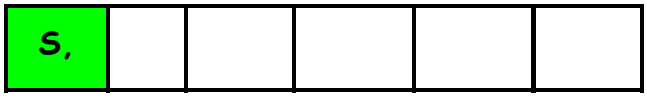
## The Signed Magnitude System (C)

Number Systems always have the need to express **negative numbers**. The following method is **NOT** the method we will end up using. It is included for your information for continuity of your knowledge level. **This system is being taught as a lead in to the 2's complement system. We will not actually use it.**

### Signed Negative Numbers

Signed # representation: **"0" means (+), and "1" means (-).**




The sign and the magnitude are separated by a comma for illustration purposes. The comma isn't normally used in the actual representation. **Feel free to use it in this course.**

### The importance of "N"

Along with the sign, we now have to officially **define the length of the number.** This length, **N, includes the number and the sign**. This is very important. **If 'N' is too small, it might not be enough to hold the number if any math is performed on it.**

### *Signed Magnitude Example 1*

**Find the negative of $13_{10}$ in the signed magnitude system with an N value of five.**

- **N=5** includes the binary number and the sign. So, the first thing to do is convert the **decimal 13** into a **4-bit binary #,** and place a temporary negative sign in front of it.

$$-13_{10} = -(\underbrace{1101}_{\text{13, 4 bits wide}})_2$$

- Next, add on the **signed magnitude sign bit**, separated by a comma, to total **N=5** bits.

$$-13_{10} = -(\underbrace{1101}_{\text{13, 4 bits wide}})_2 = \boxed{1,1101_{2sm}}$$

**Example continued on Next Page)**

**Example Continued)**

- The '**2sm**' subscript stands for "**base 2, signed magnitude**"
- The sign bit was separated from the rest of the number with a comma. You need to do the same with any system which has sign bits.

***Signed Magnitude Example 2***

**Find the negative of $18_{10}$ in the signed magnitude system with an N value of five.**

**Solution:** **This problem can't be done.** $18_{10} = 10010_2$ which is **5 bits without the sign bit.** But the **N value INCLUDES the sign bit.** Therefore, **N would have to be at least N=6.** The next example will reexamine this example with a larger N value.

***Signed Magnitude Example 3***

**Find the negative of $18_{10}$ in the signed magnitude system with an N value of seven.**

- Since the N value includes the sign bit, the 1st thing to do is to find the binary equivalent of $18_{10}$ using 7-1=6 bits.
- The binary 18 is $10010_2$; which is 5 bits. Since we need 6-bits, a **0** needs to pad the left side of the number. Include a temporary negative sign.

$$-18_{10} = -(\underbrace{\overset{padding}{\overset{\lceil}{0}}\ 10010_2}_{18})$$

- Finally, the signed magnitude bit for a negative number is added to the left side, separated from the rest of the number with a comma.

$$-18_{10} = -(010010_2) = \boxed{1,010010_{2sm}}$$

**As indicated earlier, the value of N (the length of the word including the sign bit) is very important.** Obviously, the number would be different with **different values of N**. If **N=6** had been required, **the answer** to the previous example would have been. **$1,10010_{2sm}$.**

***Positive "Signed Magnitude" number Example.***

**Find the positive Signed Magnitude base 2 # for $+12_{10}$, N=7:**

$$+12_{10} = +(\overbrace{00}^{padding}\ \underbrace{1100}_{12})_2 = \boxed{0,001100_{2sm}}$$

## Other "Signed Magnitude" systems

While we won't actually teach the signed magnitude system for **Octal** and **Hex**, you should know that it does exist. A few examples of what the representations would be like in **Hex** or **Octal** are shown here.

| Number | sm (N = 5) |
|---|---|
| $(+24)_8$ | $0,0024_{8sm}$ |
| $(-42)_8$ | $7,0042_{8sm}$ |
| $(+3C)_{16}$ | $0,003C_{16sm}$ |
| $(-5)_{16}$ | $F,0005_{16sm}$ |

## Signed Magnitude System Conclusion

**The Signed magnitude system isn't particularly useful.**

- The hardware required to implement signed magnitude hardware systems is **expensive** and the
- **Algorithms required to implement the system in software are slow.**

But we can use the system as the basis for another system which solves these two problems.