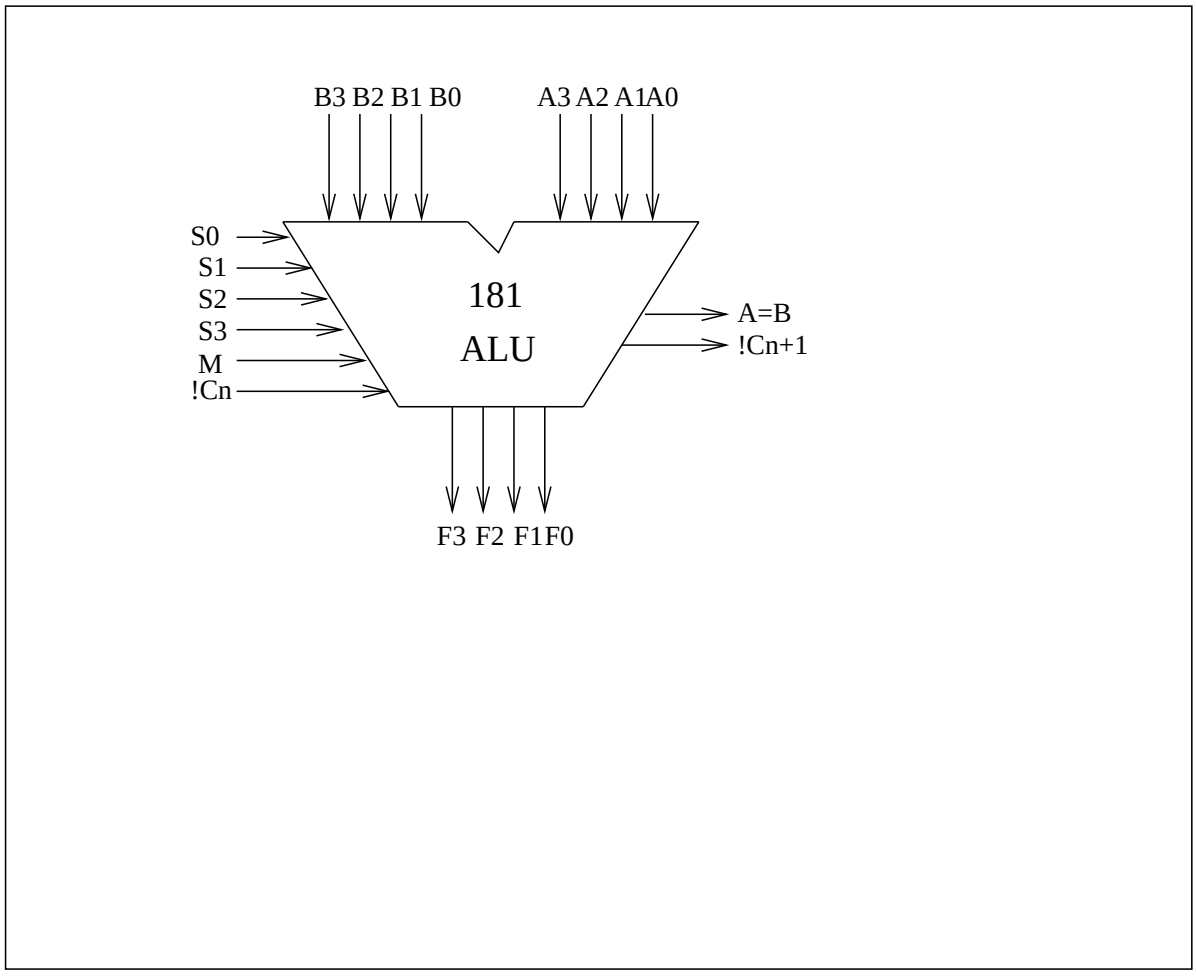
Register Level Transfer (Ch 8 Hayes)

The ALU "Arithmetic Logic Unit":

- **Arithmetic and Logic Operations:**
  F= A OP B A,B, F are 4 BIT Variables
  F0=(M+CN) XOR !(A0+B0S0+B0!S0) XOR !(A0.!B0.S2+A0.B0.S3)



