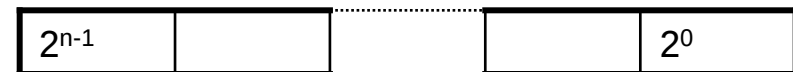


Signed Binary Numbers

- **Unsigned binary numbers**

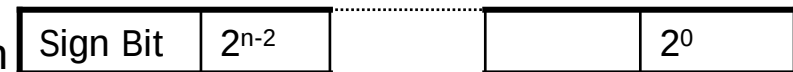
n bits binary number



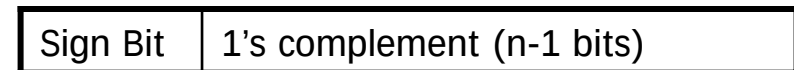
- **Signed binary numbers**

- Signed magnitude representation

The sign bit is '0' for '+' and '1' for '-'



- Signed 1's complement representation



- Signed 2's complement representation



- Exercise: Using 6 bits represent the numbers $+9_{10}$ and -9_{10} using the three different signed binary numbers

Addition of Signed Binary Numbers

- In signed magnitude representation follow the rules of ordinary arithmetic.
 - If the signs are the same, add the magnitudes and give the sum the same sign.
 - If different signs, subtract and give the result the sign of the big number.
- In complement representation, add the two numbers including the sign bit. Any carry out from the sign bit is ignored. No comparison or subtraction is needed.
- Examples: Add (-6_{10}) and $(+13_{10})$ in binary using signed 2's complement form with 8 bits. Repeat for $(+6_{10}) + (-13_{10})$

Answer:

$$(+6_{10}) \equiv 00000110 \text{ and } (+13_{10}) \equiv 00001101$$

$$\therefore (-6_{10}) \equiv 11111010 \text{ and } (-13_{10}) \equiv 11110011$$

$$\begin{array}{r} -6 \quad 11111010 \\ +13 \quad 00001101 \\ \hline 100000111 \end{array}$$

Discard

Sign Bit

Answer is +7

$$\begin{array}{r} +6 \quad 00000110 \\ -13 \quad 11110011 \\ \hline 11111001 \end{array}$$

Sign Bit

Answer is -7

Arithmetic Subtraction

- Take the 2's complement of the subtrahend, including the sign bit, and add it to the minuend. A carry out is discarded.

$$(\pm A) - (\pm B) = (\pm A) + (\mp B)$$

- Example: Perform the subtraction $(-6_{10}) - (-13_{10})$ in binary using signed 2's complement representation with 8 bits.

-6	1 1 1 1 1 0 1 0
+13	<u>0 0 0 0 1 1 0 1</u>
	1 0 0 0 0 0 1 1 1

Discard

Sign Bit

Answer is +7