Notes
On
8085 microprocessor

Submitted To:
Patna University

Submitted By:
Dr. Gargi Tiwari
Guest Asst. Prof. (Physics)

Introduction

- **Microprocessor is a Central Processing Unit (CPU) etched on a single chip. A single Integrated Circuit (IC) has all the functional components of a CPU namely Arithmetic Logic Unit (ALU), Control Unit and registers. The 8085 microprocessor is an 8-bit processor that includes on its chip most of the logic circuitry for performing computing tasks and for communicating with peripherals.**
- **What about micro? • Micro is a new addition. – In the late 1960's, processors were built using discrete elements. • These devices performed the required operation, but were too large and too slow. – In the early 1970's the microchip was invented. All of the components that made up the processor were now placed on a single piece of silicon. The size became several thousand times smaller and the speed became several hundred times faster. The "Micro"Processor was born.**

Definition of the Microprocessor:

The microprocessor is a programmable device that takes in numbers, performs on them arithmetic or logical operations according to the program stored in memory and then produces other numbers as a result.

Programmable device: The microprocessor can perform different sets of operations on the data it receives depending on the sequence of instructions supplied in the given program. By changing the program, the microprocessor manipulates the data in different ways. –

Instructions: Each microprocessor is designed to execute a specific group of operations. This group of operations is called an instruction set. This instruction set defines what the microprocessor can and cannot do.

Takes in: The data that the microprocessor manipulates must come from somewhere. • It comes from what is called "input devices". • These are devices that bring data into the system from the outside world. • These represent devices such as a keyboard, a mouse, switches, and the like.

Numbers: The microprocessor has a very narrow view on life. It only understands binary numbers. A binary digit is called a bit (which comes from binary digit). The microprocessor recognizes and processes a group of bits together. This group of bits is called a "word". The number of bits in a Microprocessor's word, is a measure of its "abilities".

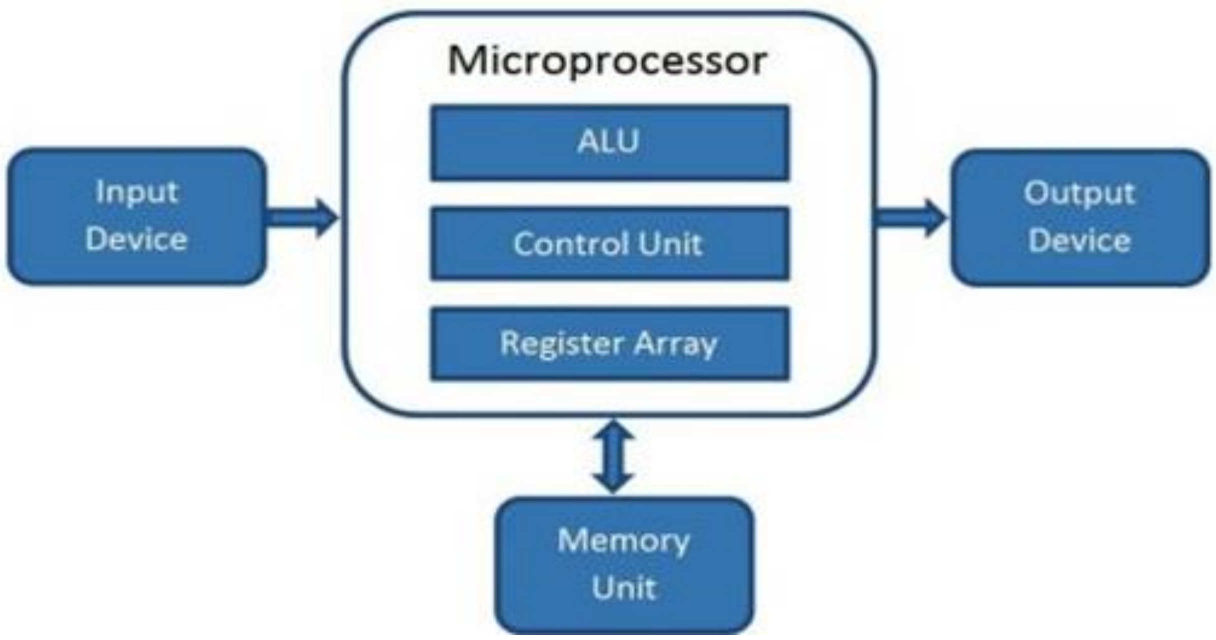
Arithmetic and Logic Operations:

Every microprocessor has arithmetic operations such as add and subtract as part of its instruction set. – Most microprocessors will have operations such as multiply and divide. – Some of the newer ones will have complex operations such as square root. • In addition, microprocessors have logic operations as well. Such as AND, OR, XOR, shift left, shift right, etc. • Again, the number and types of operations define the microprocessor's instruction set and depends on the specific microprocessor.

Stored in memory : **First, what is memory?** – Memory is the location where information is kept while not in current use. – Memory is a collection of storage devices. Usually, each storage device holds one bit. Also, in most kinds of memory, these storage devices are grouped into groups of 8. These 8 storage locations can only be accessed together. So, one can only read or write in terms of bytes to and form memory. – Memory is usually measured by the number of bytes it can hold. It is measured in Kilos, Megas and lately Gigas. A Kilo in computer language is 210 =1024. So, a KB (KiloByte) is 1024 bytes. Mega is 1024 Kilos and Giga is 1024 Mega.

When a program is entered into a computer, it is stored in memory. Then as the microprocessor starts to execute the instructions, it brings the instructions from memory one at a time. • Memory is also used to hold the data. – The microprocessor reads (brings in) the data from memory when it needs it and writes (stores) the results into memory when it is done.

- **A Microprocessor-based system**
- From the above description, we can draw the following block diagram to represent a microprocessor-based system:



Machine Language

The number of bits that form the "word" of a microprocessor is fixed for that particular processor. – These bits define a maximum number of combinations.