Examples of Different Operations in ALU

- **Need to perform F=A PLUS B**
  M=0 (Aritmetic)
  !Cn=1 (no carry in)
  S3S2S1S0=1001

- **need F= A XOR B**
  M = 1 Logic
  S3S2S1S0=0110

- **Need F=0**
  M=1 Logic
  S3S2S1S0=0011

Data and Control

Control:

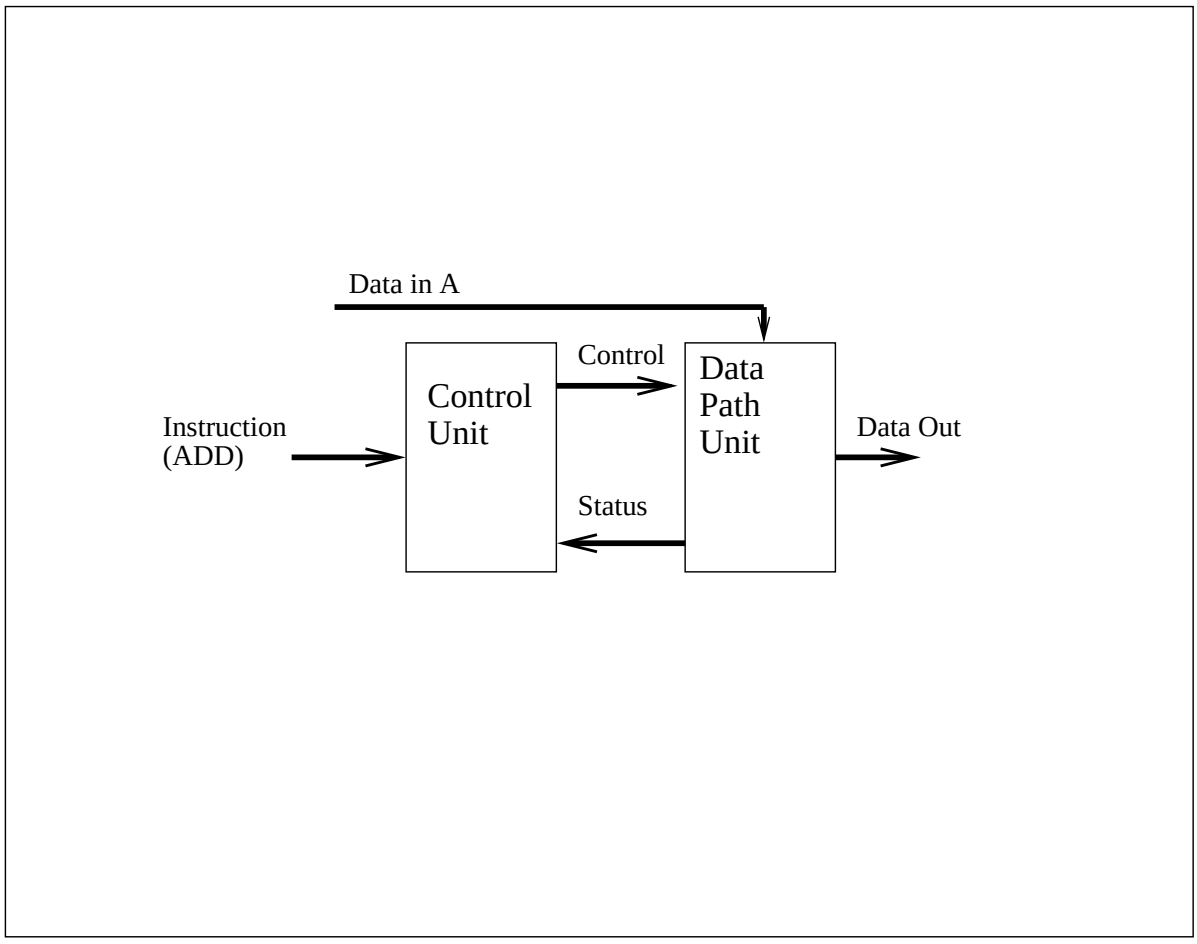
Sets control signals for Data Path unit to operate on inpute.

