Electronics
Voltage Dividers

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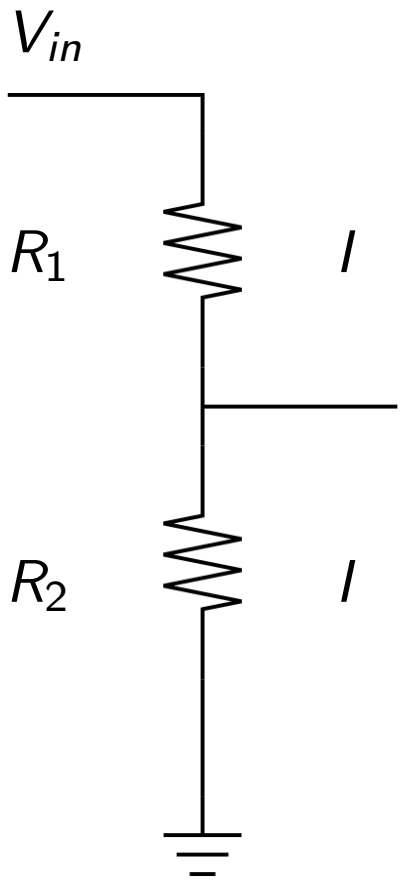
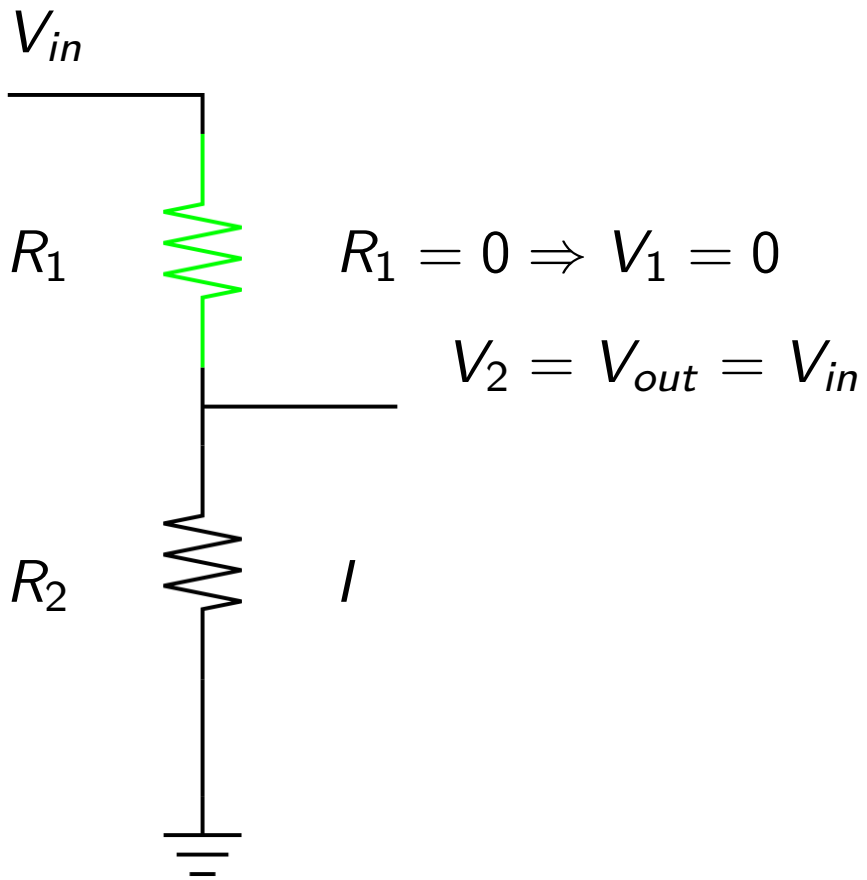
Following is an illustration of a voltage divider where one element is a switch.



