

1.3. What is the 16-bit FP number representation of -5.375 in hex with 1-bit sign, 4-bit biased exponent, and 11-bit fraction, where bias offset = 7?

Step 1: Convert decimal to binary

First convert the whole #: 5

$$\begin{array}{r} 2 \overline{) 5} \\ \underline{4} \\ 1 \end{array} \longrightarrow \boxed{1}$$

$$5_{10} = 101_2$$

$$\begin{array}{r} 2 \overline{) 2} \\ \underline{2} \\ 0 \end{array} \longrightarrow 0$$

$$\begin{array}{r} 2 \overline{) 1} \\ \underline{0} \\ 1 \end{array} \longrightarrow \boxed{1}$$

* Remember: Write binary number starting from last division digit ^{calculation} to the first division digit calculation

Now convert the fraction portion: .375

$$0.375 \times 2 = 0.75 = \boxed{0} + .75$$

$$0.75 \times 2 = 1.5 = 1 + .5$$

$$0.50 \times 2 = 1.0 = \boxed{1} + 0$$

$$0.0 \times 2 = 0.0 \rightarrow \text{End}$$

$$0.375_{10} = .011_2$$

$$5.375_{10} = 101.011_2$$

Step 2: Convert Binary to Scientific Notation

$$5.375_{10} = 101.011_2$$

$$\underline{101.011}_2 \Rightarrow 1.01011 \times 2^2 \quad \leftarrow \begin{array}{l} \# \text{ of decimal places moved} \\ \text{to the left} \end{array}$$

Step 3: Calculate Biased Exponent:

$$\text{Unbiased Exponent} = 1.01011 \times 2^{\boxed{2}}$$

$$\text{Biased Exponent} = \text{Unbiased Exponent} + \text{Biased offset}$$

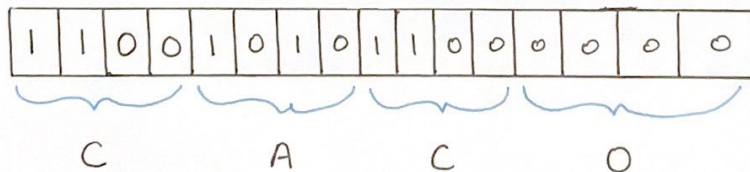
$$\text{Biased offset} = 7$$

$$\begin{aligned} \text{Biased Exponent} &= \underline{2} + \underline{7} \\ &= 9_{10} \\ &= 1001_2 \end{aligned}$$

Step 4: Fusion of Floating Point

$$\begin{array}{c} \nearrow \text{sign bit} \\ 1.01011 \times 2^9 = 1.01011 \times 2^{\overbrace{1001_2}^{\text{Biased Exponent}}} \end{array}$$

MantissaBiased Exponent



0xCAC0

1.4. What is the real number equivalent to FP number $0x3400$ with 1-bit sign, 4-bit biased exponent, 11-bit fraction, and bias offset = 7?

Step 1: Convert Hex to 16-bit binary

$$3 = 0011$$

$$4 = 0100$$

$$0 = 0000$$

$$0 = 0000$$

$$0x3400 \Rightarrow [0011\ 0100\ 0000\ 0000]_2$$

$$\text{sign bit} = 0$$

$$\text{mantissa} = 10000000000$$

$$\text{exponent} = 0110$$

Step 2: Calculate Unbiased Exponent.

$$\text{Biased Exponent} = 0110_2 = 6$$

$$\text{Biased Exponent} = \text{Unbiased Exponent} + \text{Biased offset}$$

$$\text{Unbiased Exponent} = \text{Biased Exponent} - \text{Biased offset}$$

$$= 6 - 7$$

$$= -1$$

Step 3: Convert Mantissa to Decimal

~~$$\text{Mantissa} = 10000000000_2$$~~

$$\text{Mantissa} = 10000000000$$

$$= 1 \times 2^{-1}$$

$$= 0.5$$

Step 4: Find the real number equivalent using the equation:

$$\text{Real \#} = (-1)^S \times (1 + m) \times 2^E$$

S: Sign Bit

m: Mantissa

E: Unbiased Exponent

$$= (-1)^0 \times (1 + 0.5) \times 2^{-1}$$

$$= 1.5 \times 2^{-1}$$

$$= 0.75$$

1.5. What is the real number equivalent to FP number $0x3400$ with 1-bit sign, 4-bit biased exponent, 11-bit fraction, and bias offset = 8?

Step 1: Convert Hex to 16-bit Binary

$$3 = 0011$$

$$4 = 0100$$

$$0 = 0000$$

$$0 = 0000$$

$$0x3400 \Rightarrow [0011\ 0100\ 0000\ 0000]_2$$

Step 2: Calculate Unbiased Exponent

$$\text{Biased Exponent} = 0110_2 = 6$$

$$\begin{aligned}\text{Unbiased Exponent} &= \text{Biased Exponent} - \text{Biased offset} \\ &= 6 - 8 \\ &= -2\end{aligned}$$

Step 3: Convert Mantissa to Decimal

$$\begin{aligned}\text{Mantissa} &= 100\ 0000\ 0000 \\ &= 1 \times 2^{-1} \\ &= 0.5\end{aligned}$$

Step 4: Find the real number equivalent using the equation:

$$\begin{aligned}\text{Real \#} &= (-1)^S \times (1 + m) \times 2^E \\ &= (-1)^0 \times (1 + 0.5) \times 2^{-2} \\ &= 0.375\end{aligned}$$

1.14. What is a Von Neumann architecture bottleneck?

The performance of CPUs has increased at a faster rate than that of memory. Therefore, the Von Neumann architecture presents a communication bottleneck between a faster CPU and a slower memory.