History and Basic Processor Architecture

RUNGTA COLLEGE OF ENGG AND TECH.,BHILAI
DEPT OF ELECTRONICS AND TELE. ENGG

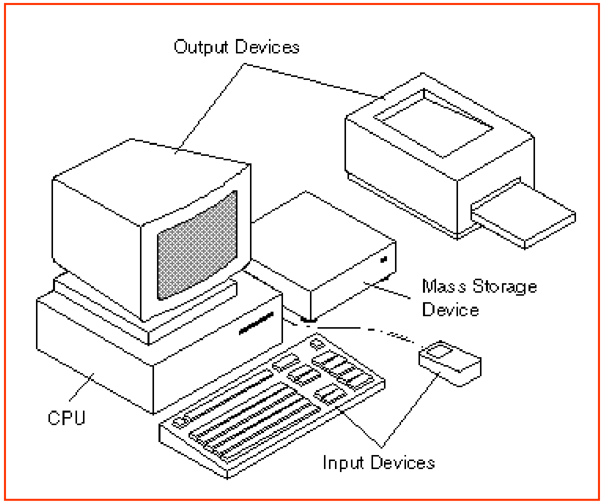
History of Computers

Module 1

Section 1

What Is a Computer?

An electronic machine, operating under the control of instructions stored in its own memory, that can accept data (input), manipulate data according to specified rules (process), produce results (output), and store the results for future use



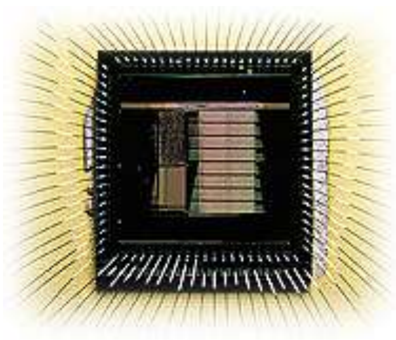
Definition of a Computer

A computer is defined in the following ways

- By the work it does
- By the kind of information it handles
- By its size and price

Categories of Computers

- Mainframes and PCs that run application software
- Embedded chips that control machines
- Internet or cyberspace

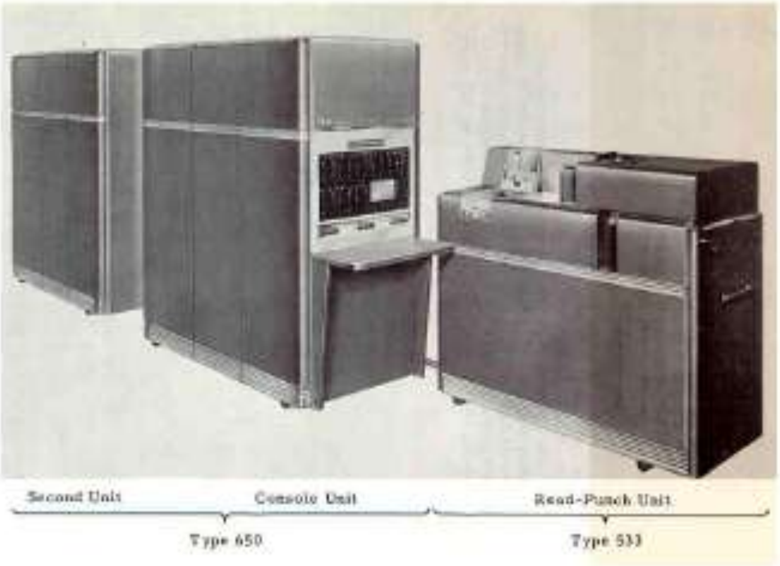


Evolution of Computers

- First generation (1939-1954) - vacuum tube
- Second generation (1954-1959) - transistor
- Third generation (1959-1971) - IC
- Fourth generation (1971-present) - microprocessor

Evolution of Computers

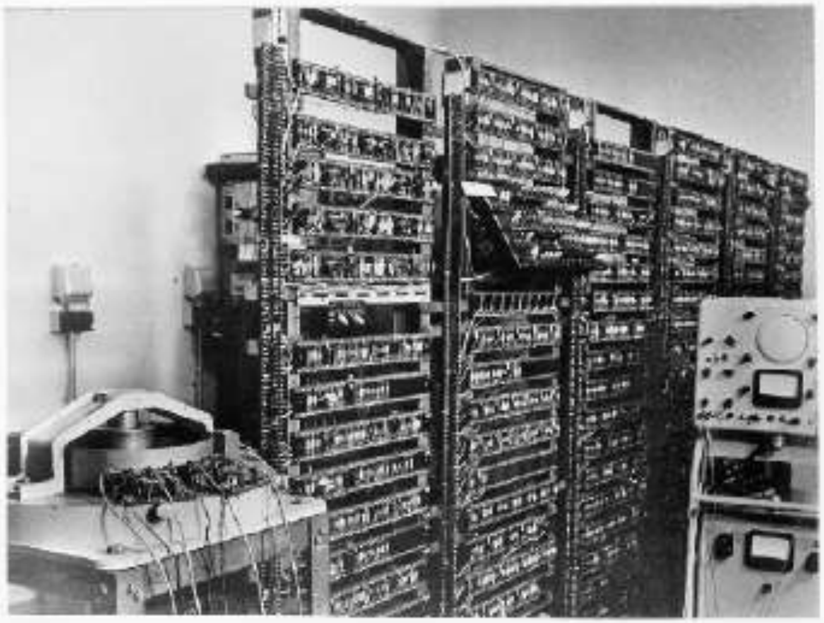
- First generation (1939-1954) - vacuum tube



IBM 650, 1954

Evolution of Computers

- Second generation (1954-1959) - transistor



Manchester University Experimental Transistor Computer

Evolution of Computers

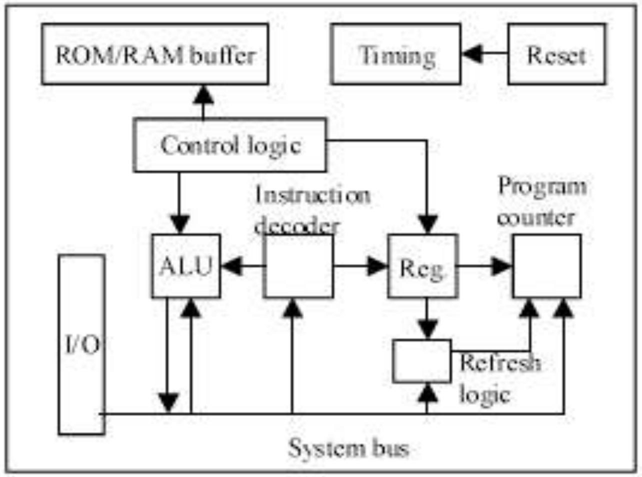
- Third generation (1959-1971) - IC

PDP-8, Digital Equipment Corporation

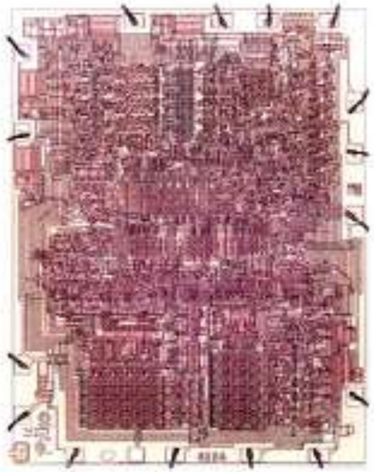
— Thanks to the use of ICs, the DEC PDP-8 is the least expensive general purpose small computer in 1960s

Evolution of Computers

- Fourth generation (1971-present) - microprocessor
  - In 1971, Intel developed 4-bit 4004 chip for calculator applications.



Block diagram of Intel 4004



http://www.intel.com

4004 chip layout

- WHAT CAN BE THE NEXT

?