$$V_{out} = V_{in}\left(\frac{R_2}{R_1+R_2}\right)$$

True if $I_{out} \equiv 0$


V_{in}
R_1
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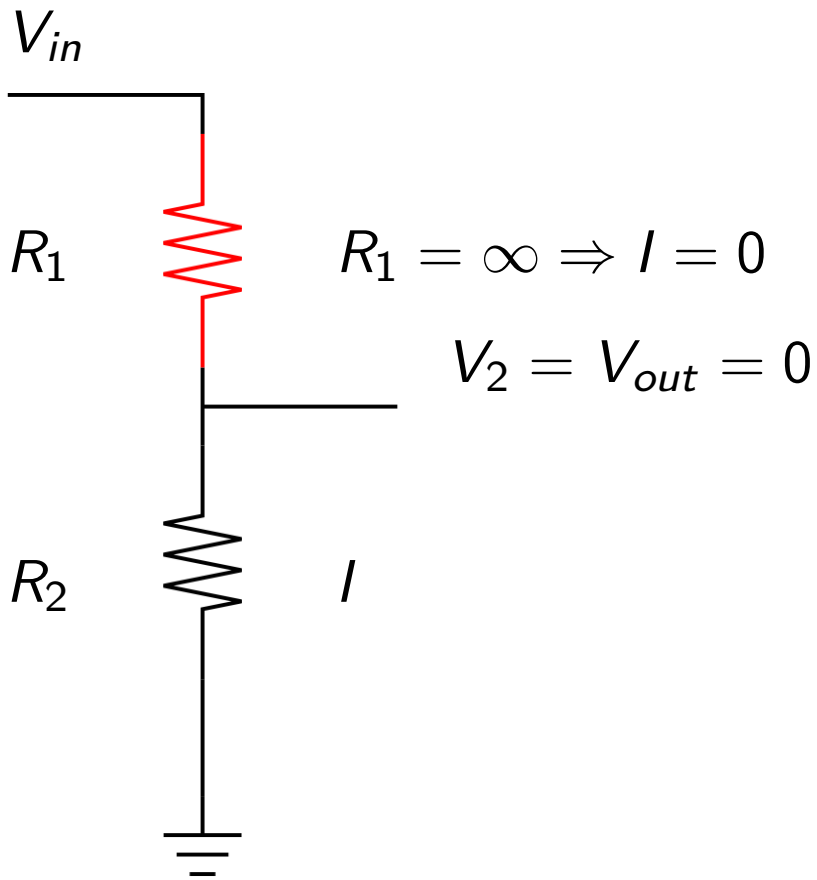
$R_1 = 0 \Rightarrow V_1 = 0$
$V_2 = V_{out} = V_{in}$