Consists of : Counters, FSM, Shift registers

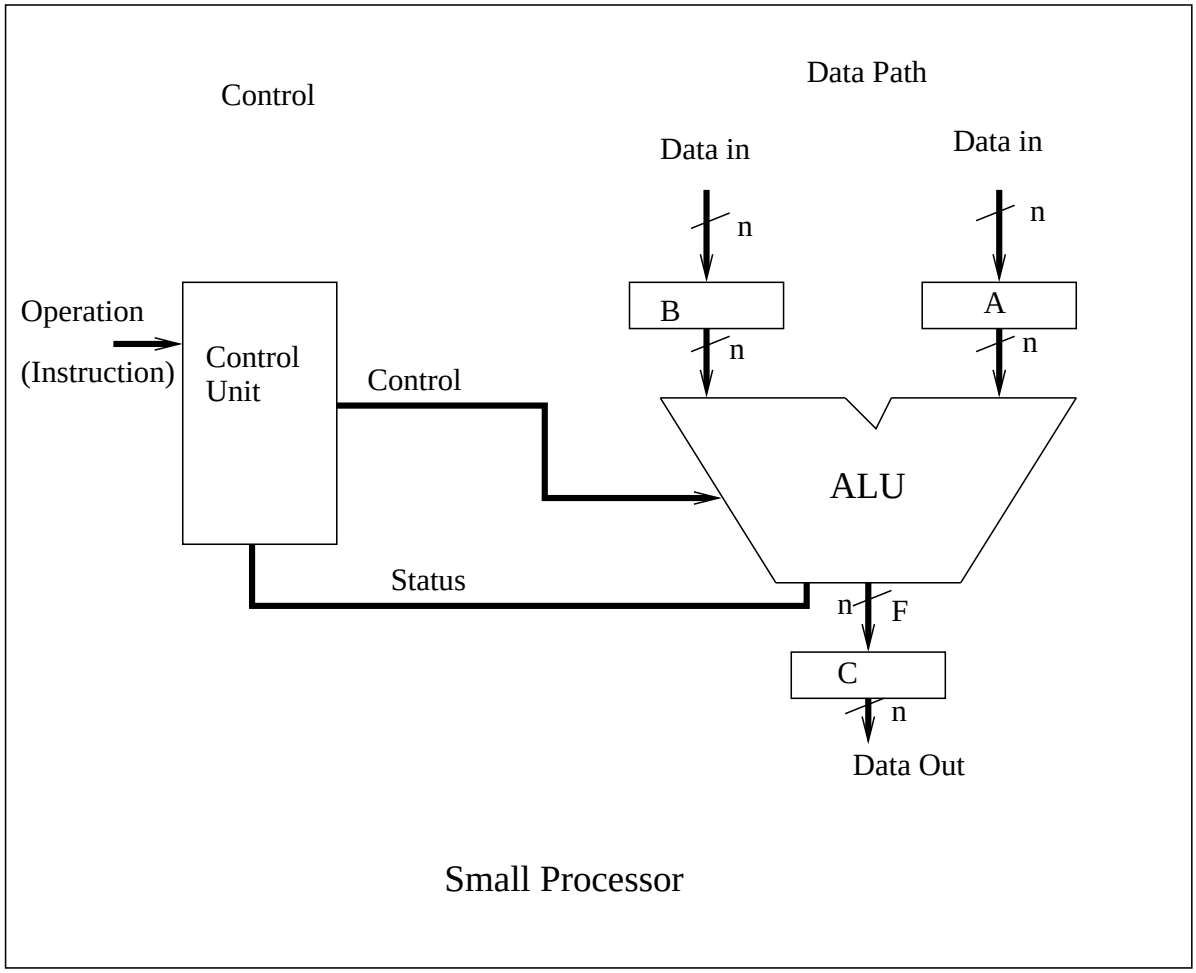
Data Path:

to perform operations

consists of: Logic gates, Multiplexers, decoder, ALU



Small Processor



Example:

Instruction: C=A - B

Steps:

Control unit sets values of S3S2S1S0, M, Cn for Subtraction

Next cycle it Store F in Register C (Load)

Check Overflow (status)

Structure of Data Path Units

Inside the CPU to perform Arithmetic and Logic Operations

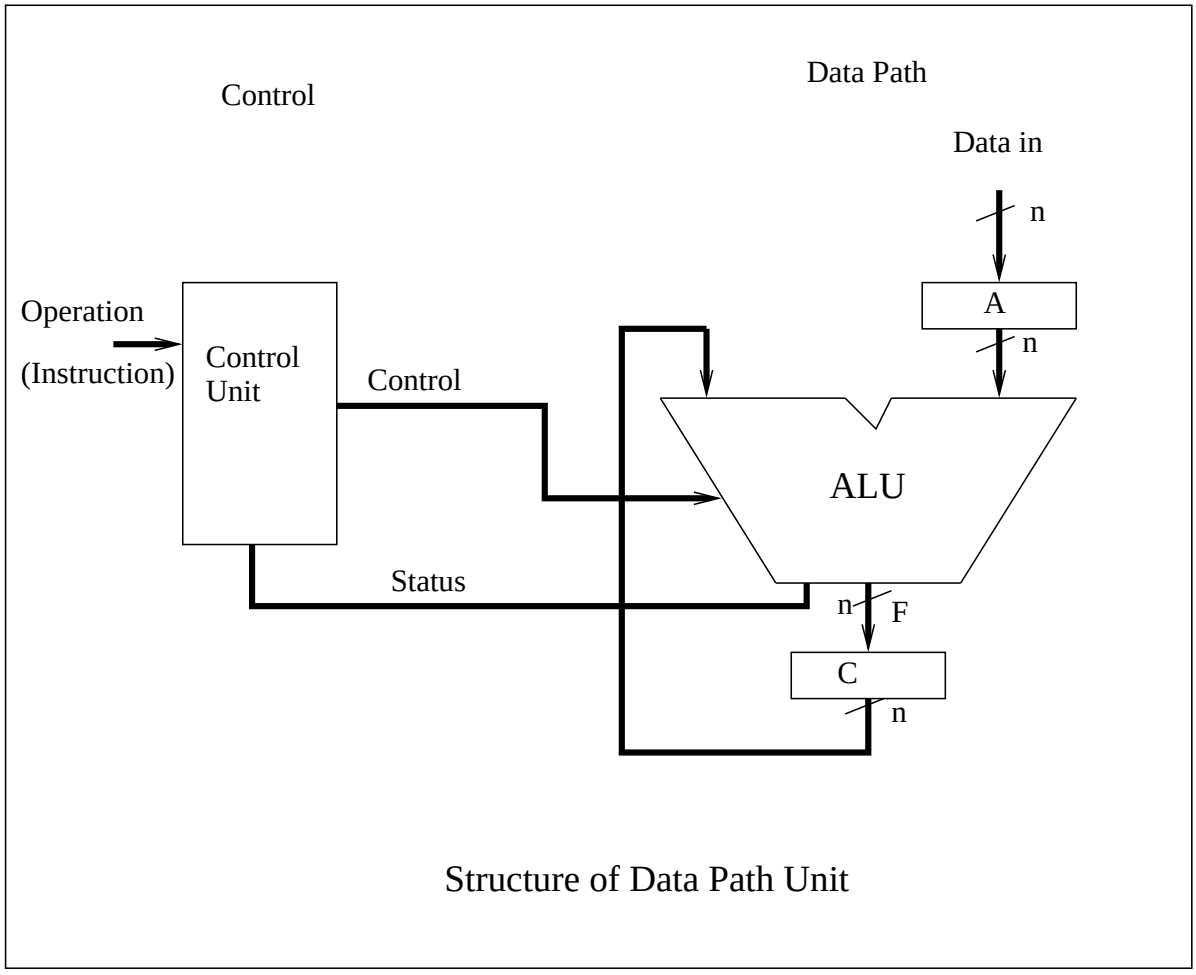
It operates on Data stored in Registers as Operands.