For example an 8-bit microprocessor can have at most 28 = 256 different combinations.

However, in most microprocessors, not all of these combinations are used. – Certain patterns are chosen and assigned specific meanings. – Each of these patterns forms an instruction for the microprocessor. – The complete set of patterns makes up the microprocessor's machine language.

- **The 8085 Machine Language**

The 8085 (from Intel) is an 8-bit microprocessor. – The 8085 uses a total of 246 bit patterns to form its instruction set. – These 246 patterns represent only 74 instructions. The reason for the difference is that some (actually most) instructions have multiple different formats. Because it is very difficult to enter the bit patterns correctly, they are usually entered in hexadecimal instead of binary. For example, the combination 0011 1100 which translates into "increment the number in the register called the accumulator", is usually entered as 3C.

00111100 translates to 3C in hexadecimal (OPCODE)

– Its mnemonic is: "INR A".

– INR stands for "increment register" and A is short for

accumulator.

Assembly Language

• It is important to remember that a machine language and its associated assembly language are completely machine dependent. – In other words, they are not transferable from one microprocessor to a different one. • For example, Motorolla has an 8-bit microprocessor called the 6800. – The 8085 machine language is very different from that of the 6800. So is the assembly language. – A program written for the 8085 cannot be executed on the 6800 and vice versa. "Assembling" The Program • How does assembly language get translated into machine language? – There are two ways: – 1st there is "**hand assembly**". • The programmer translates each assembly language instruction into its equivalent hexadecimal code (machine language). Then the hexadecimal code is entered into memory. – The other possibility is a program called an **"assembler",** which does the translation automatically.

Intel 8085 Microprocessor

- **Microprocessor consists of:**

– Control unit: control microprocessor operations.

– ALU: performs data processing function.

– Registers: provide storage internal to CPU.

– Interrupts

– Internal data bus

In addition to the arithmetic & logic circuits, the ALU includes the accumulator, which is part of every arithmetic & logic operation. • Also, the ALU includes a temporary register used for holding data temporarily during the execution of the operation. This temporary register is not accessible by the programmer.

General Purpose Registers • B, C, D, E, H & L (8 bit registers) • Can be used singly • Or can be used as 16 bit register pairs – BC, DE, HL • H & L can be used as a data pointer (holds memory address)

Special Purpose Registers • Accumulator (8 bit register) – Store 8 bit data – Store the result of an operation – Store 8 bit data during I/O transfer

Flag Register 8 bit register – shows the status of the microprocessor before/after an

operation

– S (sign flag), Z (zero flag), AC (auxillary carry flag), P (parity flag) &

CY (carry flag)

– Sign Flag

• Used for indicating the sign of the data in the accumulator

• The sign flag is set if negative (1 – negative)

• The sign flag is reset if positive (0 –positive)

Introduction to 8085 Instructions

Since the 8085 is an 8-bit device it can have up to 28 (256) instructions. • However, the 8085 only uses 246 combinations that represent a total of 74 instructions. – Most of the instructions have more than one format.

– These instructions can be grouped into five different groups: • Data Transfer Operations • Arithmetic Operations • Logic Operations • Branch Operations • Machine Control Operations

Each instruction has two parts. – The first part is the task or operation to be performed. • This part is called the "opcode" (operation code).

– The second part is the data to be operated on • Called the "operand"

These operations simply COPY the data from the

source to the destination.

– MOV, MVI, LDA, and STA

– They transfer:

• Data between registers.

• Data Byte to a register or memory location.

• Data between a memory location and a register.

• Data between an I\O Device and the accumulator.

– The data in the source is not changed.

Features

8 bit microprocessor (8085 microprocessor can read or write or perform arithmetic and logical operations on 8-bit data at time)

It has 8 data lines and 16 address lines hence capacity is 216 = 64 kB of memory

Cock frequency is 3 MHz

It requires +5V power supply.

It is a single chip NMOS device implemented with 6200 transistors.

It provides 74 instructions with five addressing modes.

It provides 5 hardware interrupt and 8 software interrupts.

Pin Configuration

- **40 pins classified into 6 groups:**

1. **Data bus**
2. **Address bus**
3. **Control & status lines**
4. **Externally generated**
5. **Serial interface**
6. **Power supply & clock**

1) Address Bus (A15-A8 and AD7-AD0):

The microprocessor 8085 has 16 bit address lines from A15-A8 and AD7-AD0. These lines are used to transfer 16 bit address of memory as well as 8-bit address of I/O ports.

2) Data Bus:

The lower 8 lines (AD7-AD0) are often called as multiplexed data lines.

CONTROL LINES

- **RD : Read:** This is active low signal which indicates that the selected I/O or memory device is to be read and also is available on the data bus.
- **WR : Write:** This is active low signal which indicates that the data on data bus are to be written into a selected memory location.
- **IO/ M : (Input / Output / Memory):** This is used to select either Input / Output devices or memory operation. When it is high it indicates an I/O operation and when it is low, it indicates a memory operation.

