Signed Integers

1. signed Magnitude

first bit for signed

$\boxed{1}$ 1 0 1 1 0 negative

$\boxed{0}$ 1 0 1 1 0 possitive

2. Biased

-3

we add Bias to the number

$Bias = 2^{n-1} - 1$ n = number of bits

Exp: -3 with 4 bit

$\Rightarrow -3 + 2^3 - 1$

$\Rightarrow -3 + 7 \Rightarrow 4$ 0100

it will add to +ve

Exp: $+5$

$5 + 7 = 12$ 1100

How many bit to implement

-22

find Bias that let it +ve

$$-22 + \underbrace{31}_{2^5 - 1}$$

$\Rightarrow$ we need 6 bit

---

we do this before

1	8	23
S	Exponent	Mantissa

implement $\boxed{-}1.11101 \times 2^{\boxed{-5}}$

1   101110100   ~ . . . . . .

$-5 + 127 = 122$

Range $\Rightarrow$ $-\text{Bias} \rightarrow \text{Bias} + 1$

---

③ one's comp

if number in negative ⇒ change bits

possitiv ⇒ no change

⇒ if -ve ⇒ most sig. = 1

+ve ⇒ most sig. = 0

Exp: what is the number?

1. 1100101

since most sig. = 1

then it negative

⇒ so set complement

⇒ 0011010

$= -26$

(4) 2's complement

to get it fast:

start from least sig.

first 1 no change then complement

Exp $0\ 1\ 0\ 1\ \boxed{1}\ 0$

$1\ 0\ 1\ 0\ 1\ 0$

Range $\Rightarrow -2^{n-1} \rightarrow 2^{n-1} - 1$

Exp: represent by all ways

-42

Signed: 1 1 0 1 0 1 0

Biased: $-42 + 63$

$= 21$

$\Rightarrow$ 0 0 1 0 1 0 1

1's complement

unsigned $\Rightarrow$ 1 0 1 0 1 0

overflow $\leftarrow$ 0 1 0 1 0 1

add bit 0 1 0 1 0 1 0

$\Rightarrow$ 1 0 1 0 1 0 1

2's comp: 0 1 0 1 0 1 1 0

1 0 1 0 1 1 0

---

get value of 1 0 1 1 1 0

1. usigned 46

2. Siged: − 14

3. Bias: 46 − 31 = +15

4. 1's comp: 0 1 0 0 0 1

16 + 1 = −17

5. 2's comp:

1's comp + 1

⟹ − 18

All methods has two

rep. for zero Except 2's comp.

---

sum 4 bit wit 8 bit

1 1 1 1 $\boxed{1}$ 1 0 1 +

1 0 1 0 1 1 0 1

unsigned ⇒ add zeros

signed ⇒ $\boxed{\text{add bits as most sig.}}$

---

in all methods:

if most sig. = 1 ⇒ -ve

" " = 0 ⇒ +ve

Binary Addition

0 0 1 0 1   5

1 1 0 0 0   24 Usisned

---

1 1 1 0 1   29 ✓

Signed ?

$$\begin{array}{r} 5 \\ -8 \\ \hline -3 \end{array} \checkmark$$

---

very important :

if we get sum of two numbers have same signed and result different signed then
⟹ over flow

$$\begin{array}{r} {}^{1\ 1\ 1} \\ 1\ 1\ 0\ 1 \quad -3 \\ 0\ 0\ 1\ 1 \quad 3 \\ \hline \boxed{1}\ 0\ 0\ 0\ 0 \end{array}$$

