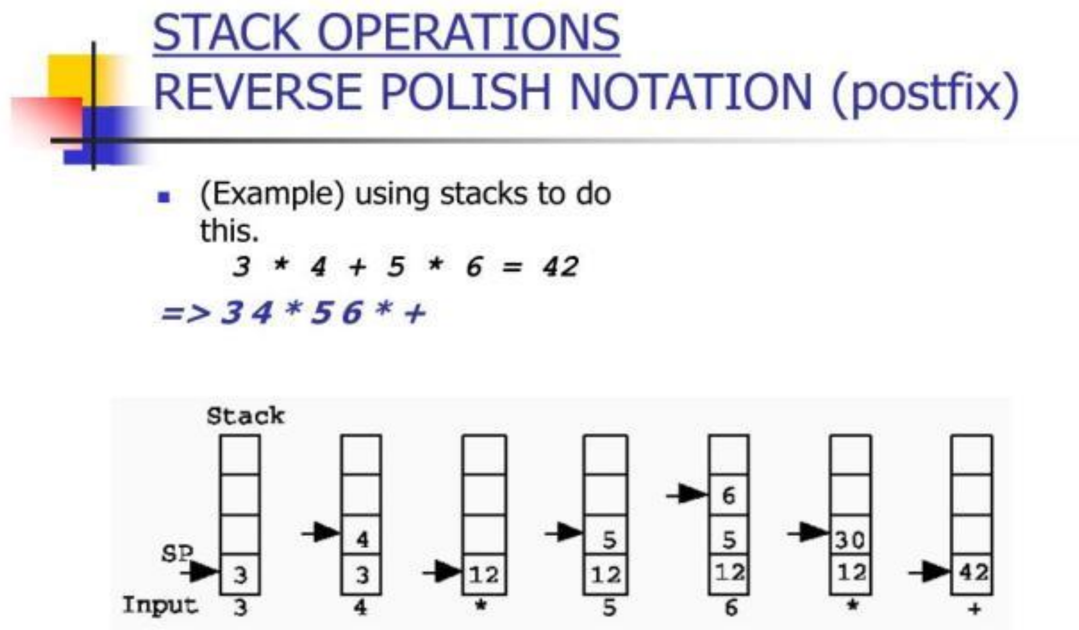
This is equivalent to its infix **notation** a + b. **Prefix notation** is also known as **Polish Notation**.

Three types:

1. **Infix** form**.**
2. **Prefix** form**.**
3. **Postfix** form**.**

A+B → Infix notation
+AB →Prefix or polish notation
AB+ →Postfix or Reverse polish notation (RPN)

Sr.No.	Infix Notation	Prefix Notation	Postfix Notation
1	a	a	a
2	a + b	+ a b	a b +
3	a - b	- a b	a b -
4	a+b+c	++abc	ab+c+
5	(a + b) ∗ c	∗ + a b c	a b + c ∗
6	a ∗ (b + c)	∗ a + b c	a b c + ∗
7	a / b + c / d	+ / a b / c d	a b / c d / +



❖ Arithmetic And Logic Unit (ALU)

→An ALU is a multi-operating combinational logic digital concept. It can perform set of basic arithmetic & logic operations.

→ Show the block diagram of 4 bit ALU.

→The four data input from an are combined with 4 data input from B to generate an operation at F output.

→The mode select input S_2 distinguishes between arithmetic and logic operations.

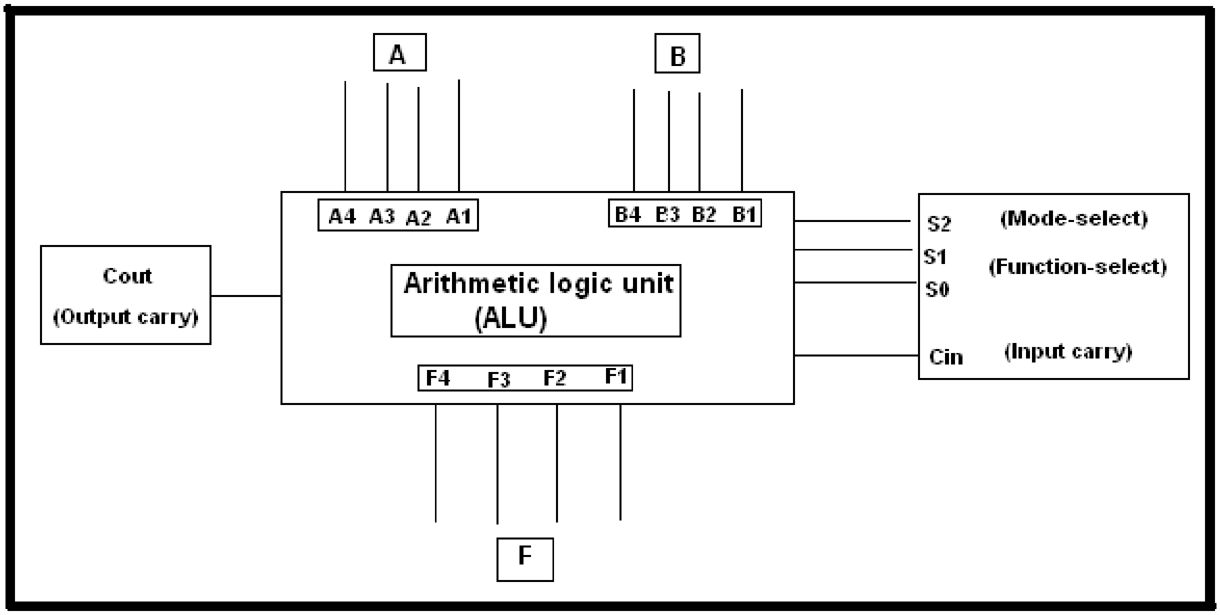
→The two function select input S_1 & S_0 specify the particular arithmetic or logic operation to be generated.