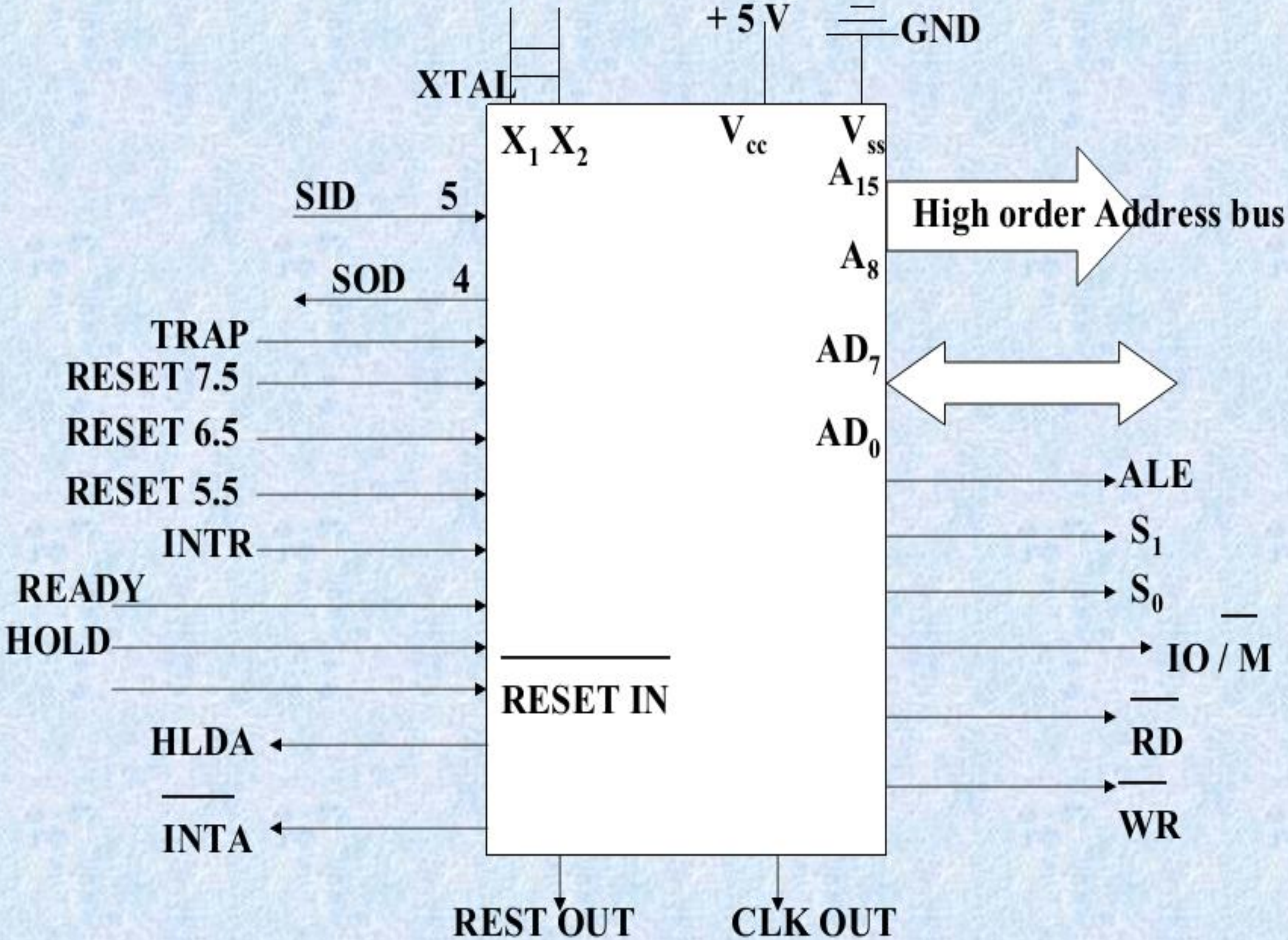
STATUS LINES

- **Status Pins (S1, S0):** The microprocessor 8085 has two status pins as S1, S0 which is used to indicate the status of microprocessor or operation which is performed by microprocessor.

