Introduction to Microprocessor Based System

Prepared as per Gaonkar's 'Microprocessor Architecture, Programming and Applications with the 8085'

Contents:

1. History of Microprocessors

The journey of microprocessors began with the Intel 4004 in 1971, a 4-bit processor with 2,300 transistors...

Subsequent developments include:

- Intel 8008 (1972): Expanded to 8-bit data bus...
- Intel 8080 (1974): Enhanced instruction set, used in early personal computers...
- Intel 8085 (1976): Single +5V supply, 74 instructions, integrated clock...

Discussion on evolution of instruction set complexity, integration levels, and impact on embedded systems.

2. Architecture of 8085 Microprocessor

The 8085 architecture comprises the following key elements:

- Arithmetic and Logic Unit (ALU): Performs arithmetic and logical operations.
- Register Array: Six general-purpose registers and the accumulator...
- Flag Register: Five flip-flops indicating status of ALU operations...
- Control Unit: Decodes instructions and generates control signals...
- Timing and Control Circuits: Synchronize internal and external operations.

Detailed block-level explanation of data flow for MOV A,B instruction.

3. Pin Details of 8085

The 8085 has a 40-pin DIP package categorized as:

- Power Supply and Clock: Vcc, GND, X1, X2, CLK OUT...
- Address and Data Bus: AD0-AD7 (multiplexed), A8-A15...
- Control Signals: RD, WR, IO/M, S0, S1...
- Status and Interrupts: INTR, RST7.5, RST6.5, TRAP...

A comprehensive table of pin numbers, names, directions, and functions.

4. Functional Block Diagram

Explanation of the overall functional block diagram:

- Interconnections between ALU, registers, buses, and control unit...
- Role of the temporary register and instruction register...
- Timing signals like T1-T4 and their relationship with machine cycles...

Textual walkthrough of signal propagation during an opcode fetch cycle.

5. 8085 Programming Model

In-depth coverage of the programming model:

- Accumulator operations and implicit use in arithmetic instructions...
- Register pair operations (BC, DE, HL) for 16-bit data handling...
- Stack management using SP and the stack segment...
- Use of program counter for control transfer instructions...

Examples: PUSH and POP operations with timing details.

6. Buses: Address, Data, Control

The role and characteristics of each bus:

- Address Bus: 16-bit, unidirectional, carries memory addresses...

- Data Bus: 8-bit, bidirectional, transfers data and instruction bytes...

- Control Bus: Includes signals RD, WR, IO/M, HLDA, HOLD...

Comparison chart between internal and external bus timing.

7. Demultiplexing of Buses

Mechanism to separate address and data on AD0-AD7:

- Use of ALE (Address Latch Enable) pulse to latch low-order address...

- External latch 74LS373 example circuit and timing diagram...

Waveform explanation showing address on AD lines during T1 and data during T2.

8. Generation of Control Signals

Control signal generation by the control unit:

- RD and WR timing relative to T-states...

- IO/M distinction for memory vs I/O operations...

- Status signals S0, S1 for machine cycle identification...

Detailed timing diagram with annotated control signals for a memory write cycle.

9. Instruction Cycle, Machine Cycle, T-State

Definitions and relationships:

- Instruction Cycle: Complete processing of an instruction...
- Machine Cycle: Subdivision (Fetch, Read, Write, Interrupt acknowledge)...
- T-State: Single clock period; illustrated across cycles...

10. Timing Diagrams and Examples

Sample timing diagrams for:

- Opcode fetch machine cycle...

- Memory read and write cycles...

- I/O read and write cycles...

Annotated plots of ALE, RD, WR, and IO/M signals.

11. Sample Assembly Programs

Detailed examples with comments:

a) 8-bit Addition Using Registers:

```
MOV A, #25H
ADD B ; Adds content of B to A
```

b) Memory-to-Memory Data Transfer:

```
LXI H, 4000H
MOV A, M
STA 5000H
```

Step-by-step explanation and timing per instruction.

12. Applications of 8085

Embedded systems using 8085:

- Traffic signal controllers...

- Data acquisition systems...

- Early video games and calculators...

Discussion on modern relevance and alternatives.

13. Review Questions

1. Explain the role of ALE in 8085.
2. Differentiate between machine cycle and instruction cycle.
3. Draw and explain the timing diagram for a memory write cycle.
4. Write an 8085 program to block copy 10 bytes.

14. References

1. Ramesh S. Gaonkar, 'Microprocessor Architecture, Programming and Applications with the 8085', 6th Edition, Penram International.

2. Intel 8085 Data Sheet and Reference Manual.

3. External research articles on microprocessor development.