Chapter 3

BINARY ARITHMETIC AND TWO's COMPLEMENT ARITHMETIC

Lesson 2

Two’s complement number and binary subtraction

Outline

- **Two's complement**
- Two's complement Examples
- Binary subtraction

Finding Two's Complement

- Step 1: First complement all the bits (that is find one's complement)

  Make all 1s as 0s and all 0s as 1s

- Step 2:Then perform increment by 1

  Add 0001_b

Two’s Complement as -ve Number

- Two’s complement is -ve number because binary addition of a *n*-bit number with it’s complement gives n-bit result with all bits = 0s

Highest Two's Complement format + ve Number

A highest positive arithmetic number is when at msb there is 0 and all remaining bits are 1s

Lowest Two's Complement format – ve Number

A lowest negative arithmetic number is when at msb there is 1 and all remaining bits are 0s

Arithmetic Numbers

Two's complement format arithmetic number

- Maximum 8-bit number = *0111 1111*(+127)
- Minimum 8-bit number = 1000 0000 (–128)

Arithmetic Numbers

Two's complement format arithmetic number

- Maximum 16-bit number

= *0111 1111 1111 1111(* +32767)

- Minimum 16-bit number

= 1000 0000 0000 0000 *(* –32768)

Outline

- Two’s complement
- **Two’s complement Examples**
- Binary subtraction

Example

0 1 0 1 [= $+5_d$]

One's Complement 1 0 1 0

Add 0 0 0 1

Sum 1 0 1 1

Therefore,

Two's Complement = 1 0 1 1 [It is -5_d because 0101 + 1011 = 0.]

Example

Number +16392	0100 0000 0000 1000
One's complement	1011 1111 1111 0111
+	0000 0000 0000 0001
–16392	1011 1111 1111 1000

Prove = 1011 1111 1111 1000 = – 16392

Assume Decimal – 16392 =

1011 1111 1111 1000

0100 0000 0000 0111 One's Complement

0000 0000 0000 0001 Add

0100 0000 0000 1000 Two's Complement

[Since result is = Decimal + 16392, hence assumption is correct.]

Prove 1000 000 0000 0000 = – 32768

0111 1111 1111 1111 [= Decimal + 32767]

1000 0000 0000 0000 [one's Complement]

0000 0000 0000 0001 Add

1000 0000 0000 0001 Two's Complement

[= Decimal – 32767]

Now this is 1 more than 1000 000 0000 0001.

Thus 1000 000 0000 0000 = – 32768

Outline

- Two’s complement
- Two’s complement Examples
- **Binary subtraction**

Binary subtraction A – B

- Add A with two's complement of B to find A – B, provided we use two's complementation for representation – ve numbers

Example: Find 129 – 128

0000 0000 1000 0001 [= $+129_d$]

1111 1111 1000 0000 [= -128_d]

0000 0000 0000 0001 [= $+1_d$]

Example Find + **16392** – **(16392)**

A= +16392 0100 0000 0000 1000

One's complement 1011 1111 1111 0111

\+ 0000 0000 0000 0001

–B= –16392 1011 1111 1111 1000

•Find A + (– B)

Answer 0000 0000 0000 0000

Example: Find **+1020 – (– 1017)**

1111 1100 0000 0111 [– 1017_d]
0000 0011 1111 1001 [– (– $1017)_d$]
0000 0011 1111 1100 [= $+1020_d$]
0000 0111 1111 0101 [= $+2037_d$]

Example: Find – **1017** – (– **1020**)

1111 1100 0000 0111 [– 1017_d]

0000 0011 1111 1100 [– (– $1020)_d$]

0000 0000 0000 0011 [= $+3_d$]

Summary

- **Two's complement is found by first finding 1's complement and then adding 0001_b.**
- **Two's complement gives negative of a given number**
- **Adding a number with it's two's complement gives all bits = 0s**

End of Lesson 2 on

Two's complement number and binary subtraction

THANK YOU