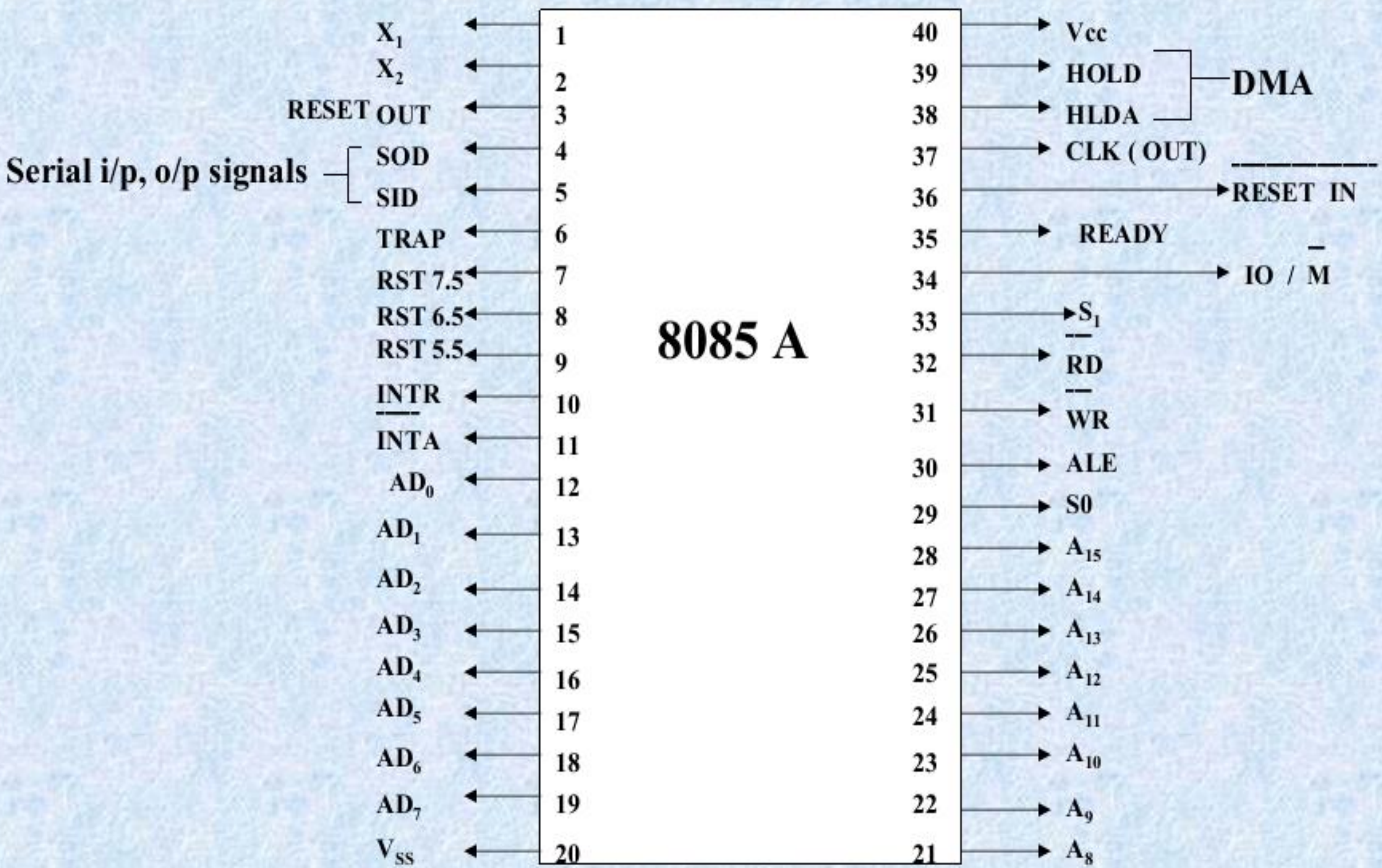
SPECIAL SIGNAL

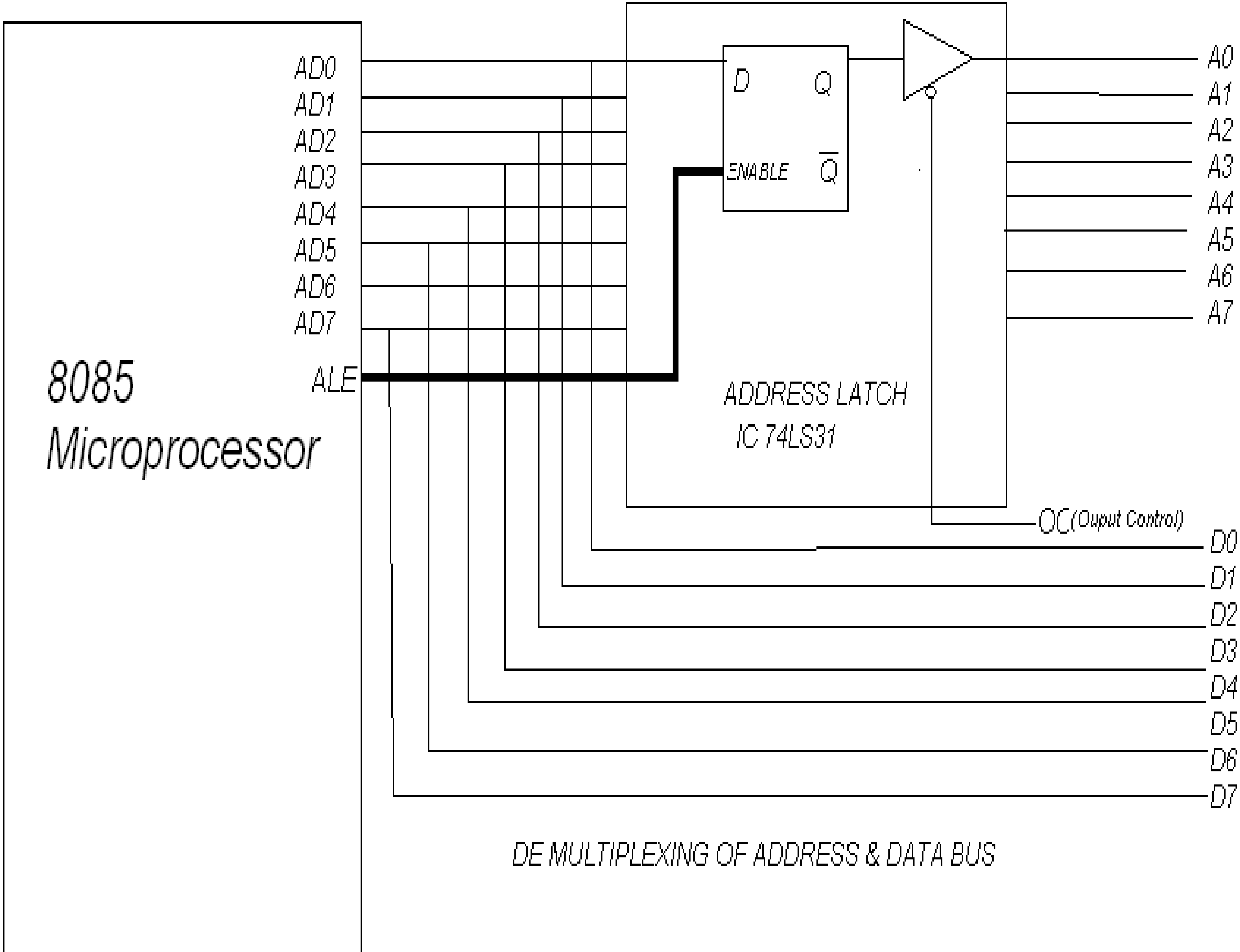
- **ALE (Address Latch Enable):** The ALE signal is used to enable or disable the external latch IC (74373/8212).
- The external latch IC is used for the de-multiplexing of AD7-AD0 lines, i.e., it is used to separate the address and data from AD7-AD0 lines.
- If ALE = 1/0 then external latch IC is enabled / disabled respectively.