signed

result

carry is true

$$\begin{array}{r} \times\ 1\ 1\ 0\ 0 \\ 1\ 1\ 0\ 1 \\ \hline \end{array}$$

1 1 0 0

1 0 0 0 0

1 1 0 0

1 1 0 0

---

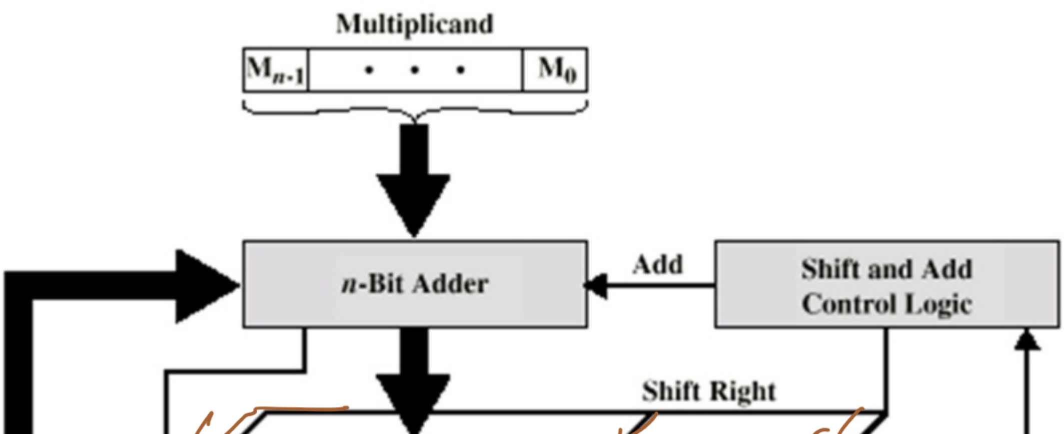
1 1 0 1 1 0 0

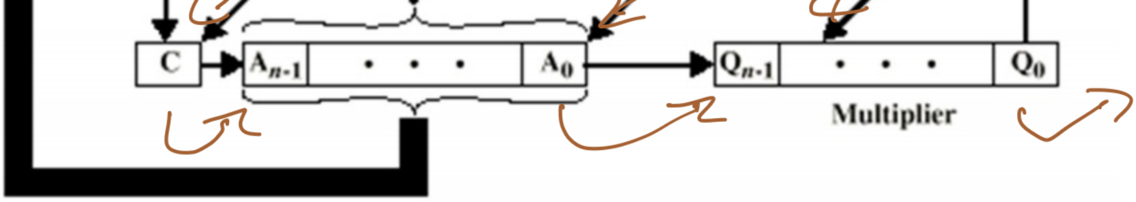
=> when multiply

4 bit * 4 bit

result => 16 bit

Unsigned Binary Multiplication





(a) Block Diagram

الشفت لـ [illegible] Register one

(C:A:Q)

$13 * 11 = 143$

C	A	Q (13, −3)	M (−5)	
0	0000	1101	1011	Count = 4
0	1011	1101	1011	A = A + M
0	0101	1110	1011	Shift (Count = 3)
0	0010	1111	1011	Shift Count = 2
0	1101	1111	1011	A = A + M
0	0110	1111	1011	Shift Count = 1
1	0001	1111	1011	A = A + M
0	1000	1111	1011	Shift Count = 0

128
15 +
143

هاض الاشي لـ unsigned

⇐ لما signed

بنسوي comp. للرقمين

وحسب الحالات بنقرر

اذا بنسوي 2's comp

فالاهم

shift Arethmetic

بنزيد

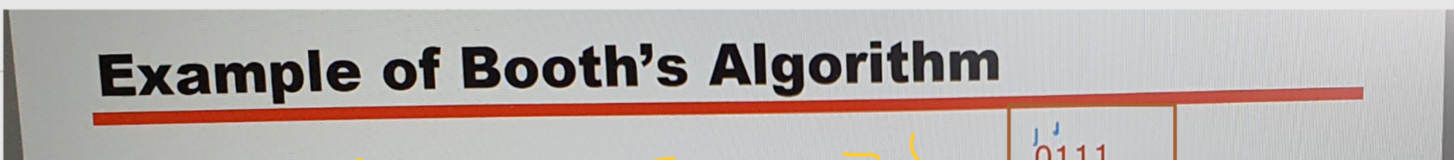
00 → shift

01 → add + shift

10 → sub + shif

11 → shift

Exp:



1110

~~0101~~

A	Q	Q_{-1}	M		
0000	0011	0	0111	Initial Values	
1001	0011	0	0111	A ← A - M	First Cycle
1100	1001	1	0111	Shift	
1110	0100	1	0111	Shift	Second Cycle
0101	0100	1	0111	A ← A + M	Third Cycle
0010	1010	0	0111	Shift	
0001	0101	0	0111	Shift	Fourth Cycle

مهم جداً

اذا الرقم سالب بوخذ
2's complement

ب الرقمين والناتج عبارة عن

signed number

How it works

- Consider a positive multiplier consisting of a **block of 1s** surrounded by 0s. For example, 00111110. The product is given by :

$$M \times "0\,0\,1\,1\,1\,1\,1\,0" = M \times (2^5 + 2^4 + 2^3 + 2^2 + 2^1) = M \times 62$$

- where M is the multiplicand.
- The number of operations can be **reduced** to **two** by rewriting the same as

$$M \times "0\,1\,0\,0\,0\,0\,0\,0\text{-}1\,0" = M \times (2^6 - 2^1) = M \times 62.$$

- Note that:

  $$2^n + 2^{n-1} + \ldots + 2^{n-k} = 2^{n+1} - 2^{n-k}$$

How it works

- So, the product can be generated by one addition and one subtraction
- In Booth's algorithm
  - —perform subtraction when the first 1 of the block is encountered (1 - 0)
  - —perform addition when the last 1 of the block is encountered (0 - 1)
- (1 - 0) and (0 - 1) are observed from $Q_0 - Q_{-1}$ (see previous example)

بنقدر نستخدم فقط الاعداد الاعشار
مثلاً
0.625

$\frac{1}{2} + \frac{1}{8} = 0.101$

1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$
0	1	0	1	0

Real Numbers

- Numbers with fractions
- Could be done in pure binary
  - $1001.1010 = 2^3 + 2^0 + 2^{-1} + 2^{-3} = 9.625$
- Where is the binary point?
- Fixed?
  - Very limited
- Moving?
  - How do you show where it is?

