ARITHMETIC MICRO-OPERATIONS

AWFUL COMPANY

AGENDA

1. What are Micro-operations and Arithmetic Micro-operations ?
2. Basic Arithmetic Micro-Operations .
3. Binary Adder
4. Adder-Subtracter
5. Binary incrementer
6. Binary decrementer
7. Shift Micro-Operations (Only Arithmetic Perspective)

WHAT ARE MICRO-OPERATIONS ?

A microoperation is an elementary operation performed with the data stored in registers. The microoperations encountered in digital computers are classified into four categories:

1. Register transfer microoperations- transfer one binary information from one register to other.
2. Arithmetic microoperations- perform arithmetic operations on numeric data stored in registers.
3. Logic microoperations- perform bit manipulation operations on non-numeric data stored in registers.
4. Shift microoperations-perform shift operations on data stored in registers.

ARITHMETIC MICROOPERATIONS- PERFORM ARITHMETIC OPERATIONS ON NUMERIC DATA STORED IN REGISTERS.

BASIC ARITHMETIC MICRO-OPERATIONS:

- addition

  R3 ← R1 + R2

- subtraction

  R6 ← R5 – R4

- increment

  R1 ← R1 + 1

- decrement

  R1 ← R1 - 1

- shift

  R1 ← ashr R1 // R1 ← ashl R1

WHAT ABOUT MULTIPLICATIONS AND DIVISIONS ?

(MULTIPLICATIONS AND DIVISIONS ARE NOT CONSIDERED MICRO-OPERATIONS.)

Multiplication is implemented by a sequence of adds and shifts.

and

Division is implemented by a sequence of subtract and shifts.

SOME ARITHMETIC MICRO-OPERATIONS

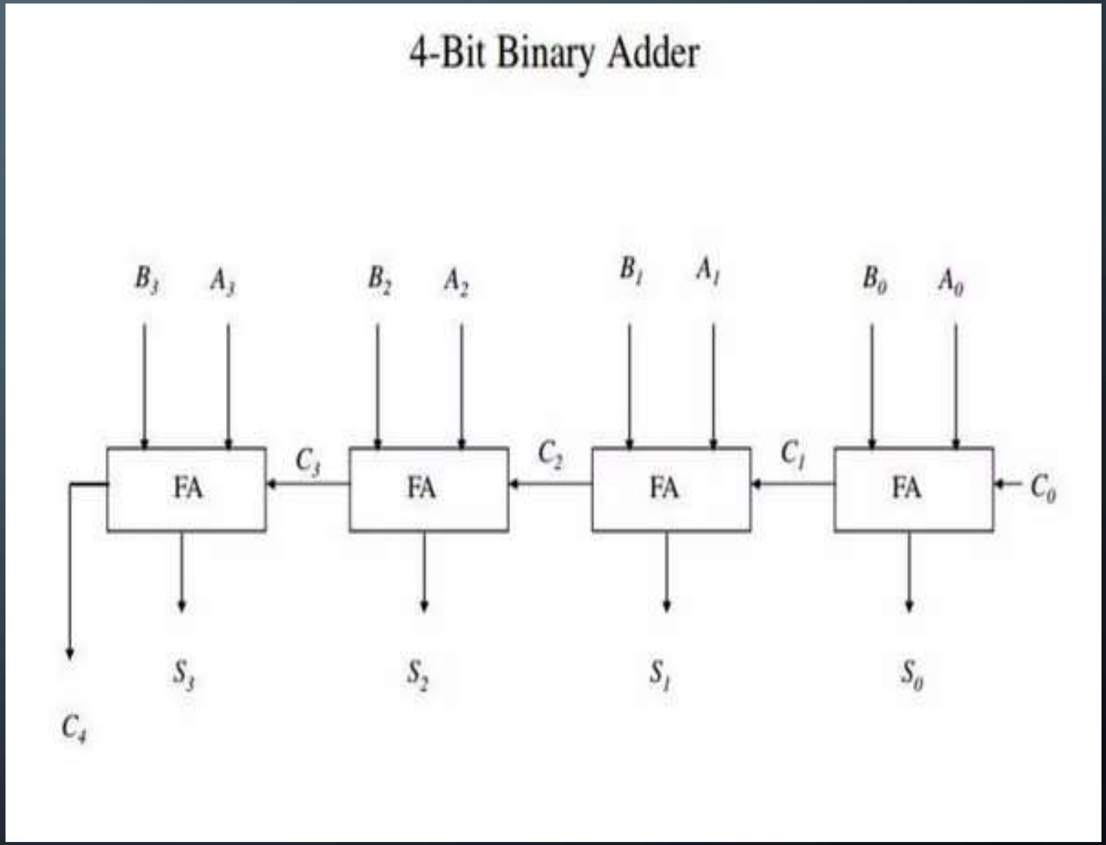
Symbolic Designation	Descriptions
R3 ← R1 + R2	Contents of R1 plus R2 transferred to R3
R3 ← R1 – R2	Contents of R1 minus R2 transferred to R3
R2 ← R2’	Complement contents of R2 (1’s Complement)
R2 ← R2’ + 1	2’s Complement contents of R2 (negate)
R3 ← R1 + R2’ + 1	R1 plus 2’s Complement of R2
R1 ← R1 + 1	Increment content of R1 by 1
R1 ← R1 – 1	Decrement content of R1 by 1