Signal Groups of 8085



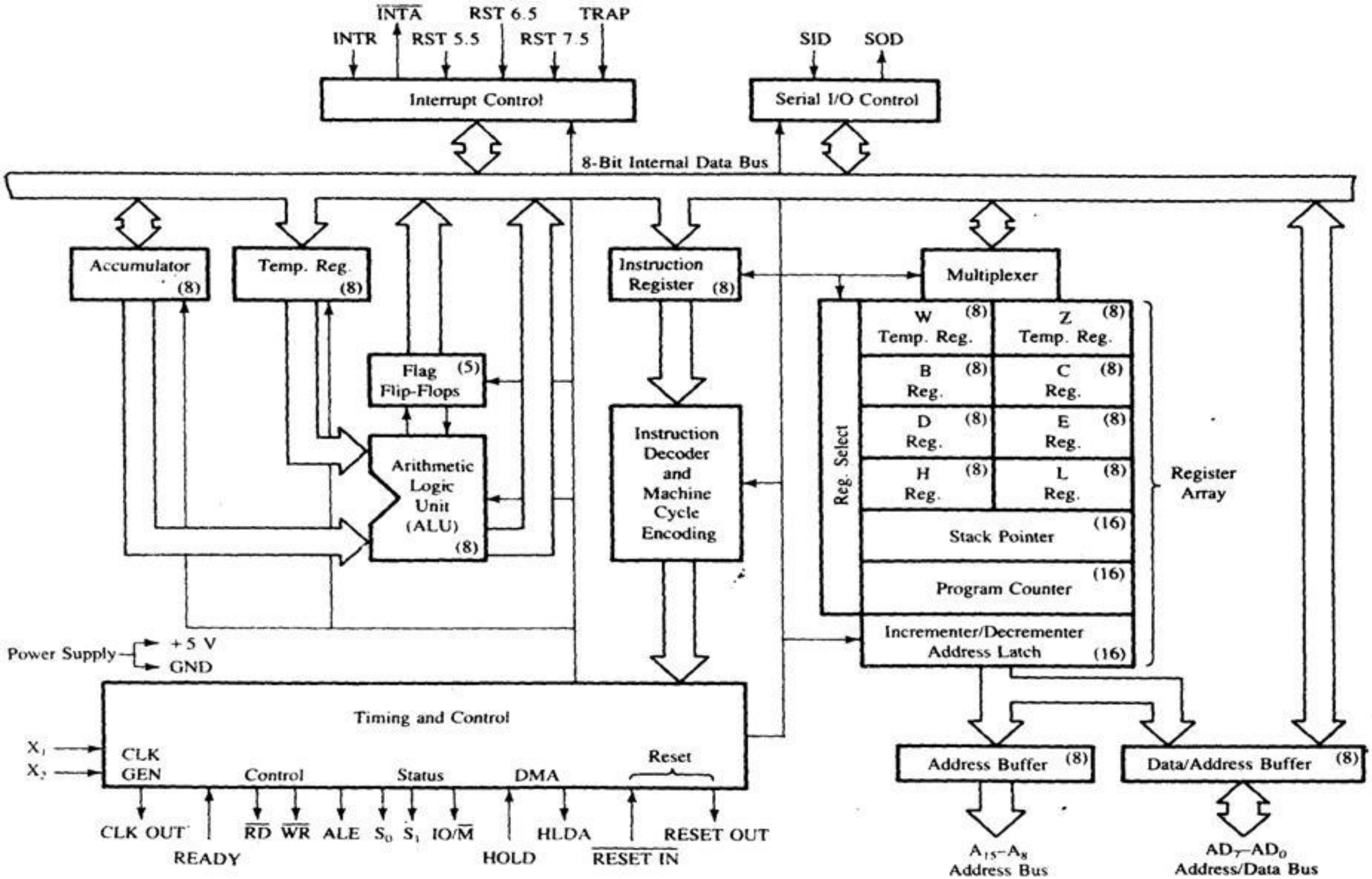
Pin Diagram of 8085





DE MULTIPLEXING OF ADDRESS & DATA BUS

DRAWN BY ATAL TRIKHA

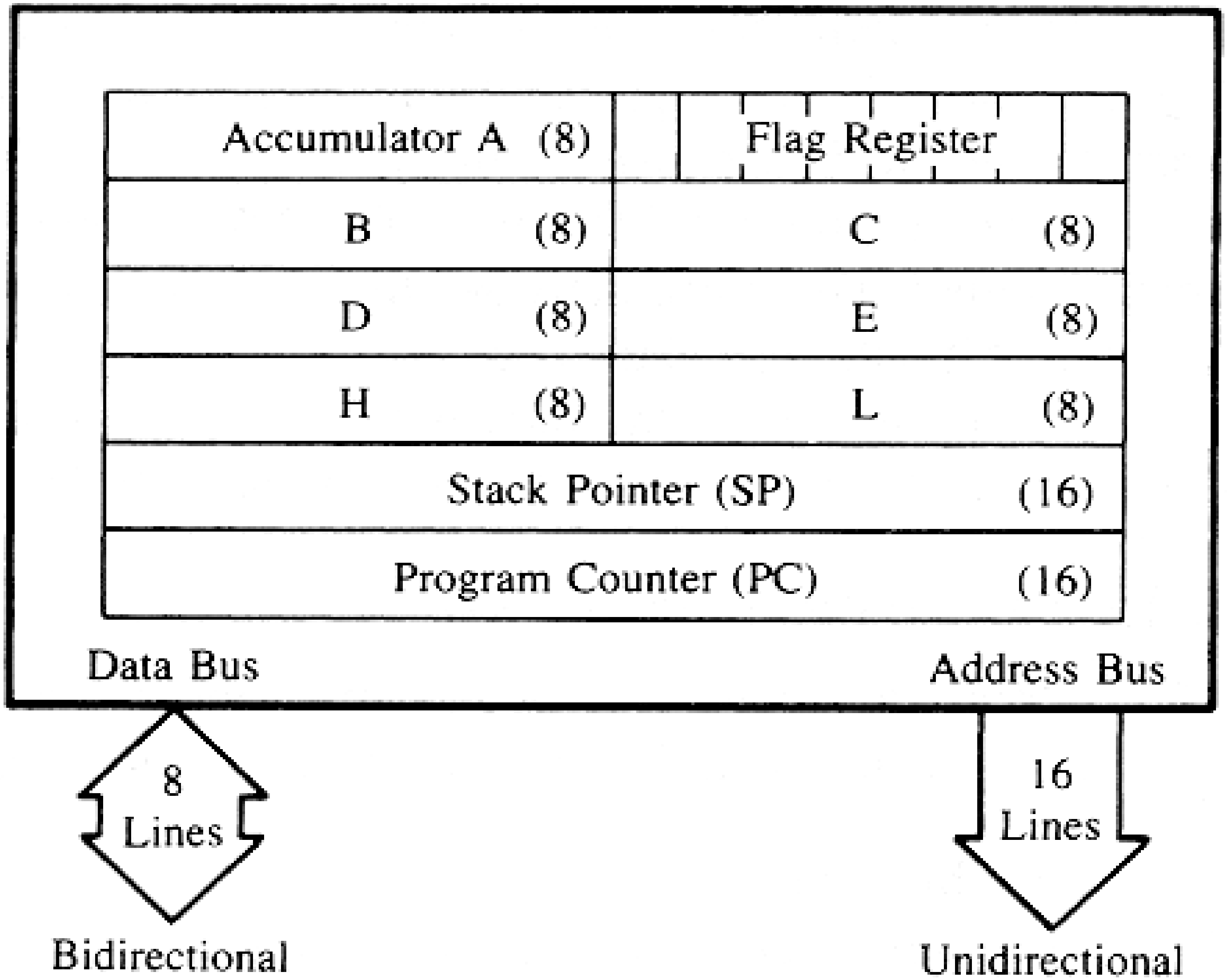


INTA
INTR
RST 5.5
RST 6.5
RST 7.5
TRAP
SID
SOD
Interrupt Control
Serial I/O Control
8-Bit Internal Data Bus
Accumulator (8)
Temp. Reg. (8)
Instruction Register (8)
Multiplexer
Flag Flip-Flops (5)
Arithmetic Logic Unit (ALU) (8)
Instruction Decoder and Machine Cycle Encoding
W Temp. Reg. (8)
Z Temp. Reg. (8)
B Reg. (8)
C Reg. (8)
D Reg. (8)
E Reg. (8)
H Reg. (8)
L Reg. (8)
Reg. Select
Stack Pointer (16)
Program Counter (16)
Incrementer/Decrementer Address Latch (16)
Register Array
Power Supply
+5 V
GND
Timing and Control
X1
X2
CLK GEN
Control
Status
DMA
Reset
CLK OUT
READY
RD
WR
ALE
S0
S1
IO/M
HOLD
HLDA
RESET IN
RESET OUT
Address Buffer (8)
Data/Address Buffer (8)
A15–A8 Address Bus
AD7–AD0 Address/Data Bus

Architecture Of 8085

1. **ALU**
2. **Timing and Control Unit**
3. **General Purpose Registers**
4. **Program Status word**
5. **Program Counter**
6. **Stack Pointer**
7. **Instruction Register and Decoder**
8. **Interrupt Control**
9. **Serial I/O Control**
10. **Address Bus**
11. **Data Bus**

PROGRAMMING MODEL OF 8085



REGISTERS

The Registers are of 8-bit & 16-bit size used for different purposes

A- Accumulator – This is an special purpose register. All the ALU operations are performed with reference to the contents of Accumulator.

B,C,D,E,H,L – General purpose registers. These registers can also used for 16-bit operations in pairs. The default pairs are BC, DE & HL.

F – Flag register – This register indicates the status of the ALU operation.

D7	D6	D5	D4	D3	D2	D1	D0
S	Z		AC		P		CY

PC – Program Counter – This is a 16-bit register used to address the memory location from where an instruction is going to be executed.

SP – Stack pointer - This is a 16-bit register used to address the top of the stack memory location.

Temporary register, W & Z – These registers are only used by 8085 and are not available for the programmer.

ALU – Arithmetic & Logic Unit

ALU of 8085 performs 8-bit arithmetic & logical operations. The operations are generally performed with Accumulator as one of the operands. The result is saved in accumulator register.