THE FIRST ELECTRONIC COMPUTER

1940's – 1950's

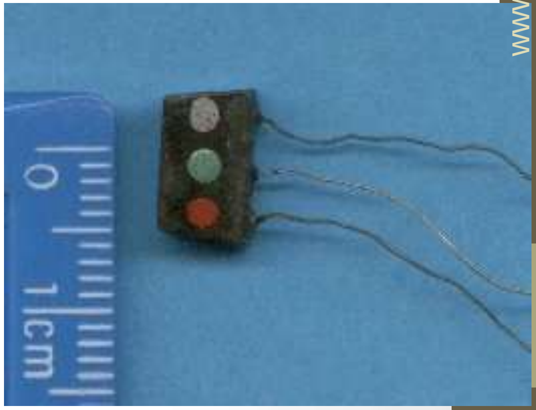
- Vacuum tubes & mechanical relays: UNIVAC, ENIAC
- 30 tons
- 150 Kwatts
- 80 bytes of memory
- Key problem was reliability
  - about 50 tubes had to be replaced per day

THE FIRST TRANSISTOR

1948

- William Shockley, Walter Brattain, and Jhon Bardeen succeeded in creating the *first point-contact germanium transistor* on the 23rd December 1947
  - they took a break for Christmas before publishing the achievement that is why the reference books state that the first transistor was created 1948

- Bipolar junction transistor (Shockley) - 1950
- Field effect transistor (MOS FET) - 1962



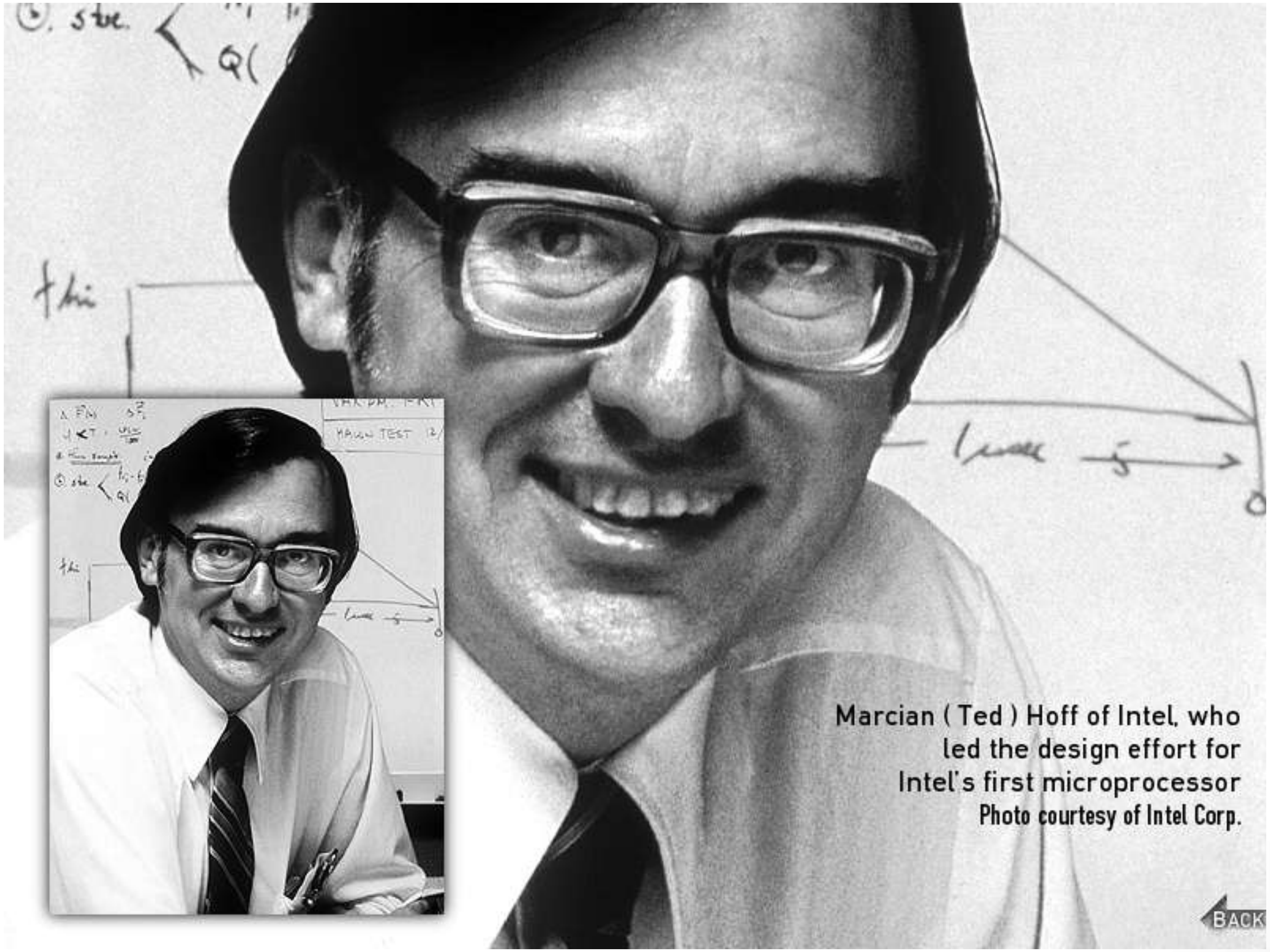
THE FIRST INTEGRATED CIRCUIT

1958

- Jack Kilby (Texas Instruments) in 1958 succeeded in fabricating multiple components on a single piece of semiconductors
  - a phase shift oscillator
- 1961 Fairchild and Texas Instruments fabricate first commercial integrated circuit comprising simple logic functions
  - two logic gates (four bipolar transistors and four resistors)

Jack Kilby

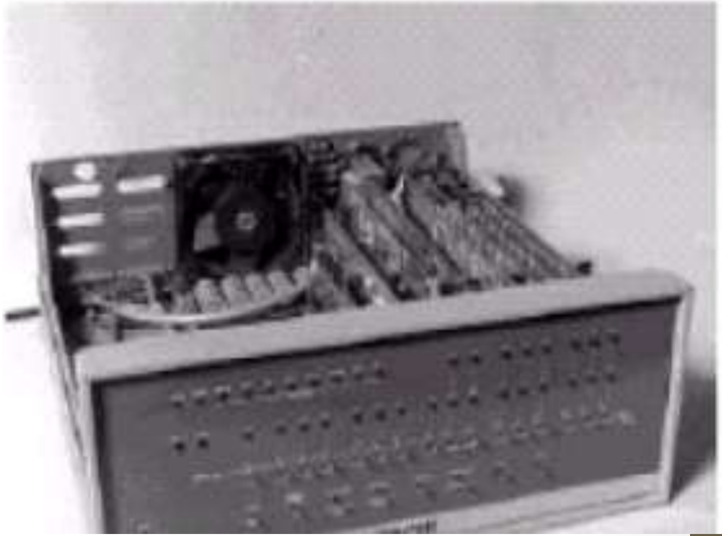
THE FIRST PROCESSOR IN INTEL LAB



PERSONEL COMPUTER

1974

- Altair 8800 (1974)
  - based on 8080 microprocessor,
  - affordable price of $375
  - no keyboard, no screen, no storage,
  - 4k memory, programmable by means of a switch panel