V_{in}
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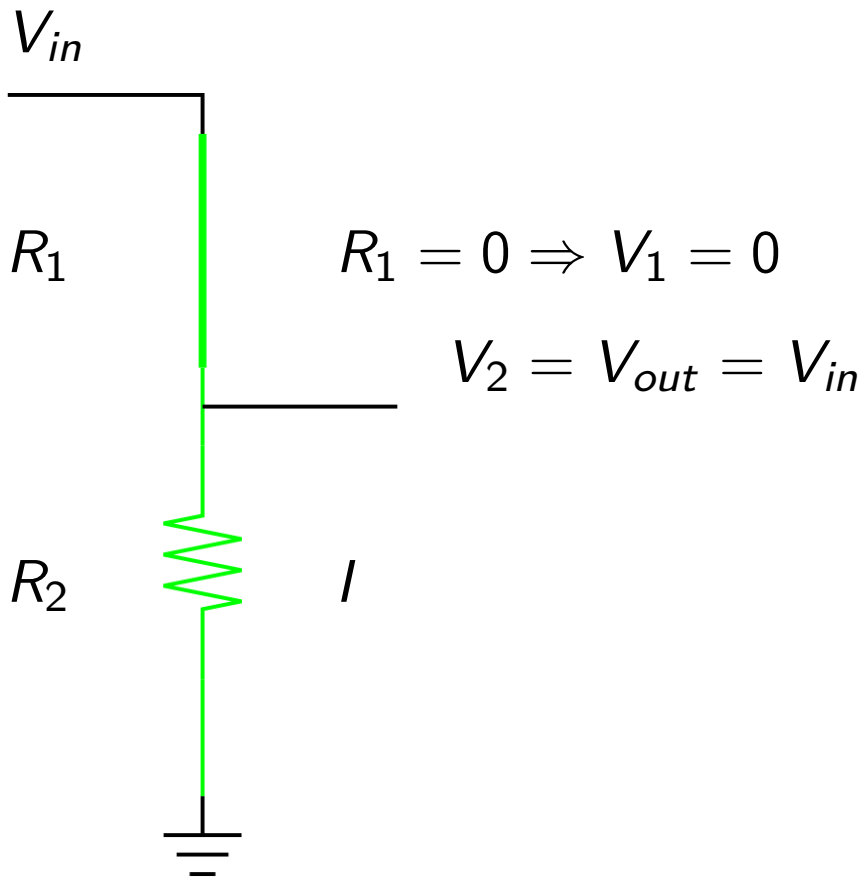
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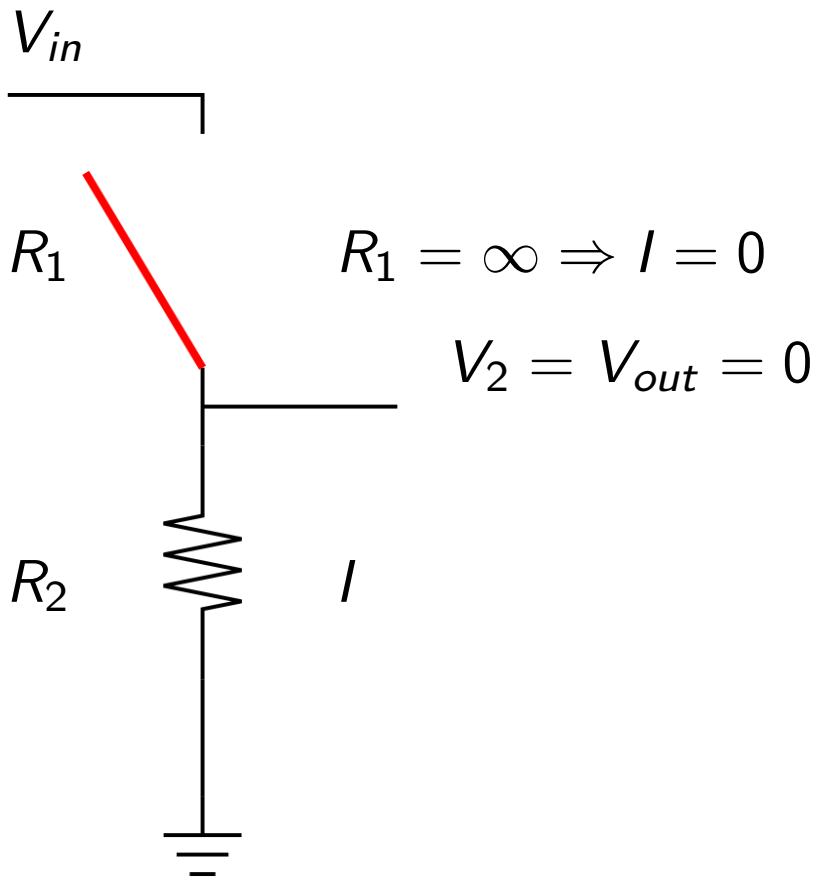
V_{in}
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So if one of the elements is a *switch*, the output varies between 0 and V_{in}.

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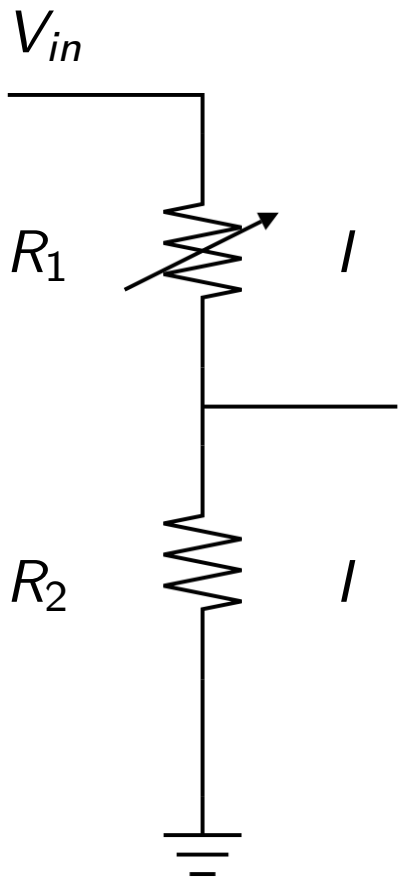
If either resistor in a voltage dividers is *variable*, then a range of output voltages is possible.