Timing & Control Unit

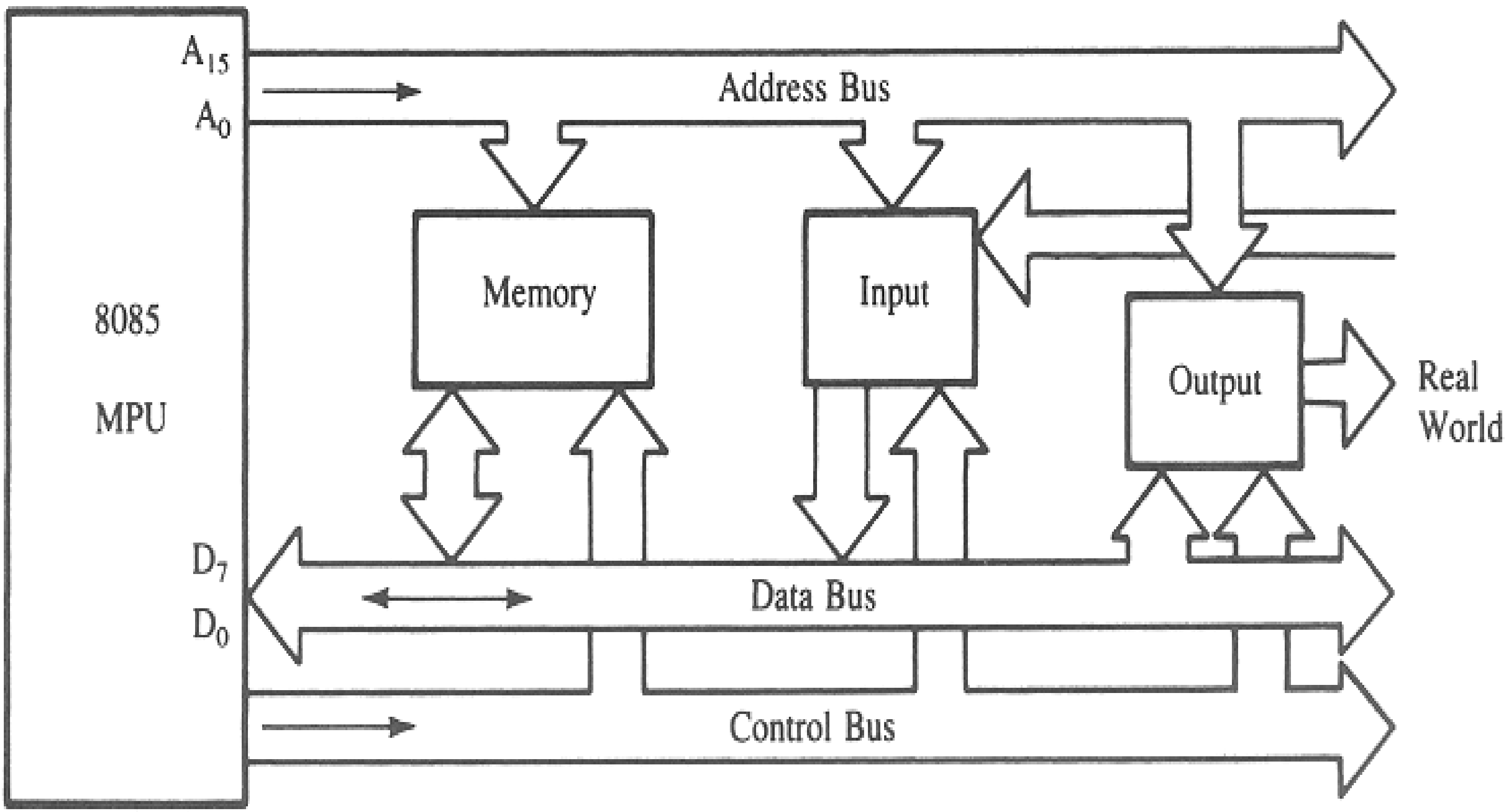
This unit works as the brain of the CPU and generates all the timing and control signals to perform all the internal & external operations of the CPU.

Instruction Decoder & Machine Cycle Encoder Unit

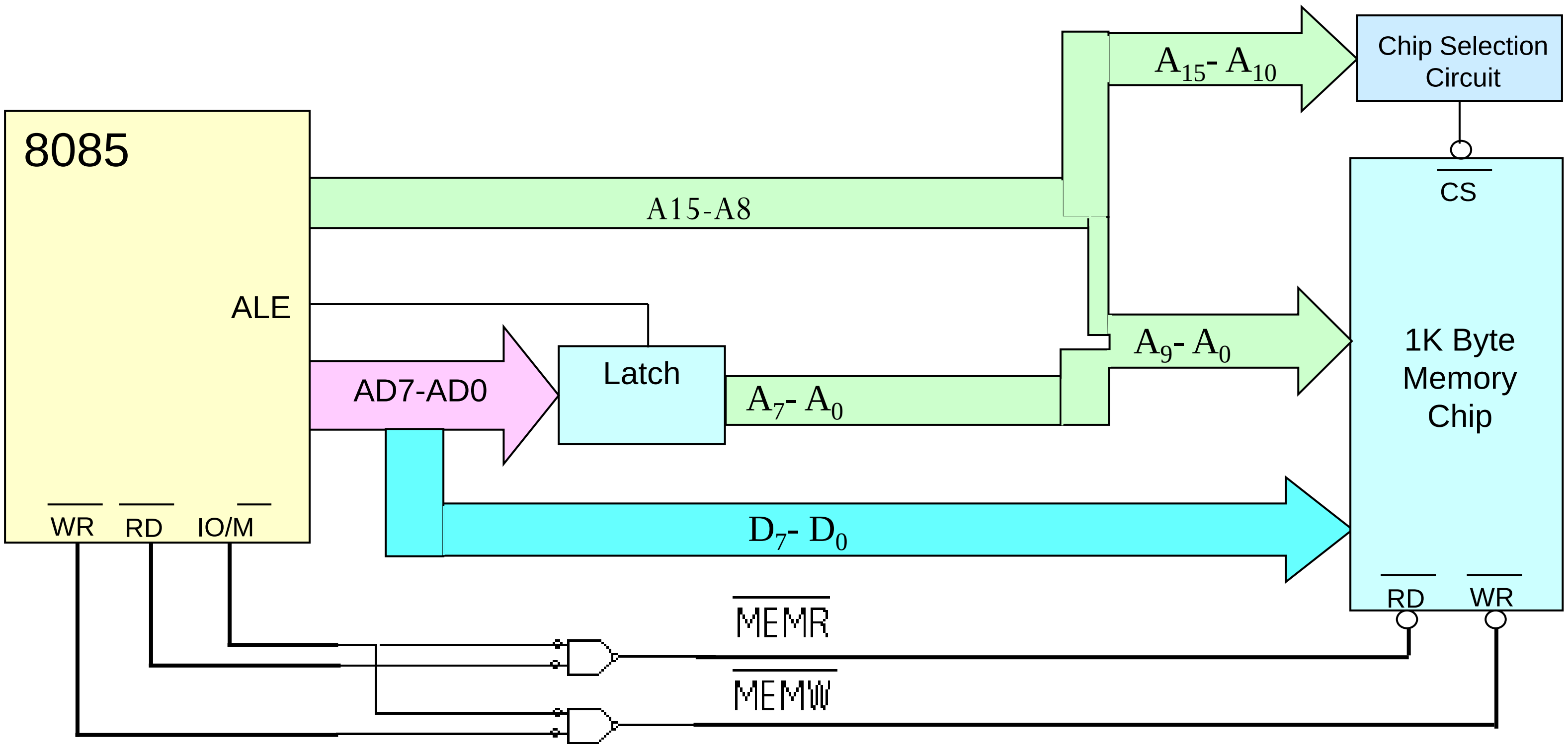
This unit decodes the op-code stored in the Instruction Register (IR) and encodes it for the timing & control unit to perform the execution of the instruction.