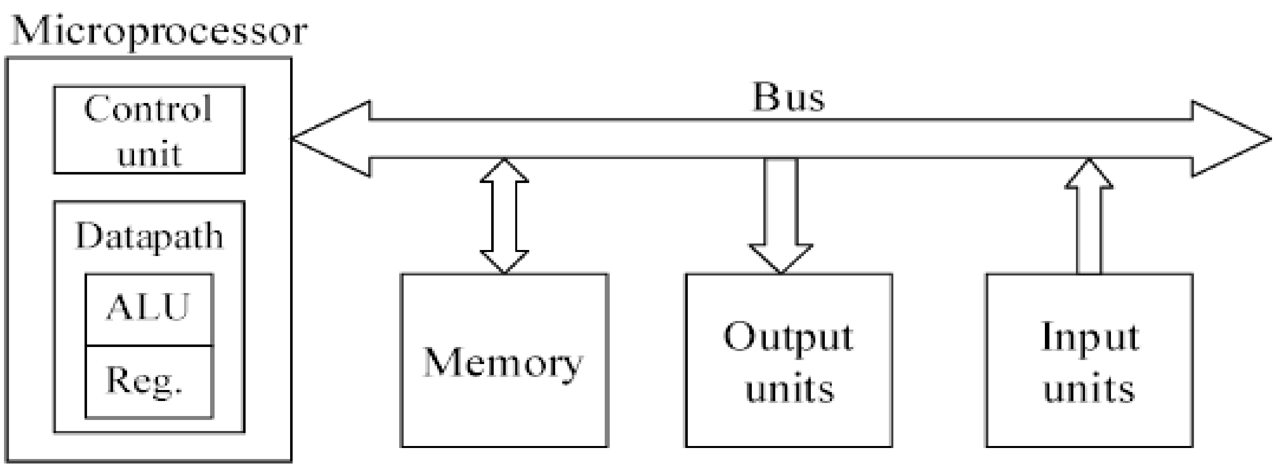


GUESS ……WHO IS THIS GREAT MAN ???

- Bill Gates and Paul Allen founded Microsoft (1975)
  - BASIC 2.0 on the Altair 8800
  - first high-level language available on a home computer

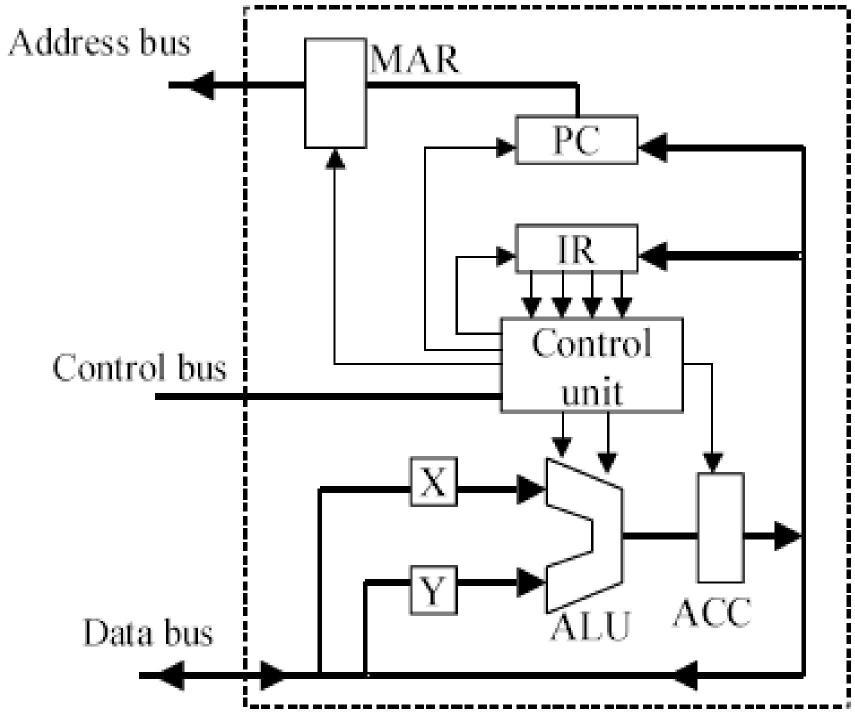
What are microprocessor-based systems?

- Microprocessor-based systems are electrical systems consisting of microprocessors, memories, I/O units, and other peripherals.
  - Microprocessors are the brains of the systems
  - Microprocessors access memories and other units through buses
  - The operations of microprocessors are controlled by instructions stored in memories



What are microprocessors?

- A microprocessor is a processor (or Central Processing Unit, CPU) fabricated on a single integrated circuit.



A simple microprocessor architecture

Processor System Architecture

The typical processor system consists of:

- CPU (central processing unit)
  - ALU (arithmetic-logic unit)
  - Control Logic
  - Registers, etc…
- Memory
- Input / Output interfaces

Interconnections between these units:

- Address Bus
- Data Bus
- Control Bus

Bus and CPU

Bus: A shared group of wires used for communicating signals among devices

- address bus: the device and the location within the device that is being accessed
- data bus: the data value being communicated
- control bus: describes the action on the address and data buses

CPU: Core of the processor, where instructions are executed

- High-level language: a = b + c
- Assembly language: add B , C
- Machine language: 0001001010111010101

Memory and I/O

Memory: Where instructions (programs) and data are stored

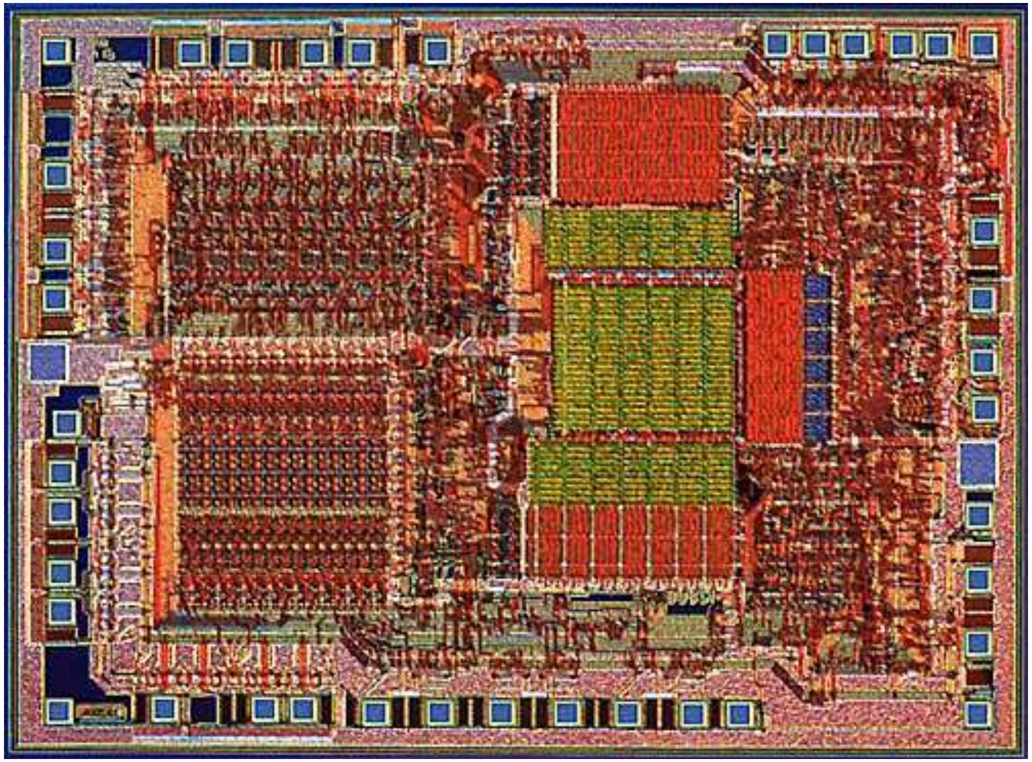
- Organized in arrays of locations (addresses), each storing one byte (8 bits) in general
- A *read* operation to a particular location always returns the last value stored in that location

I/O devices: Enable system to interact with the world

- Device interface (a.k.a. controller or adapter) hardware connects actual device to bus
- The CPU views the I/O device registers just like memory that can be accessed over the bus. However, I/O registers are connected to external wires, device control logic, etc.
- *Reads* may not return last value written
- *Writes* may have side effects

