

Unit 2

Computer Organization and Architecture

Syllabus

Design of control unit - Hardwired control unit, Micro-Programmed control unit and comparative study.

Memory organization-Memory hierarchy, Cache Memory Associative Memory, Cache memory with associative memory, Virtual Memory: Paging, Segmentation.

Input output organization –Asynchronous Data transfer: Source Initiated, Destination Initiated, Handshaking, Programmed I/O, Interrupts DMA, IOP

Hardwired Control Unit

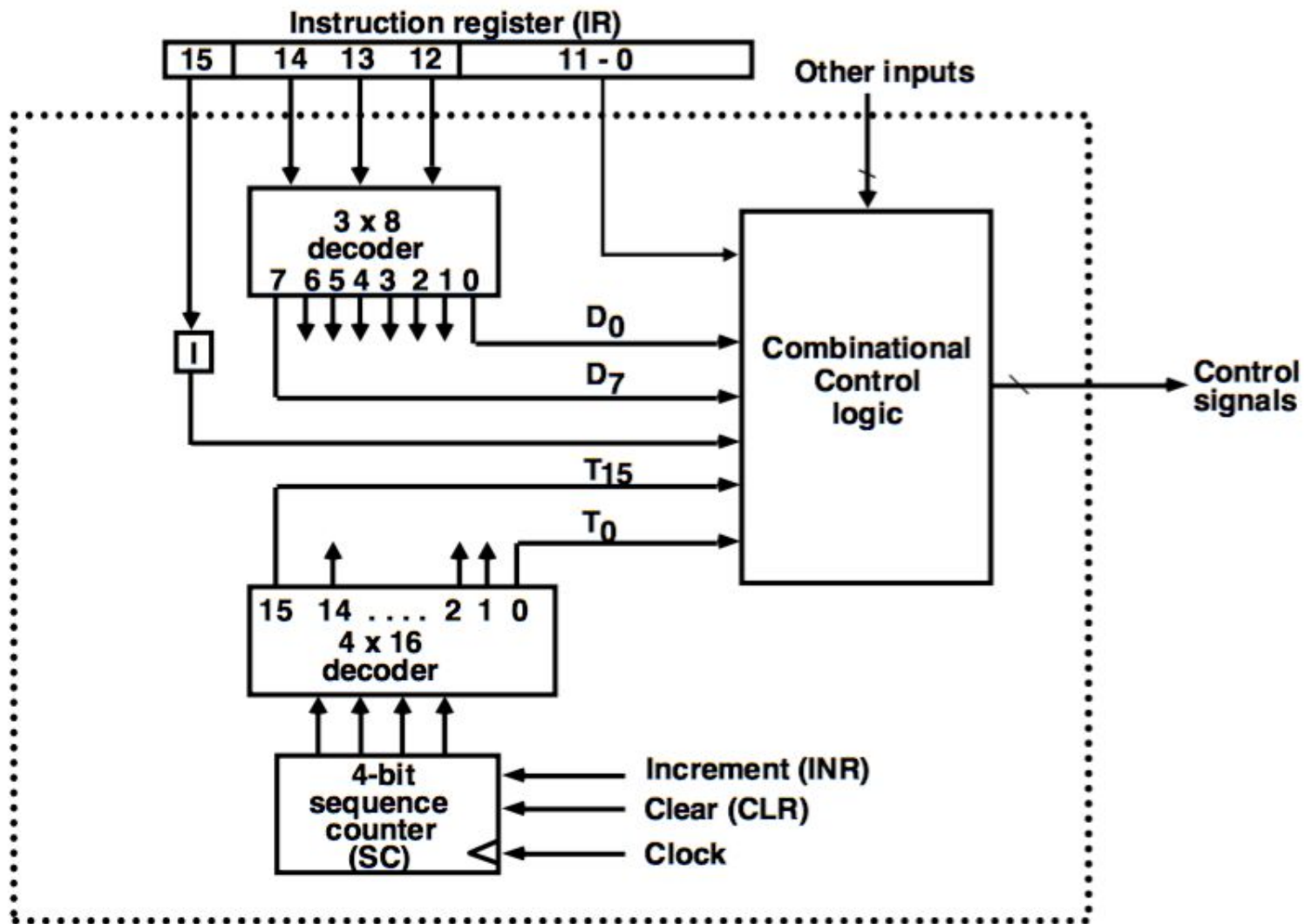
1. CU is made up of sequential and combinational circuits to generate the control signals.
2. It is implemented with the help of gates, flip flops, decoders etc. in the hardware.
3. The inputs to control unit are the instruction register, flags, timing signals etc.
4. This organisation can be very complicated if we have to make the control unit large.
5. If the design has to be modified or changed, all the combinational circuits have to be modified which is a very difficult task.

Cont.

6. It is implemented as logic circuits (gates, flip-flops, decoders etc.) in the hardware.
7. This organisation is very complicated if we have a large control unit.
8. In this organisation, if the design has to be modified or changed, requires changes in the wiring among the various components. Thus the modification of all the combinational circuits may be very difficult.

Control unit consist of the following as shown in the diagram:

- Instruction Register
- Number of Control Logic Gates,
- Two Decoders
- 4-bit Sequence Counter



An instruction read from memory is placed in the instruction register (IR).