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.



Over all structure



MPU Communication and Bus Timing

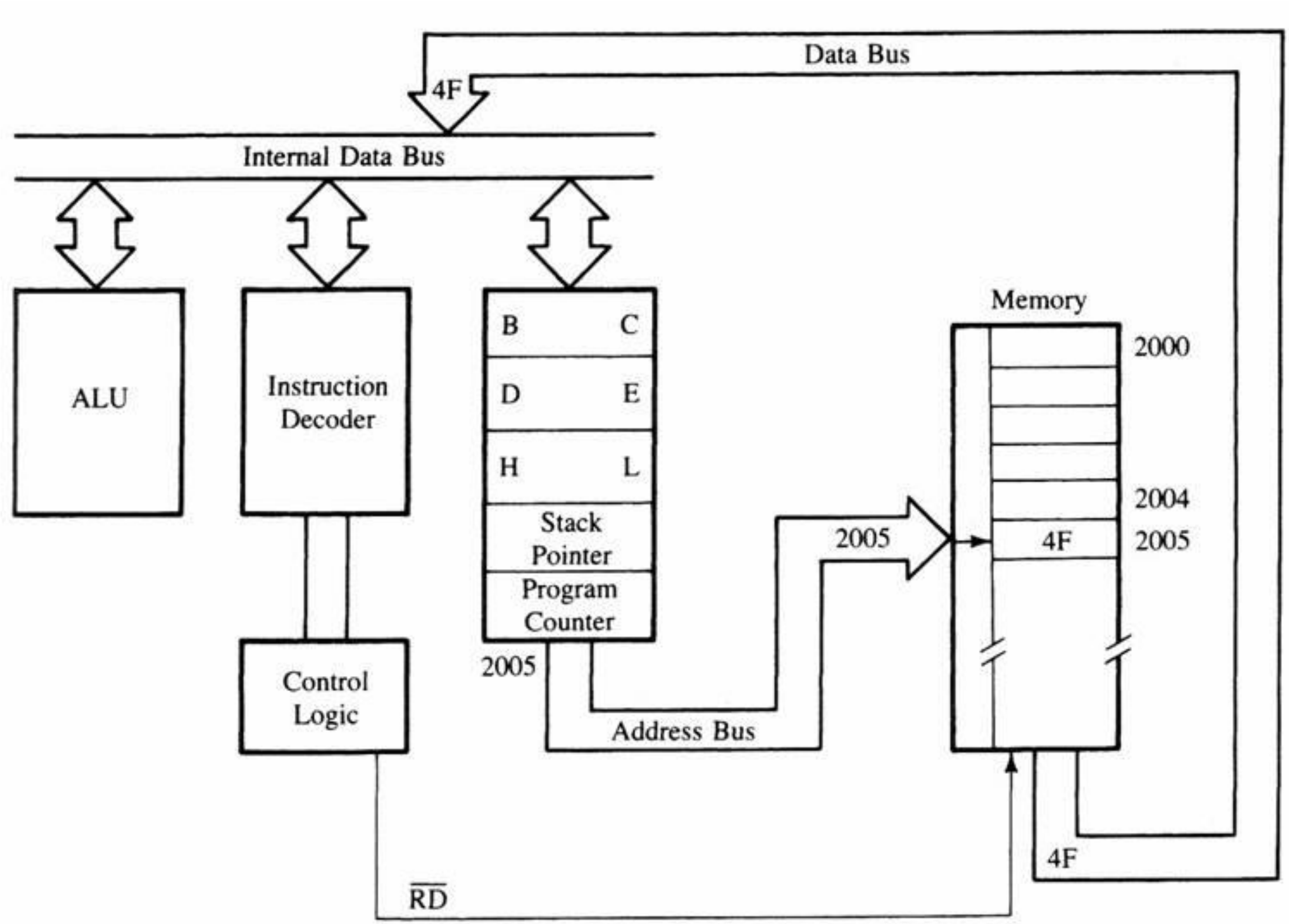


Figure 3: Moving data form memory to MPU using instruction MOV C, A (code machine 4FH = 0100 1111)

Instruction Set

- Broadly classified into two types:
  - Based on word size:
    - One word- Opcode only (CMA, ADD B)
    - Two word- Opcode ,an operand (MVI A,32H)
    - Three word- Opcode, operand, operand (LDA 4200, STA 4500)
  - Based on function:
    - Data transfer group (MOV A,B; MVI A,32H;MOV C,4500)
    - Arithmetic operations (ADD B, SBI 32H,INC D, DEC B)
    - Logical operations (ANA B, ORI 05H, RLC, RAR)
    - Branching operations (JUMP, JMP, JNZ, JC, CALL, RETURN)
    - Machine control instructions (HLT, NOP,EI,DI,SIM,RIM)

Addressing Modes

- Immediate (MOV A,B ;ADD B; SUB E;ANA C)
- Register (MVI A,05H;LXI B, 20AEH; ADI 05H;ORI 07H)
- Direct (LDA 4500H;STA 7500H;IN 09H;OUT 70H)
- Indirect (MOV A, M;MOV M,A;ADD M;ORA M)
- Implied(implicit) (HLT; NOP;RST;RET)

Timing diagrams

- **The 8085 microprocessor has 7 basic machine cycle. They are**

1. Op-code Fetch cycle(4T or 6T).

2. Memory read cycle (3T)

3. Memory write cycle(3T)

4. I/O read cycle(3T)

5. I/O write cycle(3T)

6. Interrupt Acknowledge cycle(6T or 12T)

7. Bus idle cycle

References

www.google.com

Microprocessor Architecture, Programming, and Applications with the 8085 5/e

by Ramesh Gaonkar