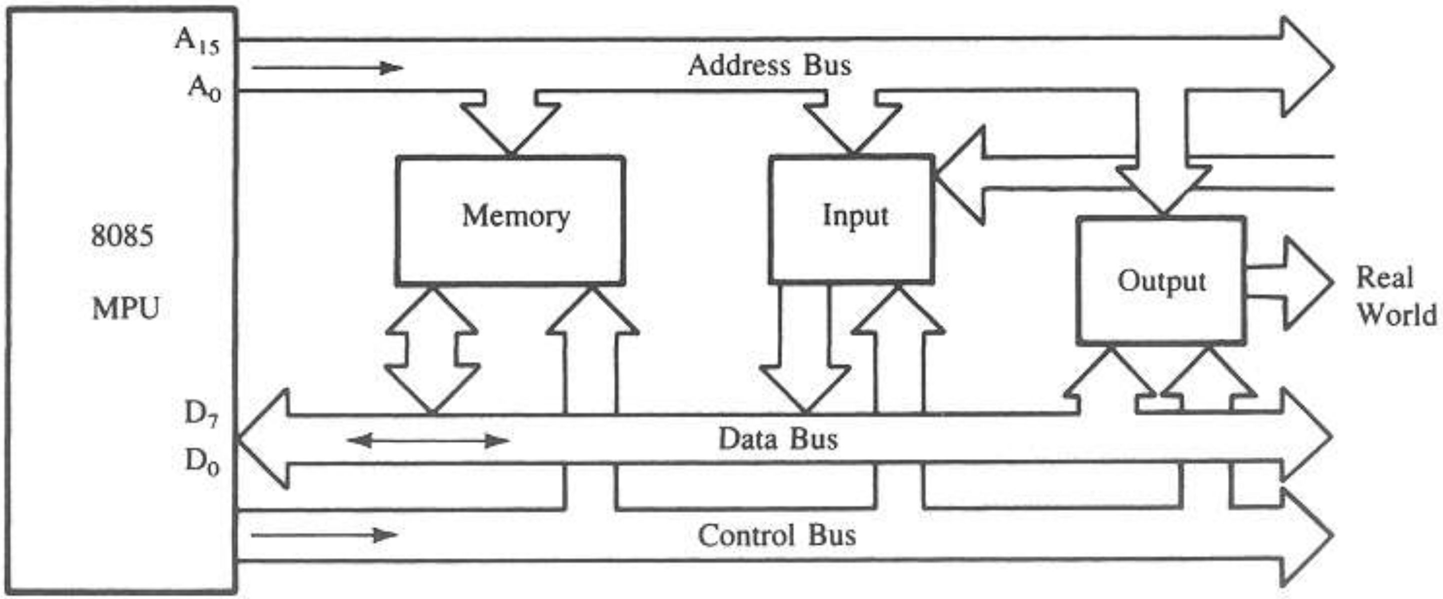
8085 Microprocessor Architecture

Now we will examine these components more closely by using the **Intel 8085 microprocessor** architecture as an example:



The 8085 Bus Structure

The 8-bit 8085 CPU (or MPU – Micro Processing Unit) communicates with the other units using a 16-bit address bus, an 8-bit data bus and a control bus.



The 8085 Bus Structure

Address Bus

- Consists of 16 address lines: $A_0 – A_{15}$
- Operates in **unidirectional** mode: The address bits are always sent from the MPU to peripheral devices, not reverse.
- 16 address lines are capable of addressing a total of 2^{16} = 65,536 (64k) memory locations.
- Address locations: 0000 (hex) – FFFF (hex)

The 8085 Bus Structure

Data Bus

- Consists of 8 data lines: $D_0 – D_7$
- Operates in **bidirectional** mode: The data bits are sent from the MPU to peripheral devices, as well as from the peripheral devices to the MPU.
- Data range: 00 (hex) – FF (hex)

Control Bus

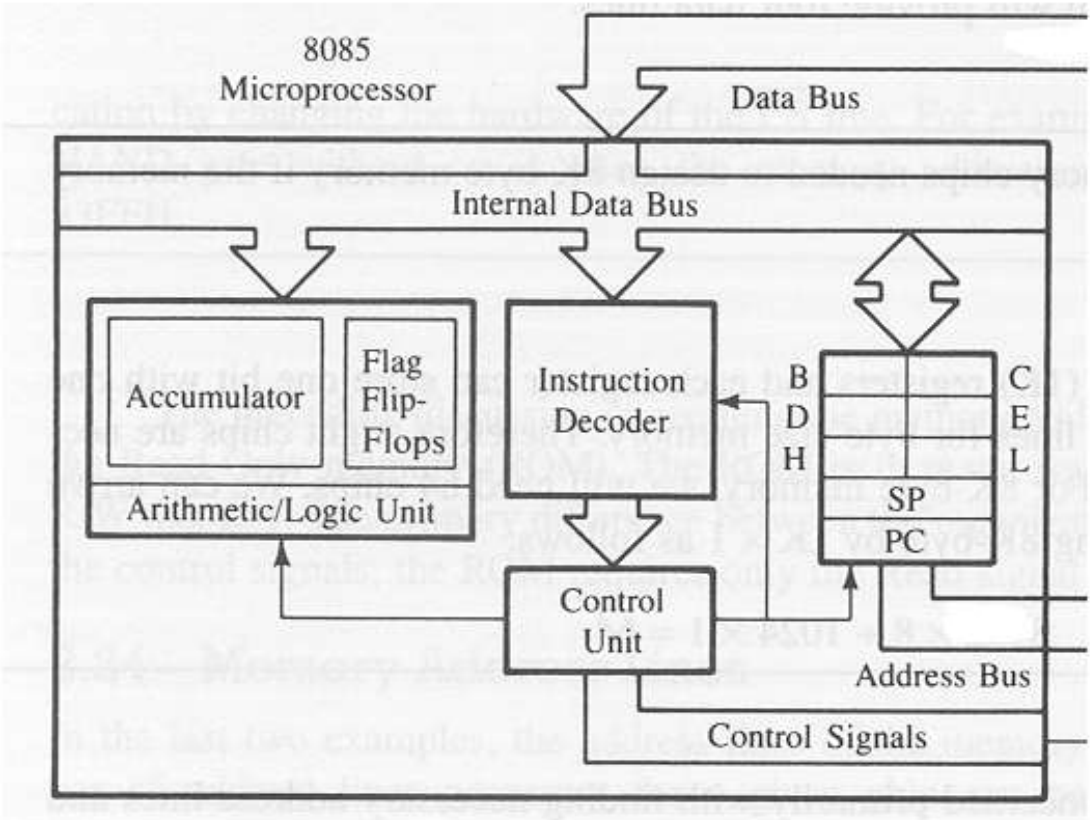
- Consists of various lines carrying the control signals such as read / write enable, flag bits.

The 8085: CPU Internal Structure

The internal architecture of the 8085 CPU is capable of performing the following operations:

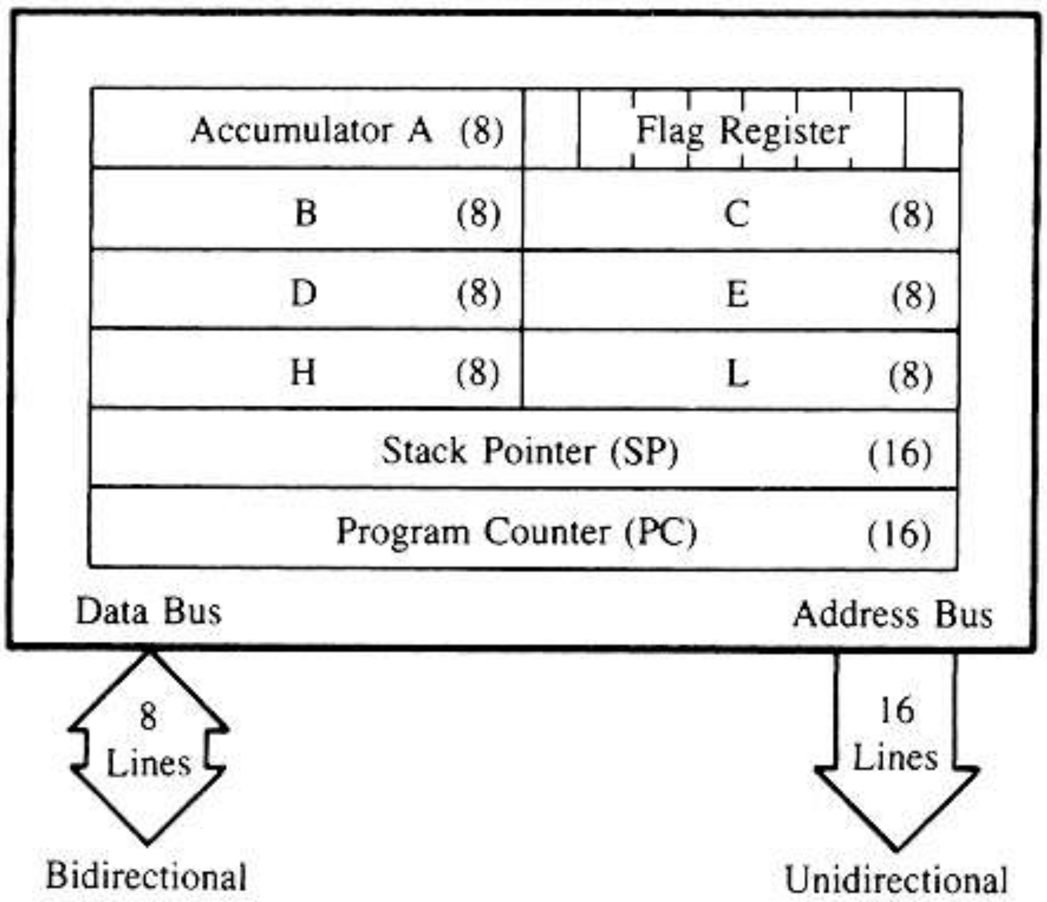
- Store 8-bit data (Registers, Accumulator)
- Perform arithmetic and logic operations (ALU)
- Test for conditions (IF / THEN)
- Sequence the execution of instructions
- Store temporary data in RAM during execution

The 8085: CPU Internal Structure

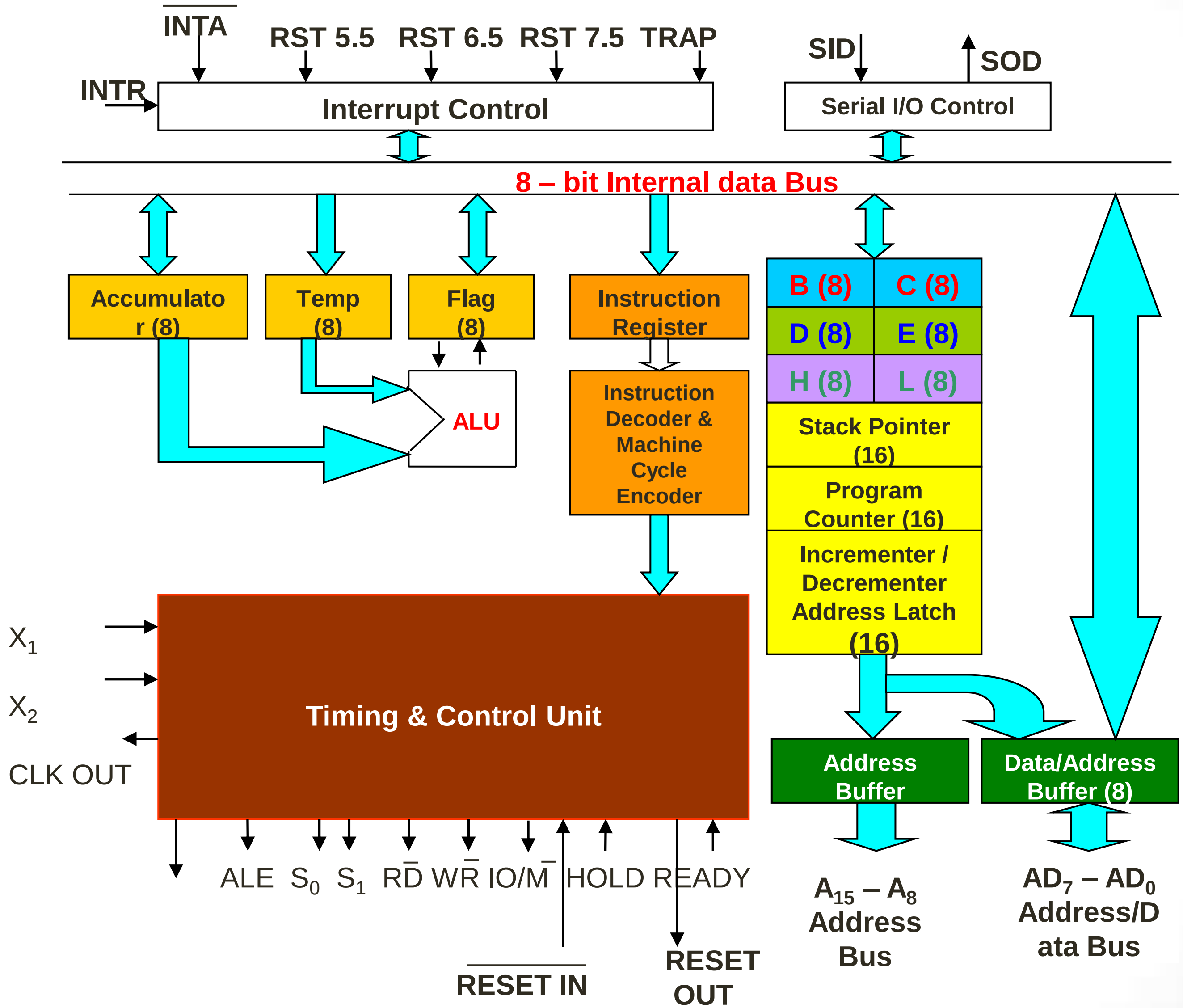


Simplified block diagram

The 8085: Registers



8085 ARCHITECTURE



The 8085: CPU Internal Structure

Registers

- Six general purpose 8-bit registers: B, C, D, E, H, L
- They can also be combined as register pairs to perform 16-bit operations: BC, DE, HL
- Registers are programmable (data load, move, etc.)

Accumulator

- Single 8-bit register that is part of the ALU !
- Used for arithmetic / logic operations – the result is always stored in the accumulator.