→With 3 select variables, it is possible to specify four arithmetic operations (with S_2 in one state) and four logic operations (with S2 in other state).

→The input and output carries have meaning only during arithmetic operation.

Working of ALU: The ALU provides arithmetic and logic operation. In addition the CPU must provide shift operation. The shifter may be placed in the input of the ALU to provide a pre-shift capability or at the output of the ALU to provide post-shifting capability.

Fig. Block Diagram of ALU



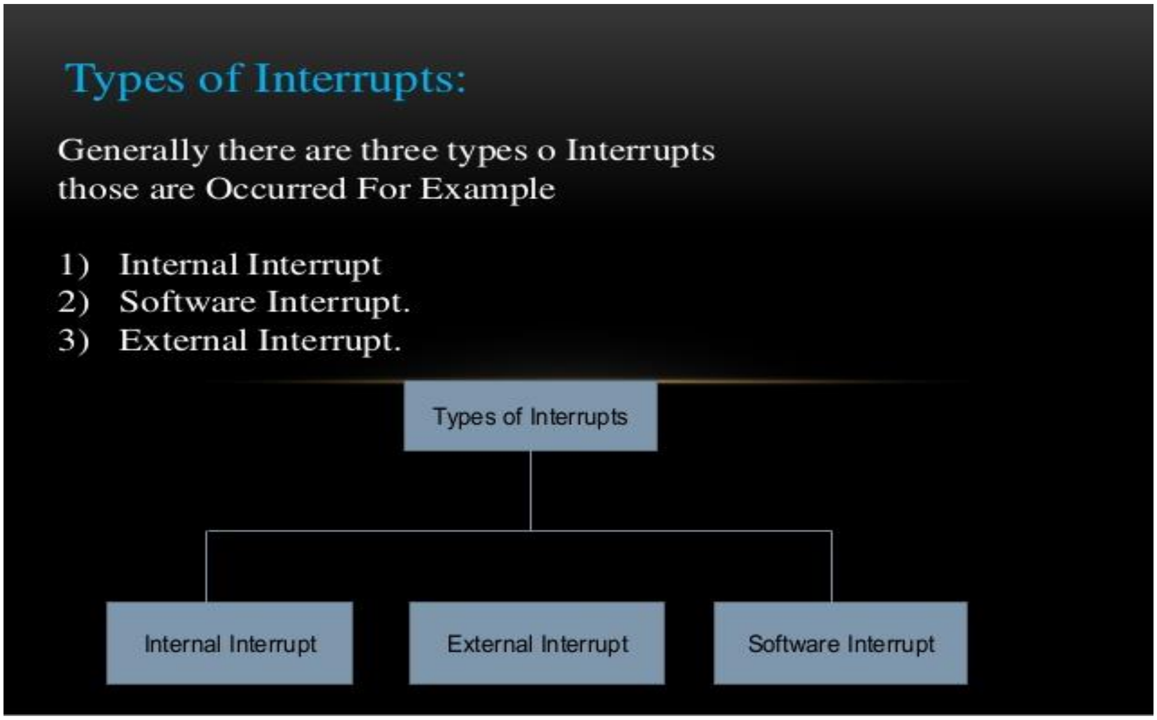
❖ INTERRUPT

The concept of program interrupt is use to handle variety of problems that arrives out of normal program sequence.

The interrupt facility is multi programming environment when two or more program is resided in the memory at same time.

Generally there are three types o Interrupts those are Occurred For Example

1) Internal Interrupt
2) Software Interrupt.
3) External Interrupt.



[A] External Interrupt

The external interrupt caused by external event, they comes from input-output devices, timing device or power supply or any other external sources.

[B]Internal Interrupt

Internal interrupt is initiated by some exceptional condition cause by the program is self. Stack overflow attempt to divide by zero and invalid operation code.

[C]Software Interrupt

Internal interrupt is initiated by some executing an instruction. Software interrupt is a special call instruction that behaves like an interrupt rather then subroutine call.

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