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Introduction to transducers

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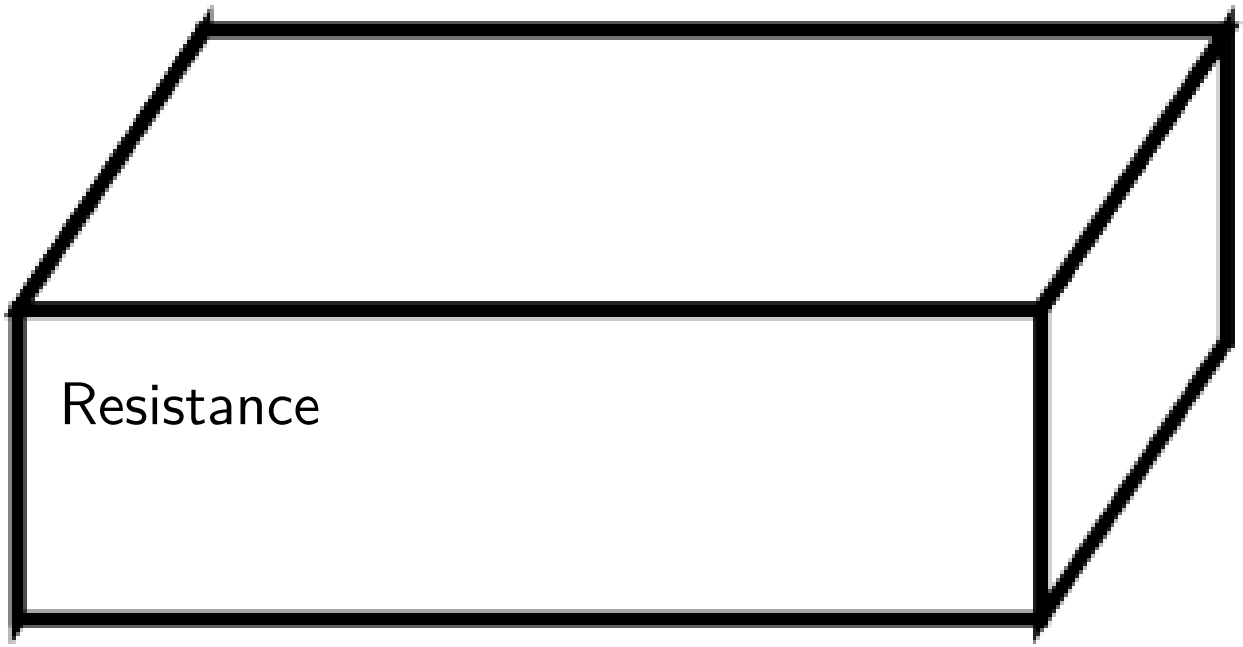
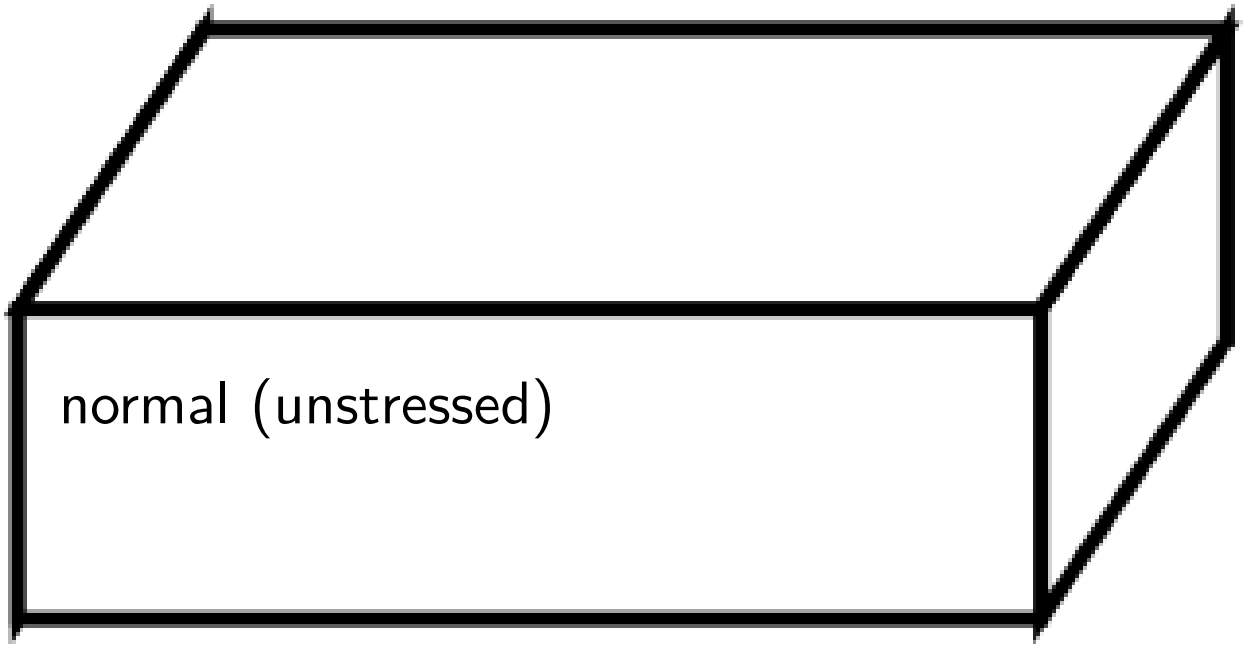
- Force-dependent resistor; the resistance varies with applied pressure