Half Adder is 2 bits and Full Adder is 3 bits.

A full adder basic consist of 2 half adders and an OR gate.

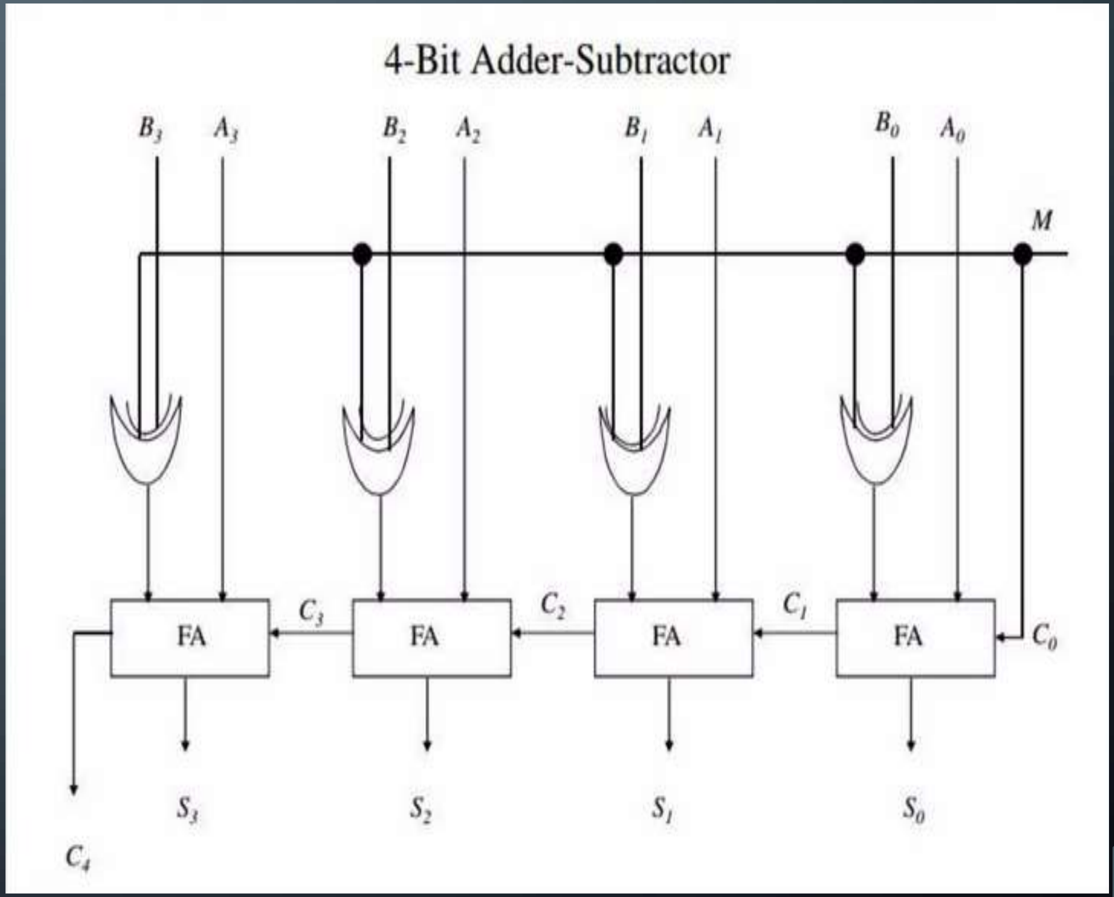
BINARY ADDER

- We implement a binary adder with registers to hold the data and a digital circuit to perform the addition.
- The Binary adders is constructed using full adders connected in cascade so that the carry produced by one full adder becomes an input for the next.
- Adding two n-bit numbers requires n full adders.
- The n data bits for A and B might come from R1 and R2 respectively.