The instruction register is divided into three parts: the I bit, operation code, and address part.

First 12-bits (0-11) to specify an address, next 3-bits specify the operation code (opcode) field of the instruction and last left most bit specify the addressing mode I.

I = 0 for direct address

I = 1 for indirect address

- First 12-bits (0-11) are applied to the control logic gates.
- The operation code bits (12 – 14) are decoded with a 3 x 8 decoder.
- The eight outputs (D0 through D7) from a decoder goes to the control logic gates to perform specific operation.
- Last bit 15 is transferred to a I flip-flop designated by symbol I.

Advantages

- **Hardwired Control Unit is fast because control signals are generated by combinational circuits.**
- **The delay in generation of control signals depends upon the number of gates.**

Disadvantages

- **More is the control signals required by CPU; more complex will be the design of control unit.**
- **Modifications in control signal are very difficult. That means it requires rearranging of wires in the hardware circuit.**
- **It is difficult to correct mistake in original design or adding new feature in existing design of control unit.**

Microprogrammed Control Unit

A control memory on the processor contains microprograms that activate the necessary control signals.

- A micro-programmed control unit is implemented using programming approach. A sequence of micro- operations are carried out by executing a program consisting of micro-instructions.
- Micro-program, consisting of micro-instructions is stored in the control memory of the control unit.

Execution of a micro-instruction is responsible for generation of a set of control signals.

A micro-instruction consists of:

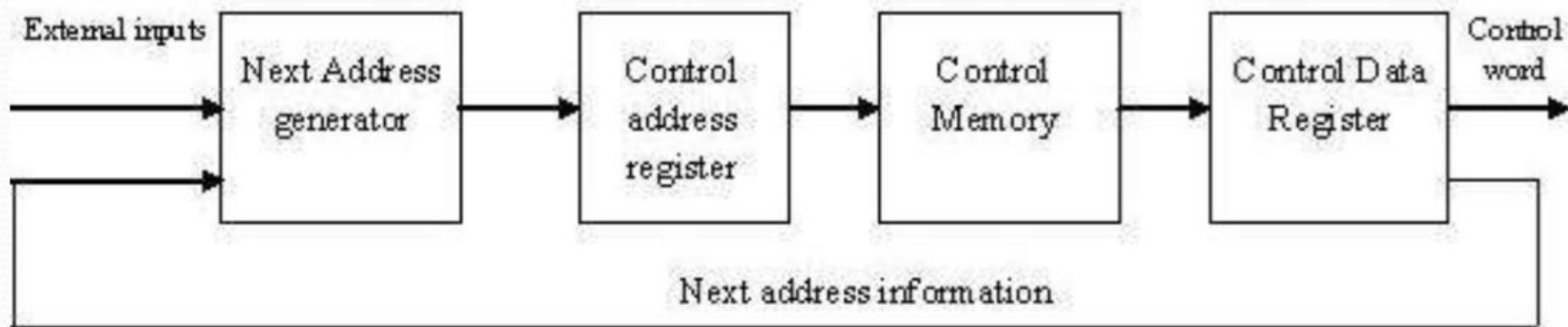
One or more micro-operations to be executed.

Address of next microinstruction to be executed.

- Micro-Operations: The operations performed on the data stored inside the registers are called micro-operations.
- Micro-Programs: Microprogramming is the concept for generating control signals using programs. These programs are called microprograms.

Micro-Instructions: The instructions that make micro-program are called micro-instructions.

- Micro-Code: Micro-program is a group of micro- instructions. The micro-program can also be termed as micro-code.
- Control Memory: Micro-programs are stored in the read only memory (ROM). That memory is called control memory.



- The address of micro-instruction that is to be executed is stored in the control address register (CAR).
- Micro-instruction corresponding to the address stored in CAR is fetched from control memory and is stored in the control data register (CDR).
- This micro-instruction contains control word to execute one or more micro-operations.
- After the execution of all micro-operations of micro-instruction, the address of next micro-instruction is located.

ADVANTAGES

- The design of micro-program control unit is less complex because micro-programs are implemented using software routines.
- The micro-programmed control unit is more flexible because design modifications, correction and enhancement is easily possible.
- The new or modified instruction set of CPU can be easily implemented by simply rewriting or modifying the contents of control memory.
- The fault can be easily diagnosed in the micro-program control unit using diagnostics tools by maintaining the contents of flags, registers and counters.

DISADVANTAGES

- The micro-program control unit is slower than hardwired control unit. That means to execute an instruction in micro-program control unit requires more time.
- The micro-program control unit is expensive than hardwired control unit in case of limited hardware resources.
- The design duration of micro-program control unit is more than hardwired control unit for smaller CPU.

COMPARISON BETWEEN HARDWIRED AND MICRO-PROGRAMMED CONTROL UNIT

Attributes	Hardwired Control	Micro-programmed Control
Speed	Fast	Slow
Cost of Implementation	More	Cheaper
Flexibility	Not flexible, difficult to modify for new instruction	Flexible, new instructions can easily be added
Ability to Handle Complex Instructions	Difficult	Easier
Decoding	Complex	Easy
Applications	RISC Microprocessor	CISC Microprocessor
Instruction Set Size	Small	Large
Control Memory	Absent	Present
Chip Area Required	Less	More