$$R = \rho \frac{L}{A}$$



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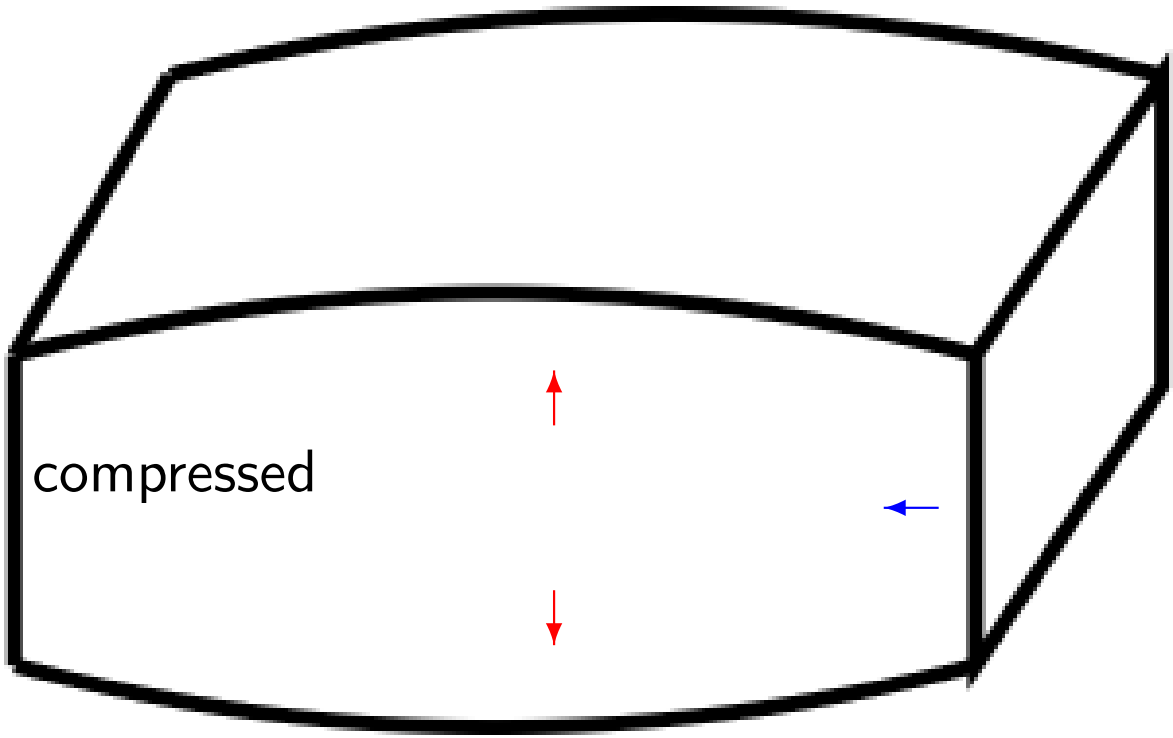
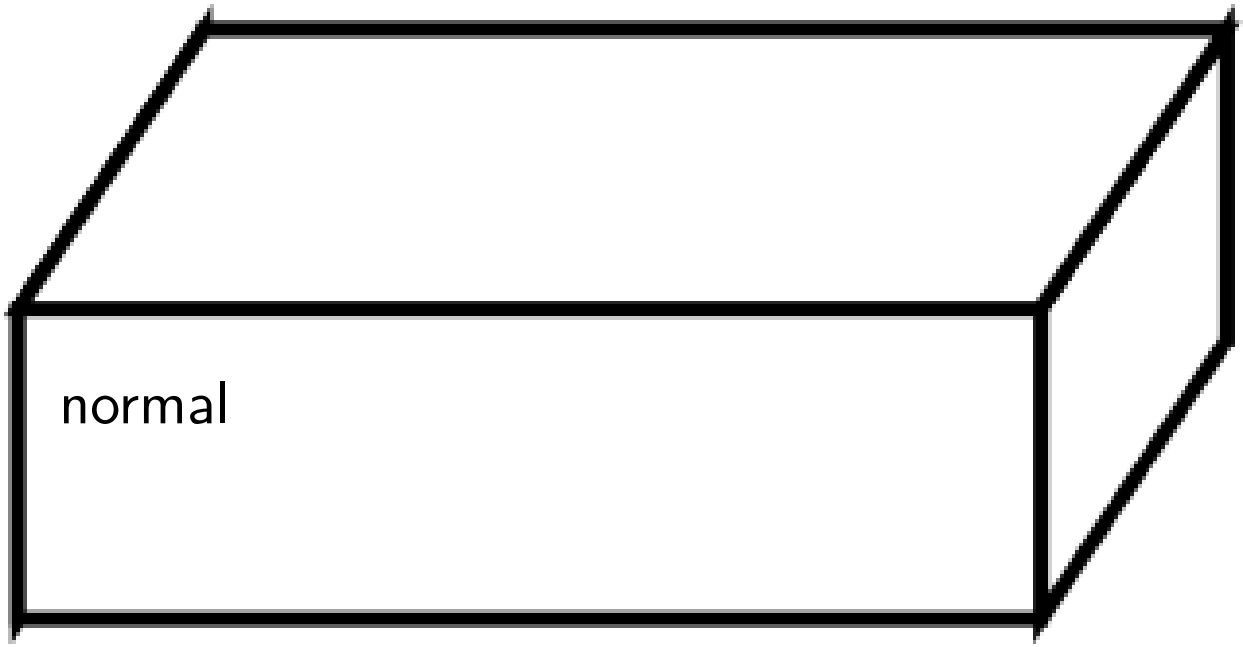