ADDER-SUBTRACTER

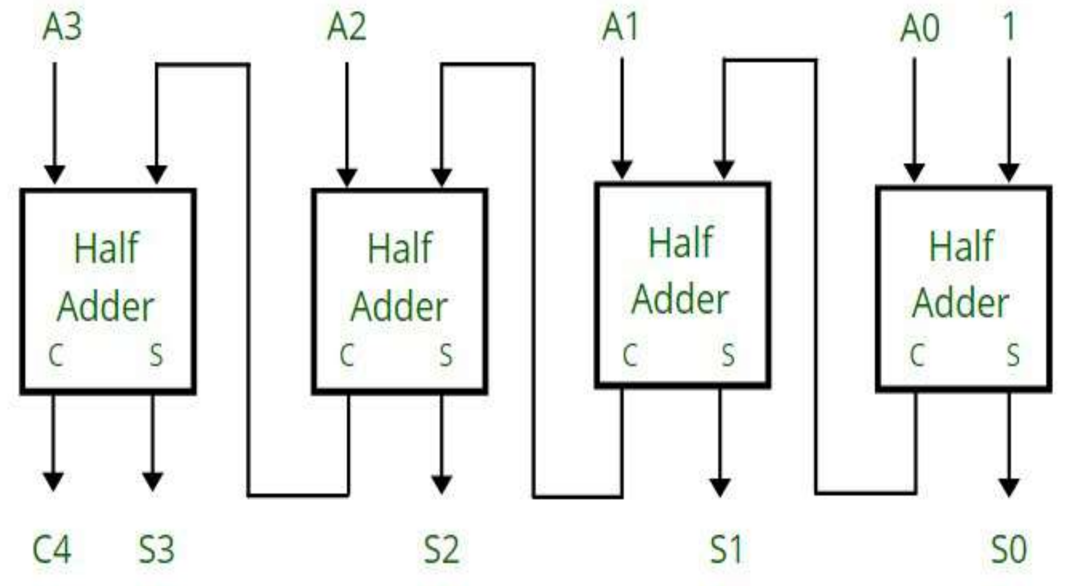
- Subtracting A – B is mostly easily done by adding B' to A and then adding 1.
- This makes it convenient to combine both addition and subtraction into one circuit, called an adder-subtracter.
- M is the mode indicator or Control (CTR)
  - M = 0 indicates addition (B is left alone and C_0 is 0.)
  - M = 1 indicates subtraction (B is complement and C_0 is 1)



XOR GATE = A.M' + A' + M
M = 0 ; XOR = A
M = 1 ; XOR = A'