The Result is stored in Register.

Need ALU to perform operation

Need Registers to store operands and results

Need specific connction (structure)of above components that is defined by the data path.

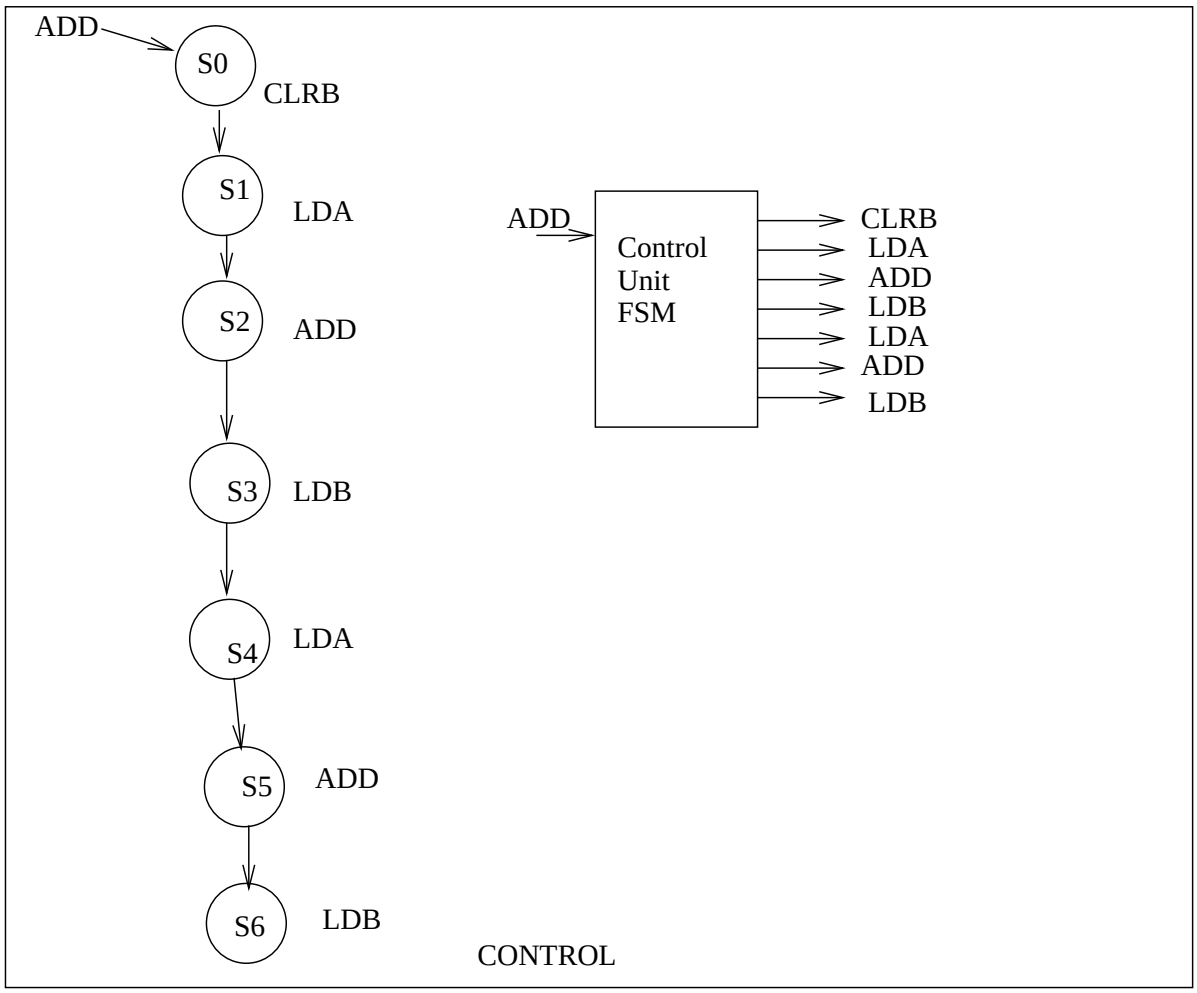


Structure of Data Path Unit

Operation: ADD two numbers from input1 (X1, X2)