$$R = \rho \frac{L-}{A+} < R_0$$



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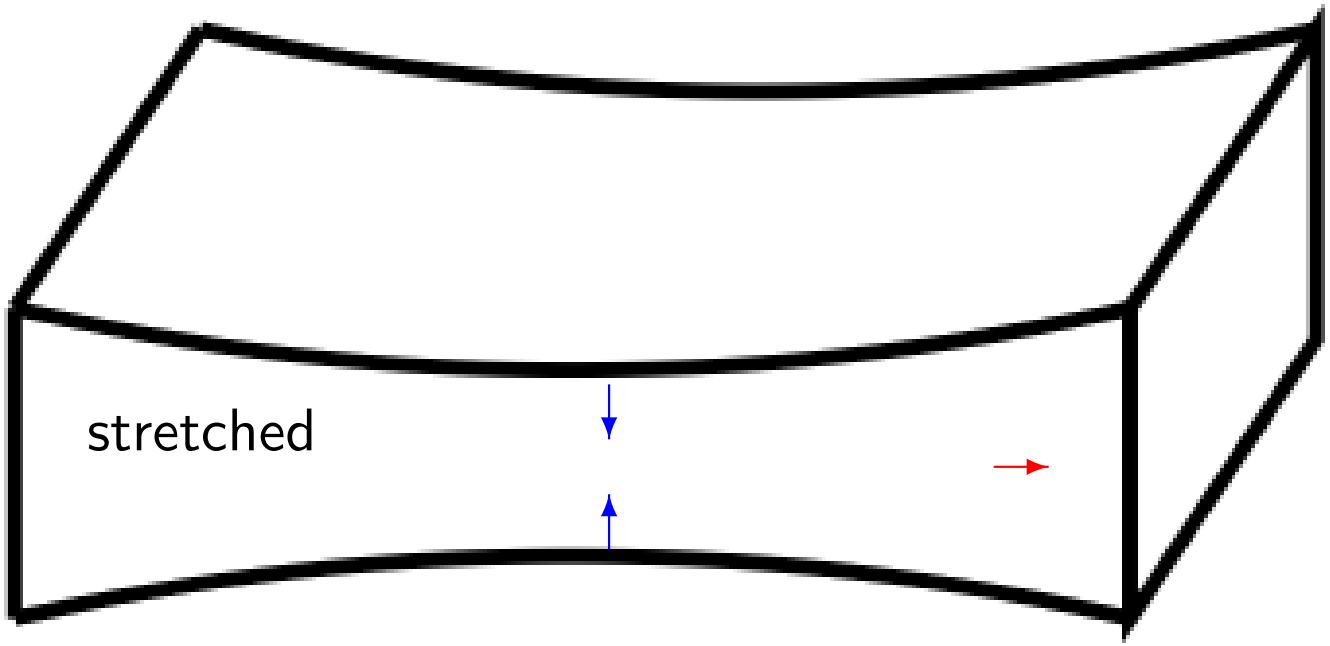