BINARY INCREMENTER

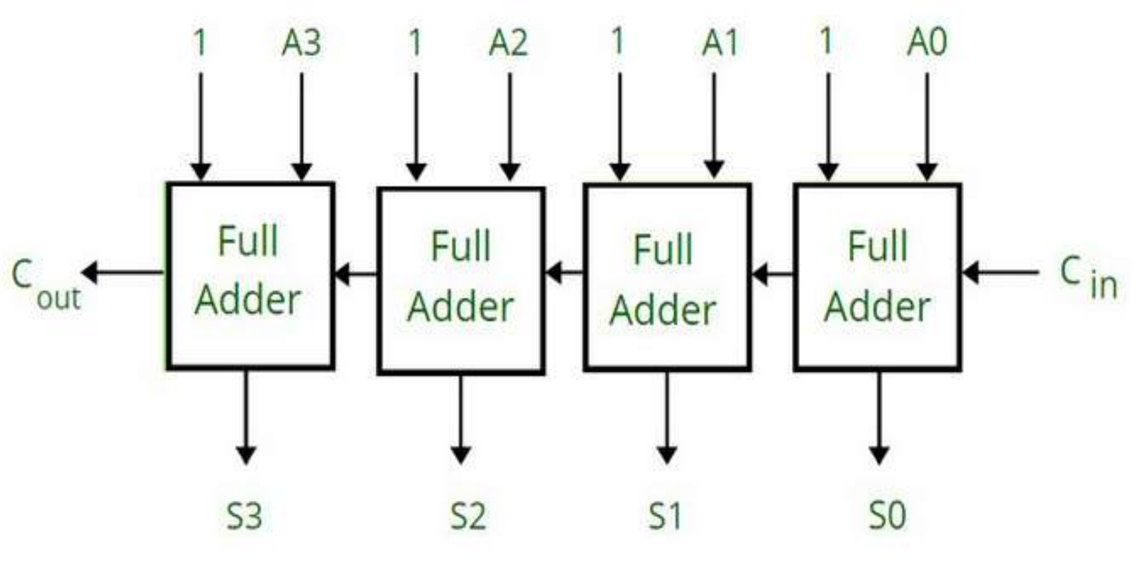
- The binary incrementer adds 1 to the contents of a register, e.g. , a register storing 0101 would have 0110 in it after being incremented.
- There are times when we want incrementing done independent of a register. We can accomplish this with a series of cascading half-adders.



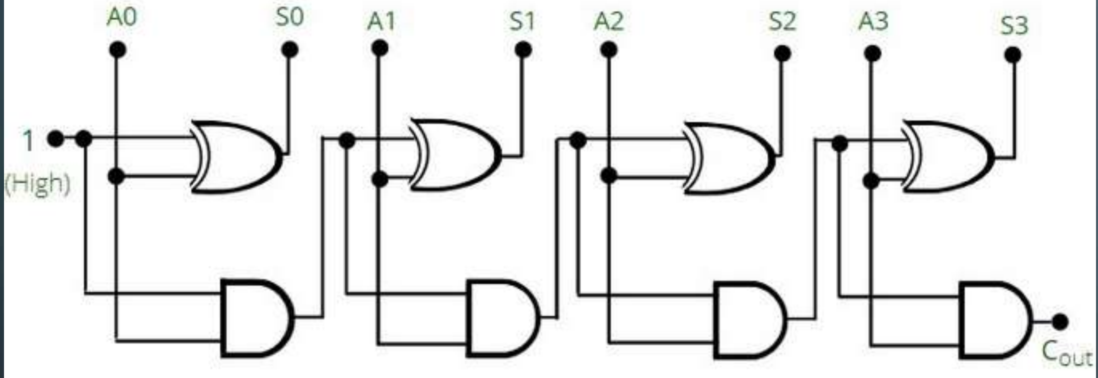
4- Bit Binary Incrementer

BINARY DECREMENTER

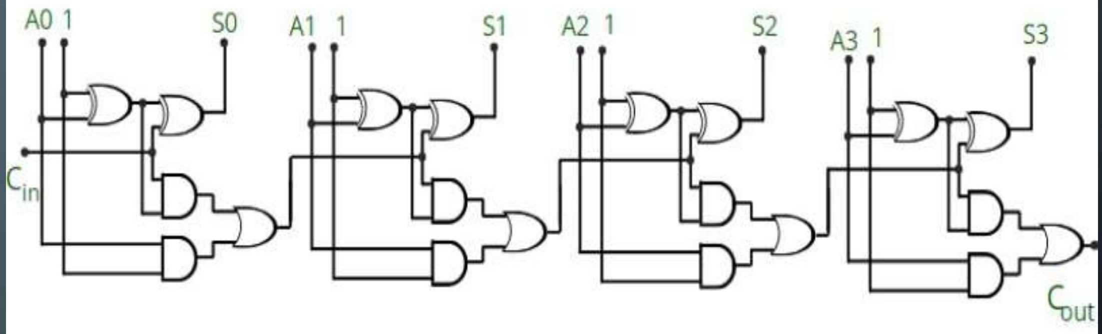
- The binary decrementer subtracts 1 to the contents of a register.
- For any n- bit binary decrementer, ‘n’ refers to the storage capacity of the register which needs to be decremented by 1. So we require ‘n’ number of full adders.