The 8085: CPU Internal Structure

Flag Bits

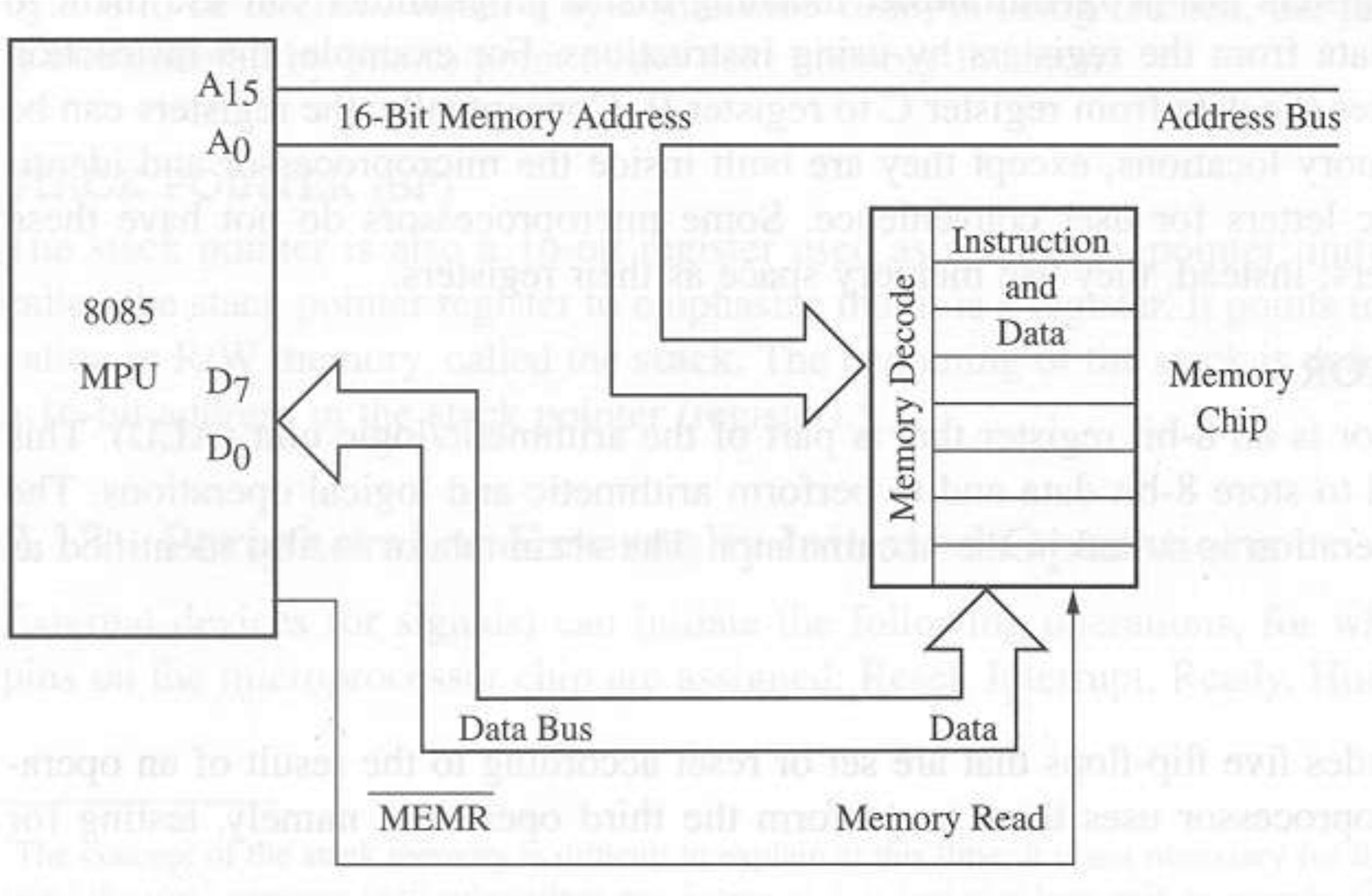
- Indicate the result of condition tests.
- Carry, Zero, Sign, Parity, etc.
- Conditional operations (IF / THEN) are executed based on the condition of these flag bits.

Program Counter (PC)

- Contains the memory address (16 bits) of the instruction that will be executed in the next step.

Stack Pointer (SP)

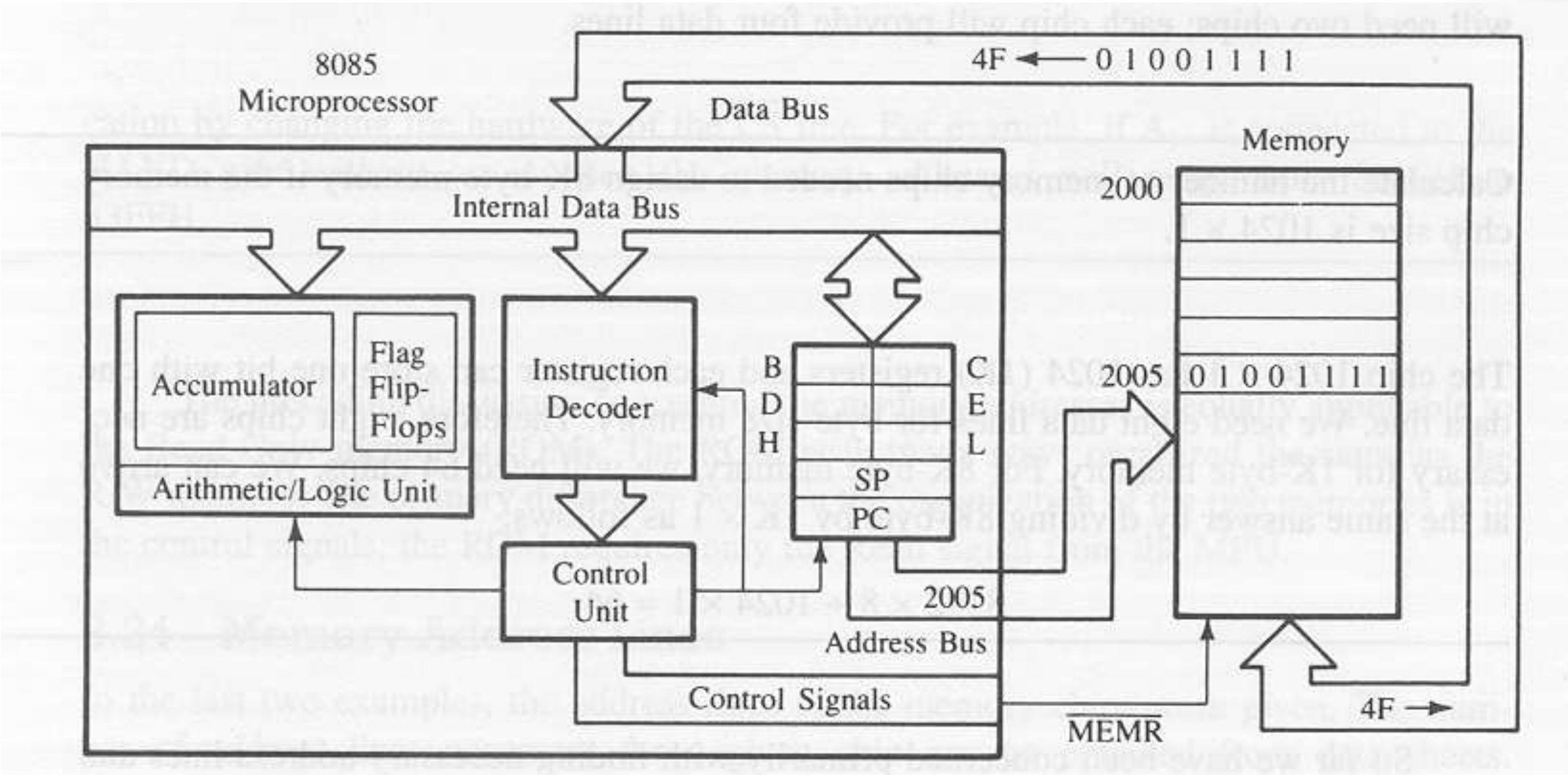
Example: Memory Read Operation



Example: Instruction Fetch Operation

- All instructions (program steps) are stored in memory.
- To run a program, the individual instructions must be read from the memory in sequence, and executed.
  - Program counter puts the 16-bit memory address of the instruction on the address bus
  - Control unit sends the Memory Read Enable signal to access the memory
  - The 8-bit instruction stored in memory is placed on the data bus and transferred to the instruction decoder
  - Instruction is decoded and executed