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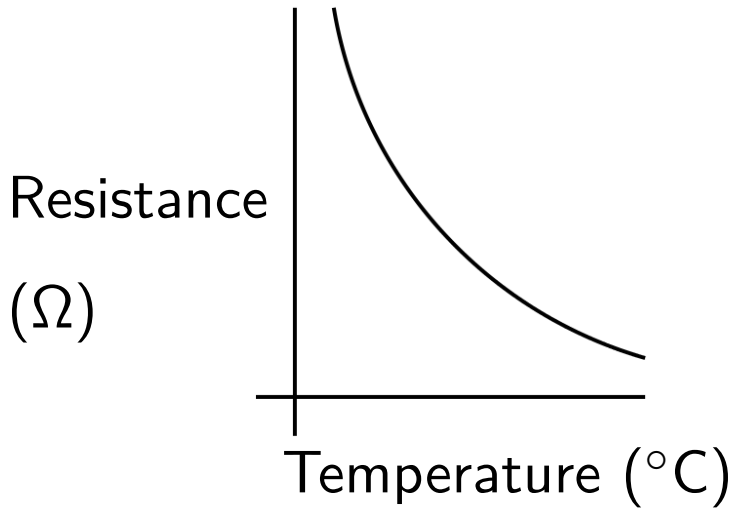
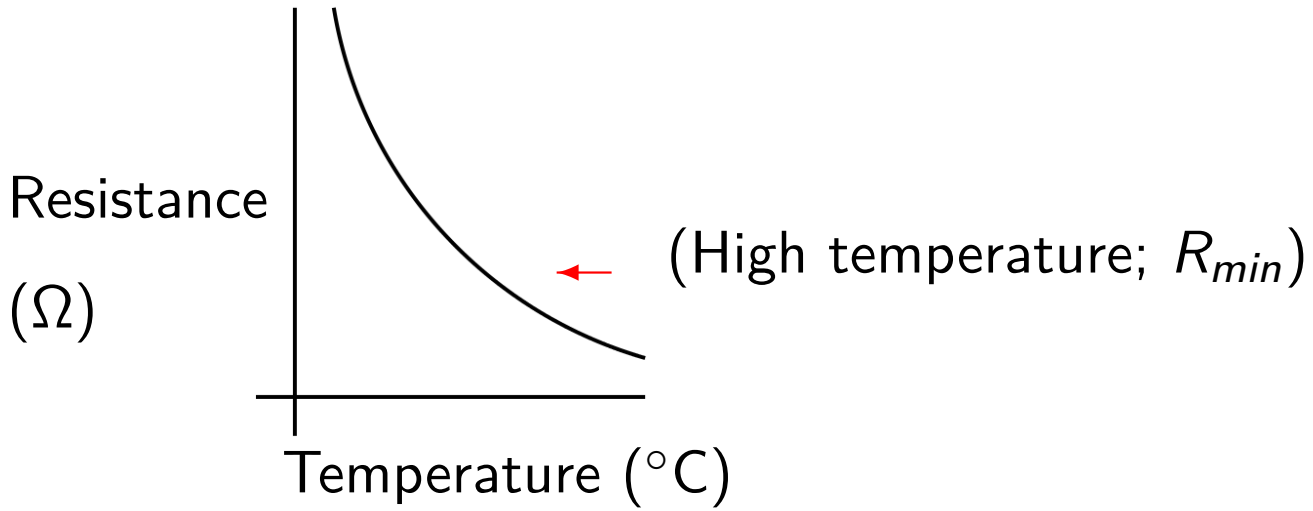


This is the resistance/temperature curve for a thermistor.