4- Bit Binary Decrementer



4- Bit Binary Incrementer (In detail)



4 Bit Binary Decrementer (In Detail)

SHIFT MICRO-OPERATIONS

- Shift Micro-operations are used for serial transfer of data and are used in conjunction with arithmetic and logical micro-operations.
- The Register contents can be shifted to the left or to the right.
- There are three types of Shift Operations:
  - Logical Shifts
  - Arithmetic Shifts
  - Circular Shifts

Arithmetic Shifts multiplies (or divides) a signed number by 2. It is used on two’s compliment binary

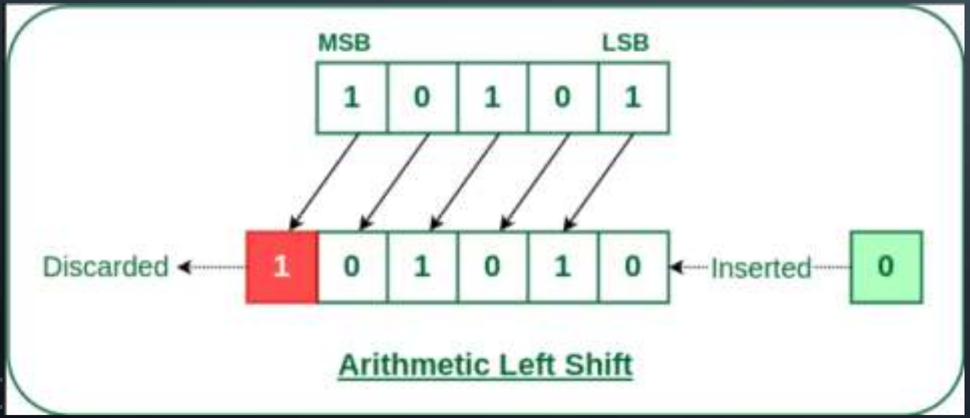
SHIFT MICRO-OPERATIONS (ARITHMETIC)

Symbolic Designation	**Descriptions**
R ← ashl R	Arithmetic shift-left register R
R ← ashr R	Arithmetic shift-right register R

ARITHMETIC SHIFT OPERATIONS

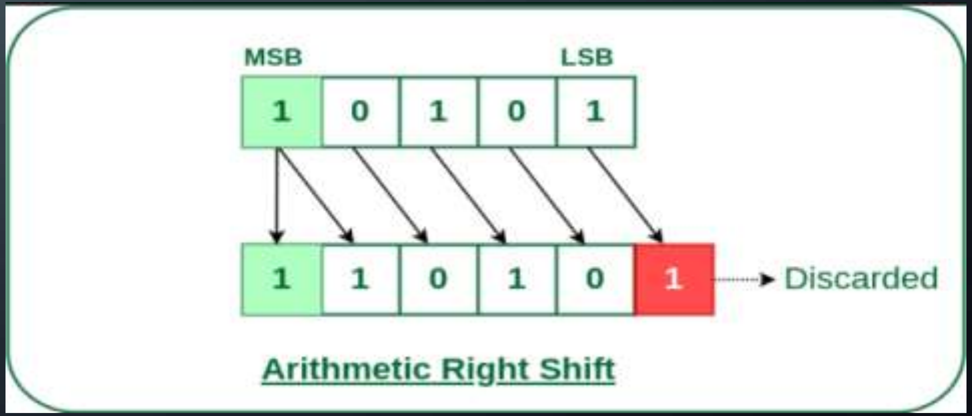
ARITHMETIC LEFT SHIFT OPERATION

- In this shift, each bit is moved to the left one by one. The empty least significant bit (LSB) is filled with zero and the most significant bit (MSB) is rejected.



ARITHMETIC RIGHT SHIFT OPERATION

- In this shift, each bit is moved to the right one by one and the least significant(LSB) bit is rejected and the empty most significant bit(MSB) is filled with the value of the previous MSB.



PRAISE BE!!!

- SHAH MALAV
- SHAH MRUNAL