Example: Instruction Fetch Operation



Features of 8085

Manufactured by INTEL

A 40 pin IC

An 8-bit microprocessor

A single chip, NMOS device implemented with approx. 7000 transistors

8 – bit data bus

Requires a single power supply of +5V

On chip clock generator

Requires two phase, 50% duty cycle TTL clock

Max. clock frequency: 3 MHz & Min. clock frequency: 500 KHz

16 address lines: it can access 64 K memory locations

Registers inside are PIPO type

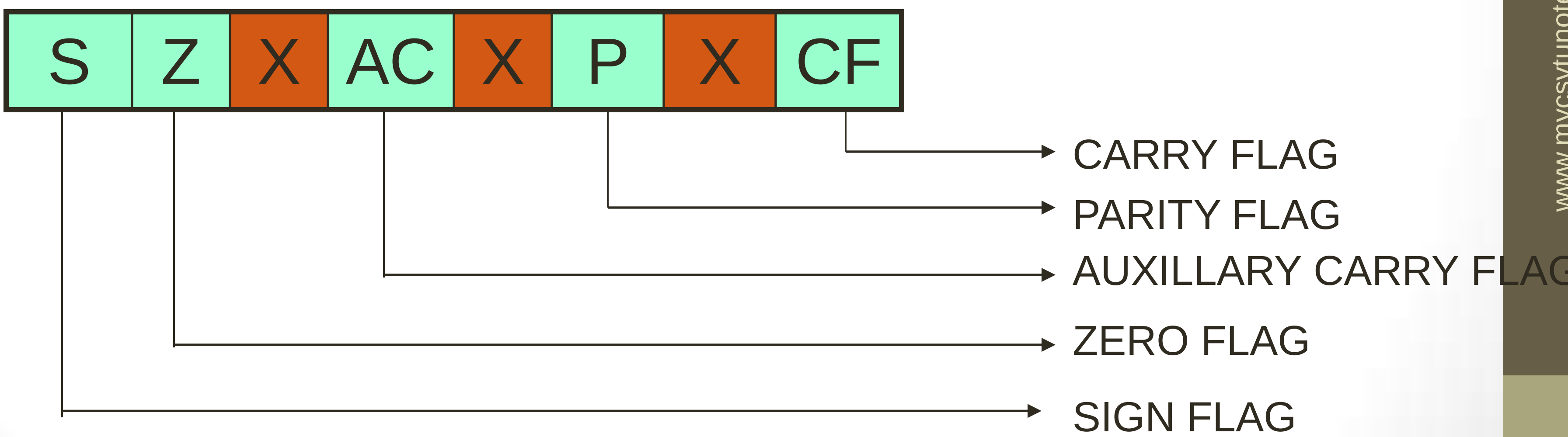
Register Structure of 8085

General Purpose : **B, C, D, E, H, L (all 8bits)**

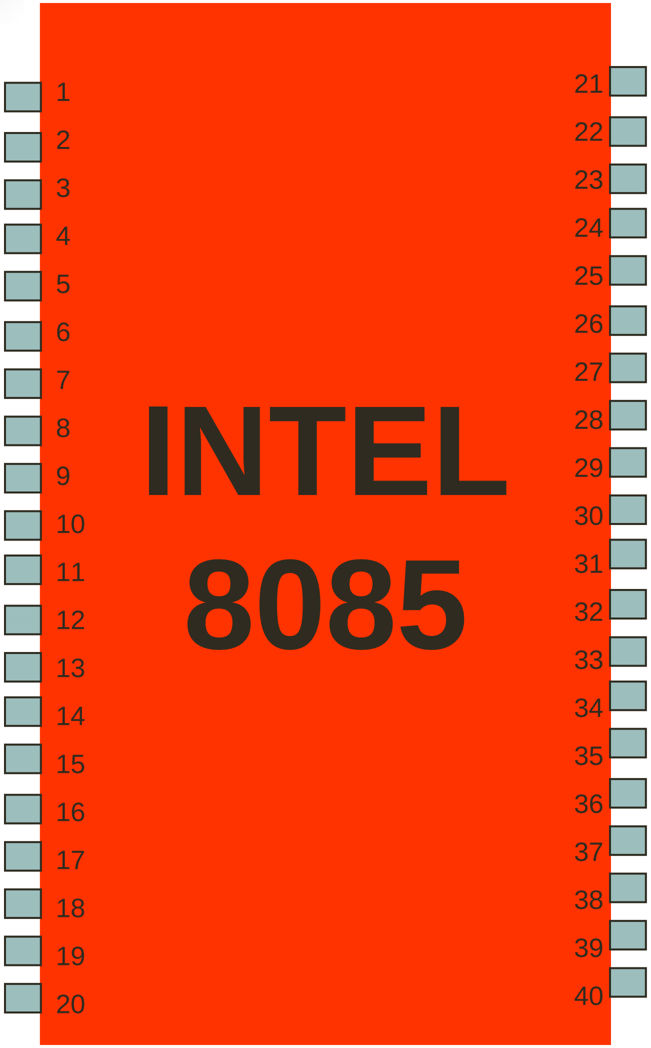
Special Purpose : **A, F, PC, SP, Incrementer / Decrementer address latch**

Temporary : **TMP, W & Z**

CONSTRUCTION OF FLAG REGISTER:



PIN DIAGRAM



PIN NO.	NAME	TYPE
1,2	X_1, X_2	I
3	RESET OUT	O
4	SOD	O
5	SID	I
6	TRAP	I
7	RST 7.5	I
8	RST 6.5	I
9	RST 5.5	I
10	INTR	I
11	$\overline{INTA}$	O
12-19	AD_0 - AD_7	I/O
20	V_{SS}	

PIN NO.	NAME	TYPE
21 - 28	$A_8 – A_{15}$	O
29	S_0	O
30	ALE	O
31	$\overline{WR}$	O
32	$\overline{RD}$	O
33	S_1	O
34	IO/$\overline{M}$	O
35	READY	I
36	$\overline{RESET\ IN}$	I
37	CLK OUT	O
38	HLDA	O
39	HOLD	I
40	V_{CC}	

Groups of Pins:

Address Bus
Data Bus
Status Signals
Control signals
Clock Signals

Power Supply
DMA Request Signals
Interrupt Signals
Reset Signals
Serial I/O Signals

Pin Function of 8085

Input Pins: **$\overline{\text{RESET IN}}$, HOLD, SID, READY, TRAP, RST 7.5, RST 6.5, RST 5.5, INTR**

Status Signal Pins: S_0, S_1

Output Pins: RESET OUT, HLDA, $\overline{\text{INTA}}$, SOD, CLK OUT, $\overline{\text{RD}}$, $\overline{\text{WR}}$, IO/$\overline{\text{M}}$, ALE, S_0, S_1, $A_8 – A_{15}$,

Power Supply Pins: V_{cc}, V_{SS}

Pins which carry data & address: $AD_0 – AD_7$ *(Bidirectional)*

Pins which carry address only: $A_8 – A_{15}$

Pins related to clock: X_1, X_2, CLOCK OUT

Pins that carry only data: SID, SOD

Pins related to Interrupt: TRAP, RST 5.5, RST 6.5, RST 7.5, INTR, $\overline{\text{INTA}}$

Control Signal Pins: RESET OUT, CLK OUT, $\overline{\text{RD}}$, $\overline{\text{WR}}$, IO/$\overline{\text{M}}$,