- CLR B
- LDA X1 (A=X1)
- ADD; ALU OUT=X1+0
- LDB X2; A=X2
- ADD; ALU OUT= X1 + X2
- LDB ; B= X1+X2

Control: ADD two numbers from input1 (X1, X2)



Improving Performance of Serial Type of Operations with "Pipelining"

Concept of Pipelining: Overlap opertaions on time so that multiple operations are done in parallel

Example: CAR Assembly Line with 3 steps:

1-Stage 1: ENGIN

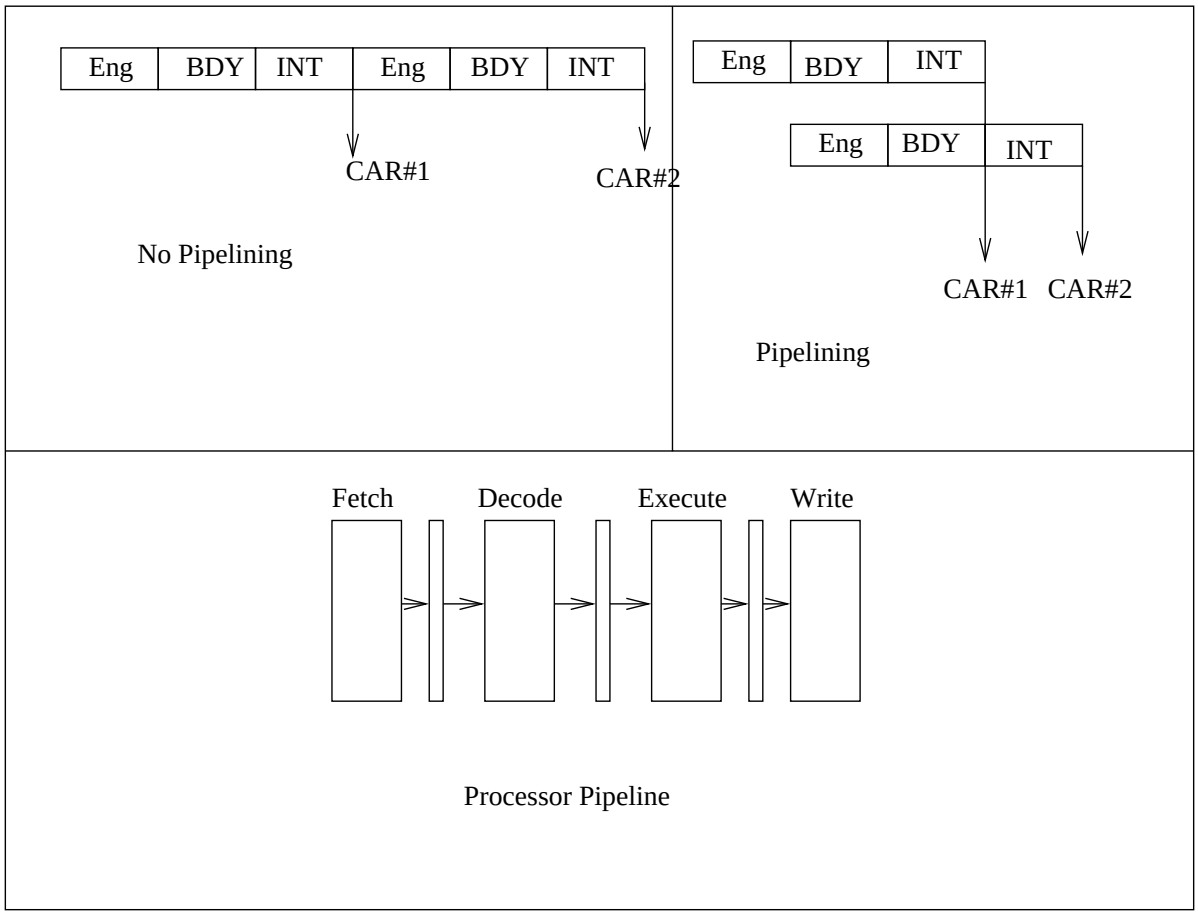
2-Stage 2: Body

3-Stage 3: Iterior

CPU Uses pipelining for instructions as:

Each instruction is divided to : FETCH, DECODE, EXECUTE, WRITE Stages

Improving Performance of Serial Type of Operations with "Pipelining"

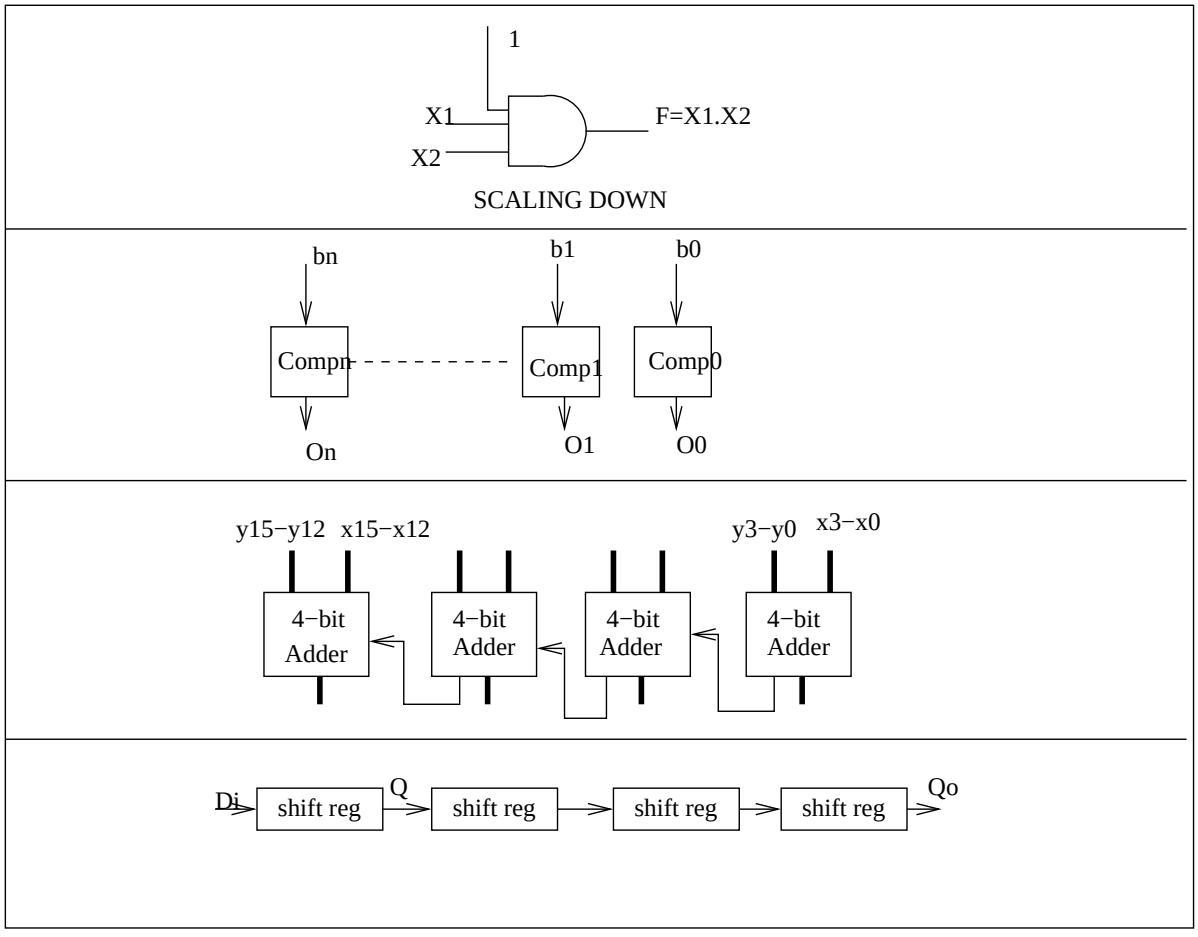


Scaling

Scaling Down: from larger to smaller

From smaller to larger using BIT SLICE (difficult to scale most functions)

