

## Start with the Sign Bits

Let's try a little harder first...

If we compare two non-negative numbers,

- the approach IS the same.
- Right?

Maybe we can just use some extra logic to handle the sign bits?

## Consider All Possible Combinations of Sign Bits

Let's make a table based on the sign bits:

$A_s$	$\mathbf{B}_{\mathbf{s}}$	interpretation	solution
0	0	$A \ge 0 \ AND \ B \ge 0$	use unsigned
			comparator
0	1	$A \ge 0$ AND $B < 0$	A > B
1	0	$\mathbf{A} < 0 \text{ AND } \mathbf{B} \geq 0$	A < B
1	1	A < 0 AND B < 0	unknown

Interpret 2's Complement as Unsigned	Negative Numbers Can be Compared Directly
Remember our "simple" rule for translating <b>2's complement</b> bit patterns to decimal? The pattern $\mathbf{A} = \mathbf{a}_{N-1}\mathbf{a}_{N-2} \dots \mathbf{a}_1\mathbf{a}_0$ has value $\mathbf{V}_{\mathbf{A}} = -\mathbf{a}_{N-1}2^{N-1} + \mathbf{a}_{N-2}2^{N-2} + \dots + \mathbf{a}_02^0$ Let $\mathbf{A}$ be negative $(\mathbf{a}_{N-1} = 1)$ . Interpreted as <b>unsigned</b> , the same bits have value $\mathbf{V}_{\mathbf{A}} + 2^N$ .* *The statement is true by definition of 2's complement, actually.	What happens if we feed two negative 2's complement numbers into our unsigned comparator?We compare $V_A + 2^N$ with $V_B + 2^N$ .And we get an answer: <, =, or >.Let's say that we find $V_A + 2^N < V_B + 2^N$ .In that case, $V_A < V_B$ , so we have the right answer for 2's complement.The same result holds for other answers.
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# We Need Special Logic for the Sign Bits

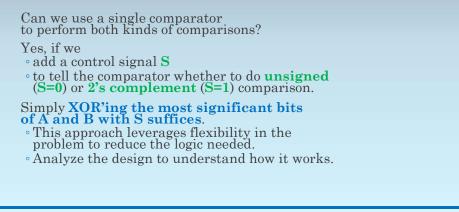
Now we can complete our table:

$\mathbf{A}_{\mathbf{s}}$	$\mathbf{B}_{\mathbf{s}}$	interpretation	solution
0	0	$A \ge 0 AND B \ge 0$	use unsigned
			comparator
0	1	$A \ge 0 AND B < 0$	A > B
1	0	$\mathbf{A} < 0 \text{ AND } \mathbf{B} \geq 0$	A < B
1	1	A < 0 AND B < 0	use unsigned
			comparator

#### Simply Flip the Wires on the Most Significant Bit

Can we just flip the wires on the sign bits? For  $A_s = 0$  and  $B_s = 1$ ,  $\circ$  we feed in  $A_{N-1} = 1$  and  $B_{N-1} = 0$ , and  $\circ$  the unsigned comparator produces A > B. For  $A_s = 1$  and  $B_s = 0$ ,  $\circ$  we feed in  $A_{N-1} = 0$  and  $B_{N-1} = 1$ , and  $\circ$  the unsigned comparator produces A < B. What about when  $A_s = B_s$ ? Flipping the bits then has no effect! Answers are also correct in those cases.

# One Comparator with a Control Signal can Do Both



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