8bit

4 bit	4 bit

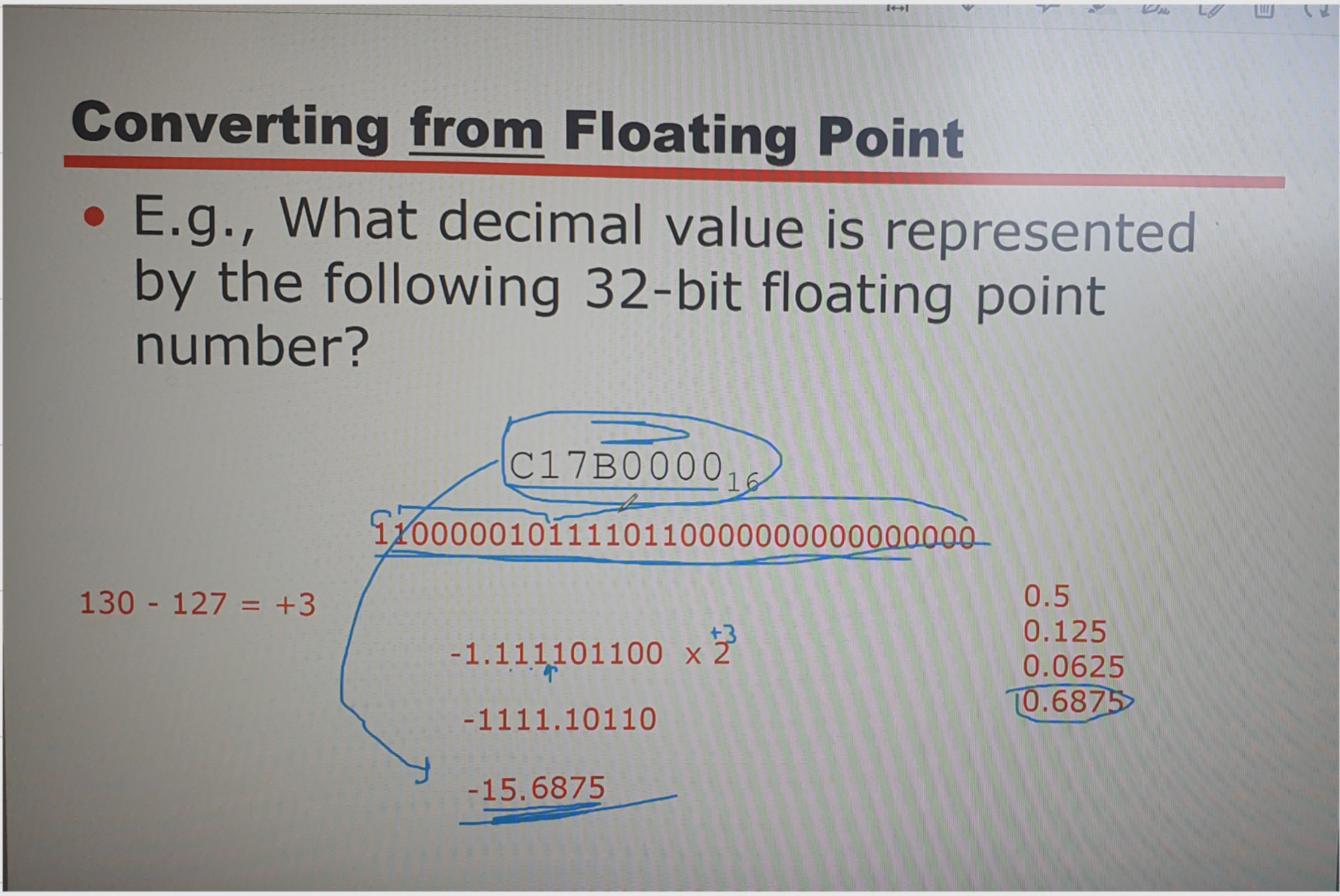
0.00000 1

بنقدرش نخزنه مثلاً

intel machine => little indian

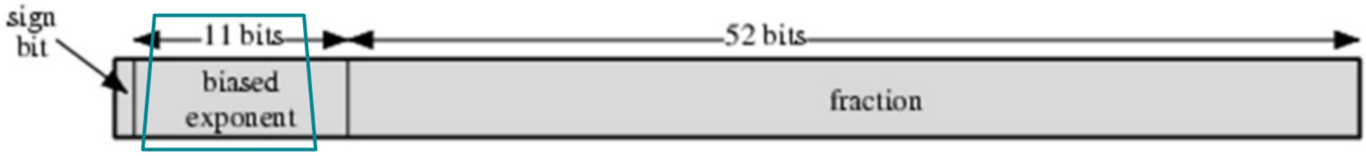
=> there are a machine we can select it

=> one bit if changed it switch the memory



IEEE 754 Formats

(a) Single format



(b) Double format

$\underbrace{+1023}_{\text{biased}}$

ممكن الدكتور يغير التقسيم

Exp

1 3 4

Bias = 3

rep -2.75

-10.11

-1.011×2^1

1 100 0110

deref. C4

11000100

-1.0100×2^{1}

-10.100

$= -2.5$

جمع وطرح وضرب وقسمة

الاعداد الغير صحيحة

← مش مطلوب (للاطلاع)