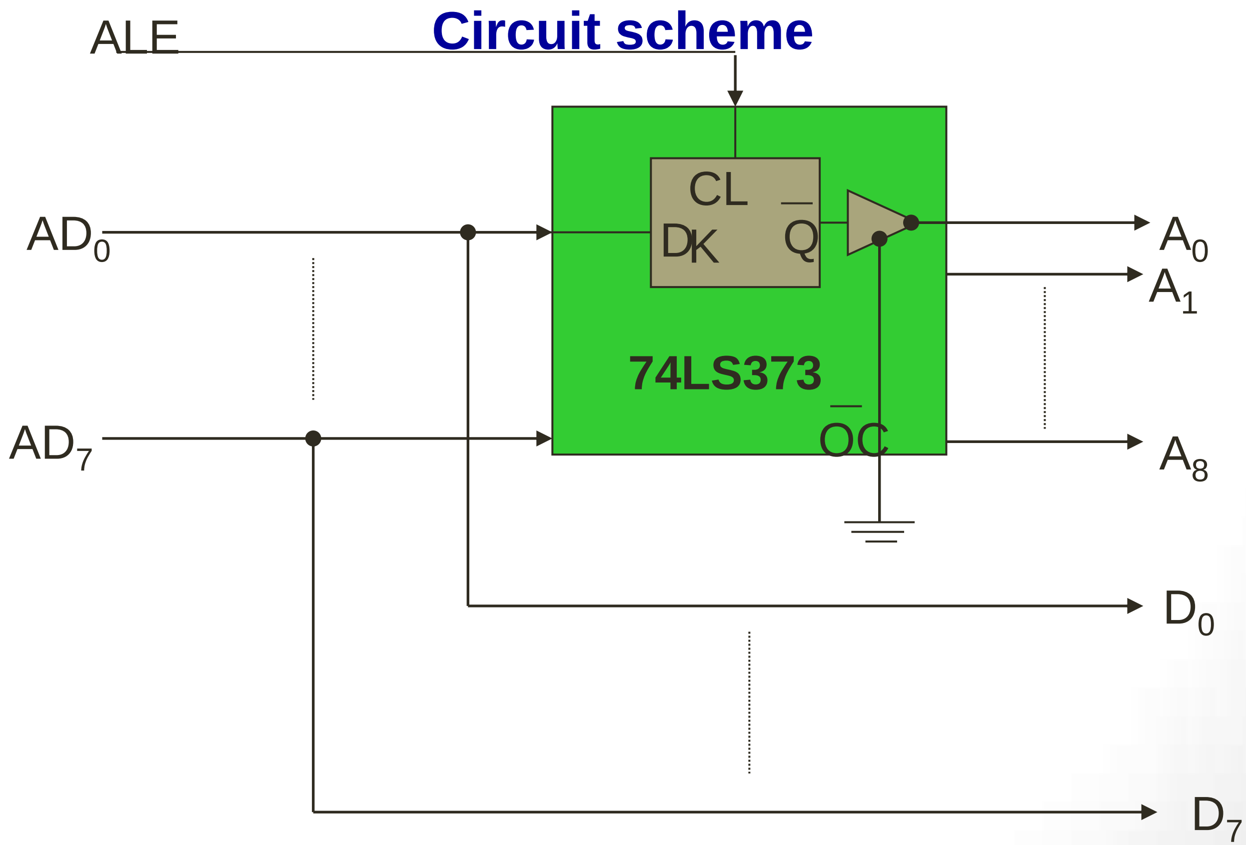
Multiplexed Pins: AD_0 - AD_7

Multiplexing of AD_0 – AD_7

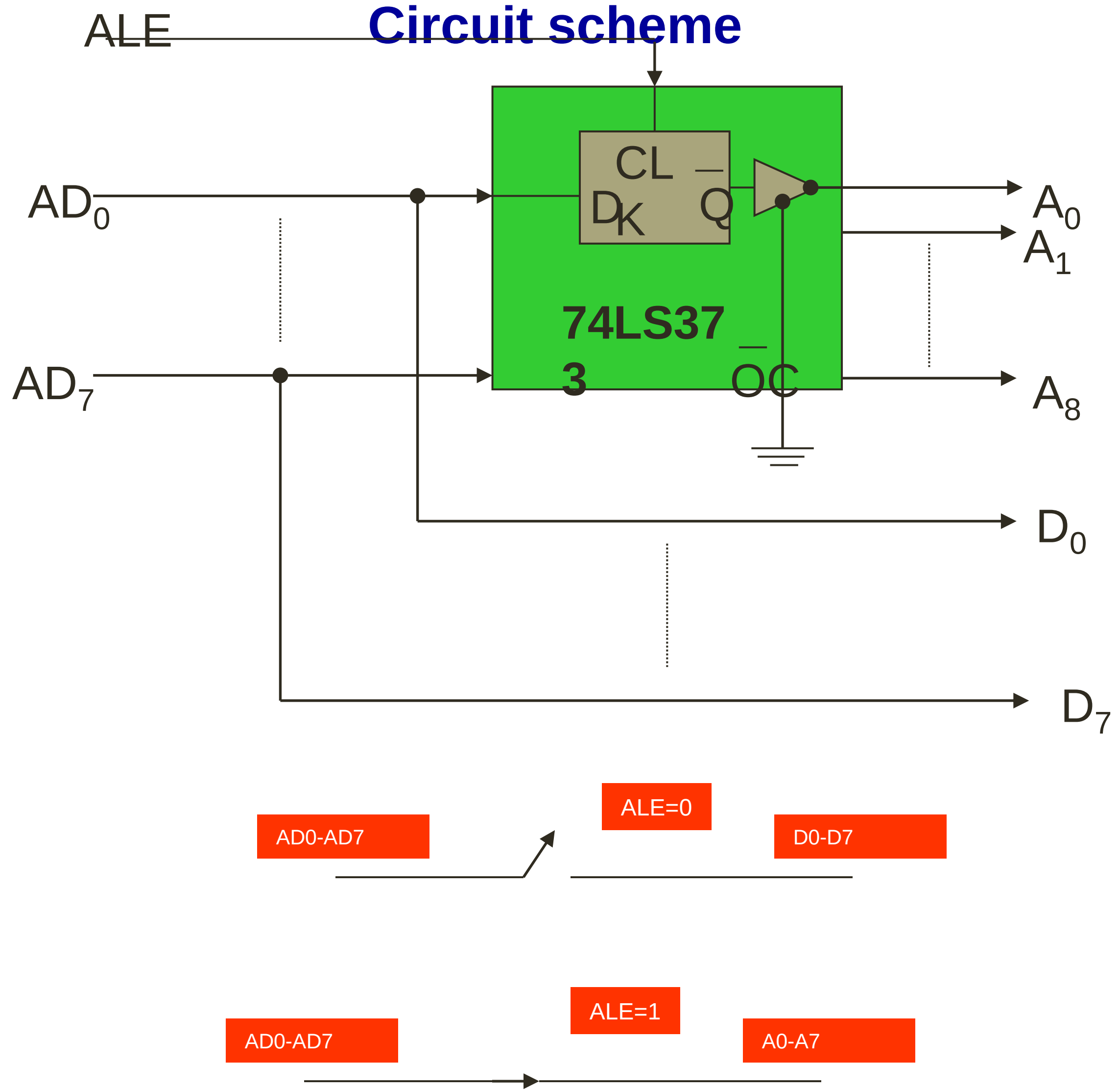
Type of Multiplexing: **Time Division** Controlled by: **ALE pin**

Requirement: **To limit the no. of pins of 8085 to 40 only**

Circuit scheme



Circuit scheme



Question Bank - I

1. Mention the features of 8085.
2. Describe the functions of the following registers of 8085: Instruction Register, PC, SP, Incrementer / Decrementer Address latch.
3. How many temporary registers are there in8085? Mention their utilizations.
4. Discuss the scheme of multiplexing Address/Data bus in 8085.
5. Explain the structure of flag register of 8085.
6. With a neat diagram discuss the architecture of 8085.
7. Classify the registers of 8085 and mention their functions in brief.
8. Why Accumulator is said to be a special register?
9. What are program visible and program invisible registers?
10. Why it is said that HL pair is a special pair?
11. Write a brief note on 'virtual register'.
12. Classify various pins of 8085.
13. Mention the functions of the following pins of 8085: ALE, CLK OUT, RESET OUT, $\overline{\text{RESET IN}}$
14. Mention the functions of the clock related pins of 8085.
15. Briefly discuss the how clock signal is generated in 8085.
16. Mention the pins which carry both address as well as data. How they are demultiplexed?
17. Which pins of 8085 carry only data?
18. Which pins of 8085 are bidirectional?
19. Why the address bus is unidirectional whereas data bus is bidirectional?
20. How can you generate $\overline{\text{IOR}}$, $\overline{\text{IOW}}$, $\overline{\text{MEMR}}$ and $\overline{\text{MEMW}}$ signals?