Examples: ADDRER, ALU, SHIFT REGISTER



Control Units "Microprogramming"

Types:

FSM

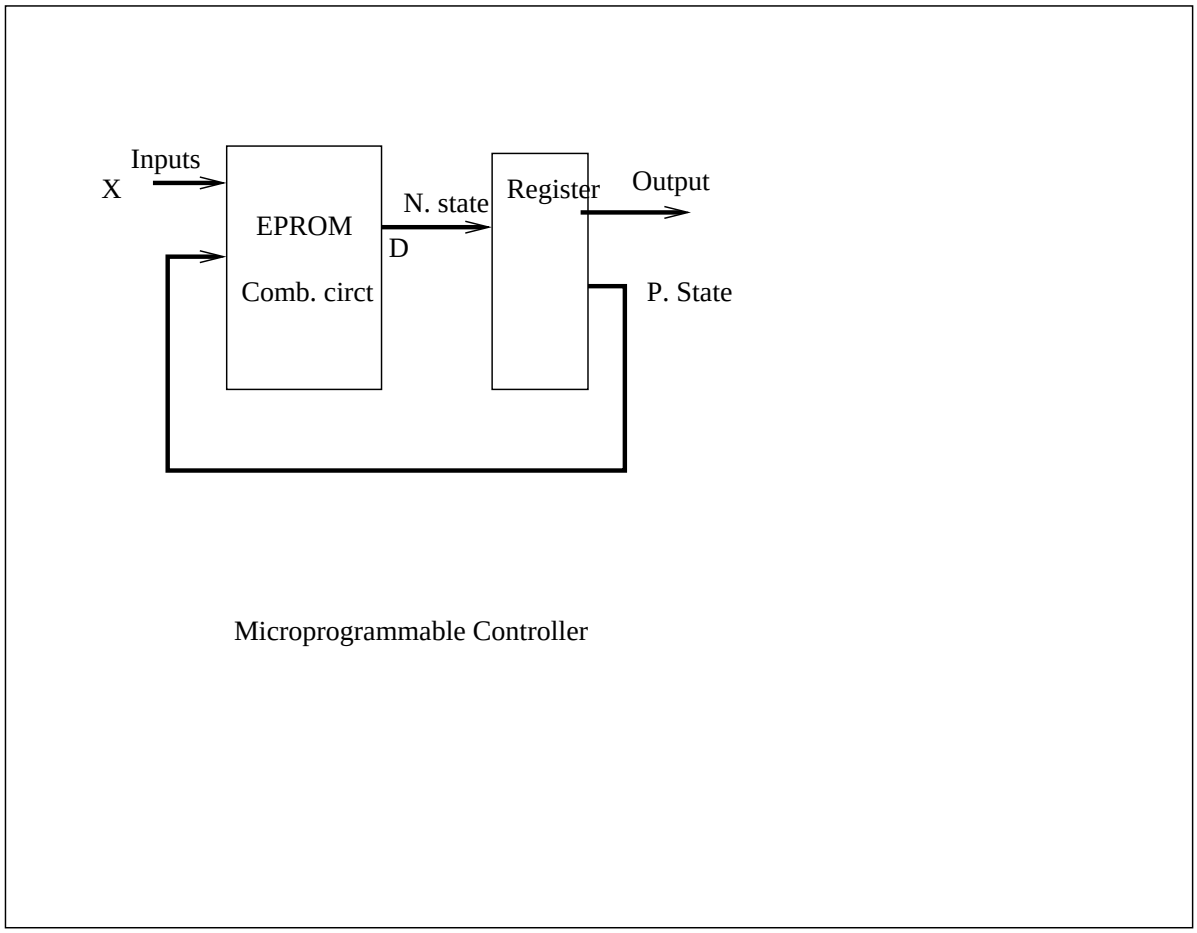
Microprogramming

One -Hot Method (Shift Register)

Microprogramming Advantages: Easy to change microinstructions with software

Consists of ROM to store that Data required to change Present state to next state (combinational circuit used in FSM).

Register used to store present state (F-F in FSM)



Microprogrammable Controller