

① overflow in 2's complement

1 01

$$\begin{array}{r} \cancel{0} \\ +3 \\ \hline -2 = -16 \end{array}$$

1000
↓
MSB
-8

$$\begin{array}{c} \text{---} \\ | \quad | \quad | \quad | \quad | \\ | \quad | \quad | \quad | \quad | \\ \hline 8 \quad 4 \quad 2 \quad 1 \\ = 15 \end{array} = -1$$

~~1110111~~

$$\begin{array}{l} 1 = -1 \\ 11 = -1 \\ 111 = -1 \\ \dots \dots 1 = -1 \\ \text{1 million} \end{array}$$

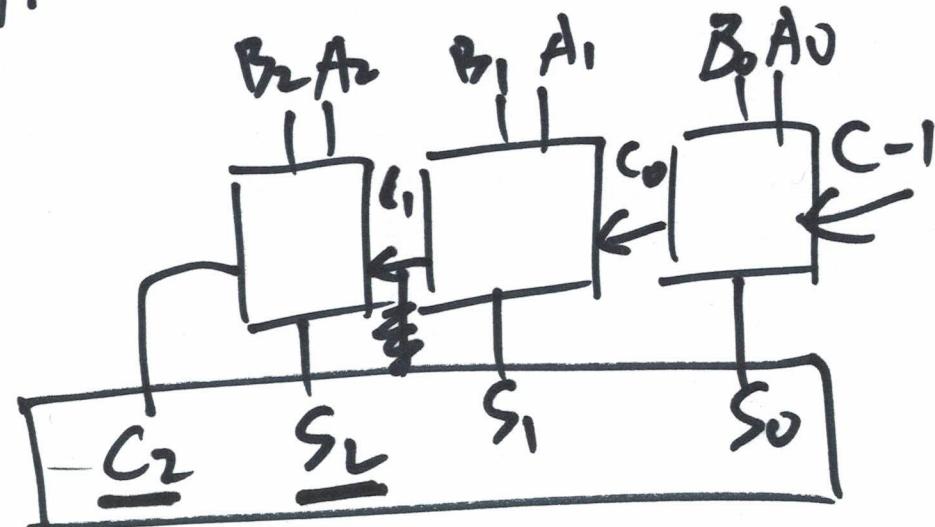
$$\begin{array}{l} 10 = -2 \\ 110 = -2 \\ \dots \dots 0 = -2 \\ \text{is} \end{array}$$

$$\begin{array}{l} 1101 \\ = -8 + 4 + 1 = -3 \\ -16 + 8 + 4 + 1 \\ = -3 \end{array}$$

①

② overflow only happens:

$$\boxed{\begin{array}{r} P \\ + P \\ \hline N \end{array}}$$



$$\begin{array}{r} \cancel{1\ 1\ 1} & N & -1 \\ + \cancel{1\ 1\ 1} & N & -1 \\ \hline \cancel{0\ 1\ 1\ 0} & N & \cancel{-1} \end{array}$$

*Discard the carry
Duplicate the MSB*

$$\begin{array}{r} \cancel{1\ 1\ 1\ 0} \\ \hline 1\ 1\ 1\ 0 \end{array} \quad -2$$

$$\boxed{\begin{array}{r} B_2 \ B_1 \ B_0 \\ + \ A_2 \ A_1 \ A_0 \\ \hline C_2 \ S_2 \ S_1 \ S_0 \end{array}}$$

$$\begin{array}{r}
 \begin{array}{r} 111 \\ + 011 \\ \hline 1010 \end{array} \quad \begin{array}{r} N = -1 \\ P = 3 \end{array} \\
 \end{array}$$

~~1010~~

0010

↓
Z
↓
Z

$$\begin{array}{r}
 \begin{array}{r} 111 \\ + 100 \\ \hline 1011 \end{array} \quad \begin{array}{r} N = -5 \\ P = -4 \end{array} \\
 \end{array}$$

-1 -5
 Overflow
 -8 + 3 = -5

$$\begin{array}{r}
 \begin{array}{r} 011 \\ + 011 \\ \hline 0110 \end{array} \quad \begin{array}{r} P \\ P \\ N \end{array} \\
 \end{array}$$

overflow
 Cn

(3)

$2^{\text{'}}\text{s complement}$ for fractional numbers

$$\begin{array}{c} \boxed{\pm 3} \\ 0.11_{(2)} \end{array} \xrightarrow{\text{2's complement}} 1.00 + 1 = \underline{101} \quad -3$$

$$\begin{array}{c} 101 \\ \hline 0.1_{(2)} \end{array} \xrightarrow{\text{2's complement}} 1.0 + \cancel{0.1} = \underline{1.1} \quad \begin{array}{c} 0.5 \\ \hline -1 + 0.5 = -0.5 \end{array}$$

$$1_{(2)} = 1_{(10)}$$

$$1_{(2)} \times 2 = 10_{(2)}$$

$$1_{(2)} \times 2 \times 2 = \underline{100}_{(2)}$$

$$1_{(10)} \times 10 = 10_{(10)}$$

$$1_{(10)} \times 10 \times 10 = \underline{100}_{(10)}$$

$$1_{(2)} \div 2 = 0.1_{(2)}$$

$$\begin{array}{c} 1.11 \\ \hline 0.11 \\ = 0.25 \end{array}$$

$$\begin{array}{c} 1.11 + 0.01 \\ = 1.11 \\ \cancel{-1} + 0.5 + 0.25 \\ = -0.25 \end{array}$$

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