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Topics included:

- Microprogrammed Control
- Control Memory
- Address Sequencing
- Microprogrammed control organization
- Design of Control unit

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Microprogrammed Control

Control Memory

- The function of the control unit in a digital computer is to initiate sequences of microoperations. The number of different types of microoperations that are available in a given system is finite. The complexity of the digital system is derived from the number of sequences of microoperations that are performed.
- When the control signals are generated by hardware using conventional logic design techniques, the control unit is said to be hardwired. Microprogramming is a second alternative for designing the control unit of a digital computer

Control Memory

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- A computer that employs a microprogrammed control unit will have two separate memories: a main memory and a control memory.
- **Main memory:** The main memory is available to the user for storing the programs. The contents of main memory may alter when the data are manipulated and every time that the program is changed. The user's program in main memory consists of machine instructions and data.
- **Control memory:** The control memory holds a fixed microprogram that cannot be altered by the occasional user. The microprogram consists of microinstructions that specify various internal control signals for execution of register microoperations. Each machine instruction initiates a series of microinstructions in control memory. These microinstructions generate the microoperations to fetch the instruction from main memory; to evaluate the effective address, to execute the operation specified by the instruction, and to return control to the fetch phase in order to repeat the cycle for the next instruction.

Address Sequencing

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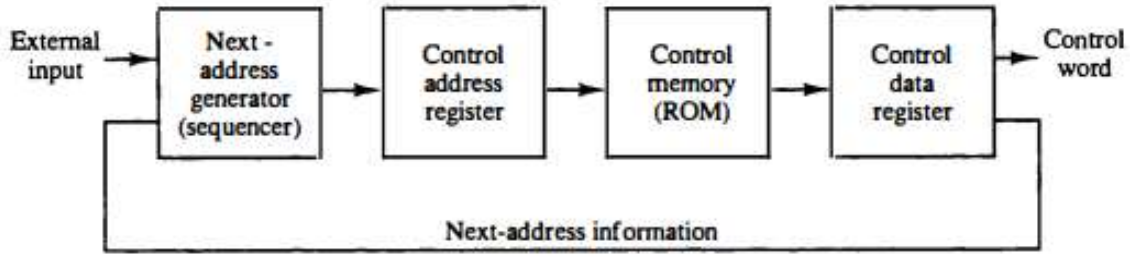
- 1. Incrementing of the control address register.
- 2. Unconditional branch or conditional branch, depending on status bit conditions.
- 3. A mapping process from the bits of the instruction to an address for control memory.
- 4. A facility for subroutine call and return.

Microprogrammed control organization



The control memory is assumed to be a ROM, within which all control information is permanently stored. The control memory address register specifies the address of the microinstruction, and the control data register holds the microinstruction read from memory.

Once these operations are executed, the control must determine the next address. The location of the next microinstruction may be the one next in sequence, or it may be located somewhere else in the control memory. For this reason it is necessary to use some bits of the present microinstruction to control the generation of the address of the next microinstruction.

The next address generator is sometimes called a microprogram sequencer, as it determines the address sequence that is read from control memory.

Design of Control unit

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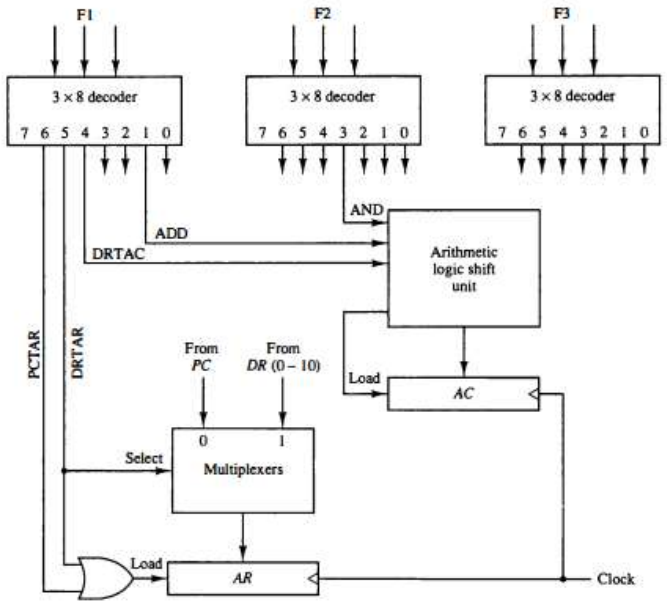
- The bits of the microinstruction are usually divided into fields, with each field defining a distinct, separate function.
- The various fields encountered in instruction formats provide control bits to initiate microoperations in the system, special bits to specify the way that the next address is to be evaluated, and an address field for branching.
- The number of control bits that initiate microoperations can be reduced by grouping mutually exclusive variables into fields and encoding the k bits in each field to provide 2k microoperations.
- Each field requires a decoder to produce the corresponding control signals. This method reduces the size of the microinstruction bits but requires additional hardware external to the control memory.
- It also increases the delay time of the control signals because they must propagate through the decoding circuit


F1
F2
F3
3 × 8 decoder
7 6 5 4 3 2 1 0
AND
ADD
DRTAC
Arithmetic logic shift unit
PCTAR
DRTAR
From PC
From DR (0 – 10)
Load
AC
0
1
Select
Multiplexers
Load
AR
Clock