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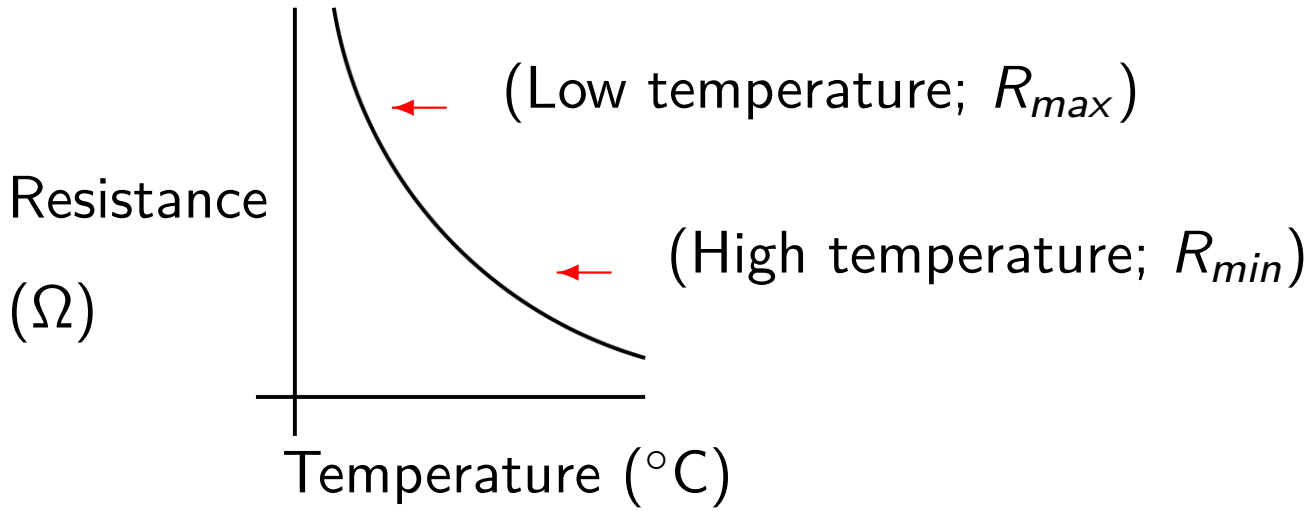

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$$R = \sqrt{R_{min} \times R_{max}}$$

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  Range of output voltages depends on range of R_t

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  From a voltage divider, the output voltage will still have an offset.

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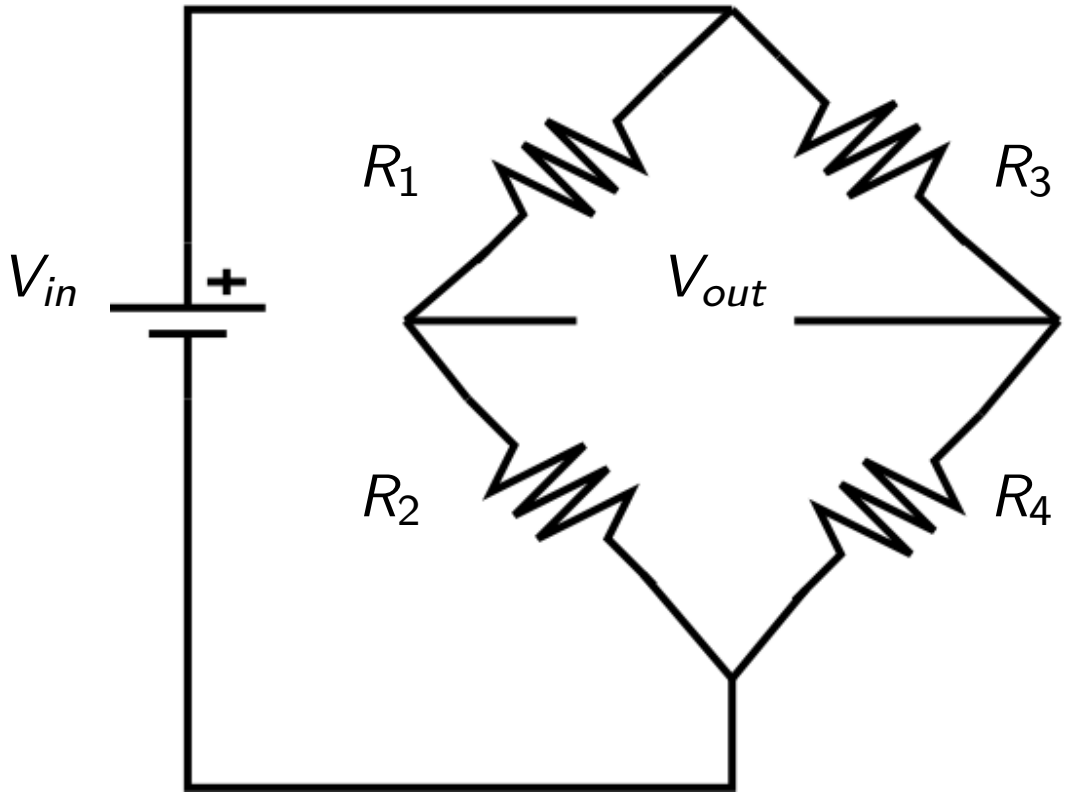
It's usually operated with the output voltage at or close to zero.



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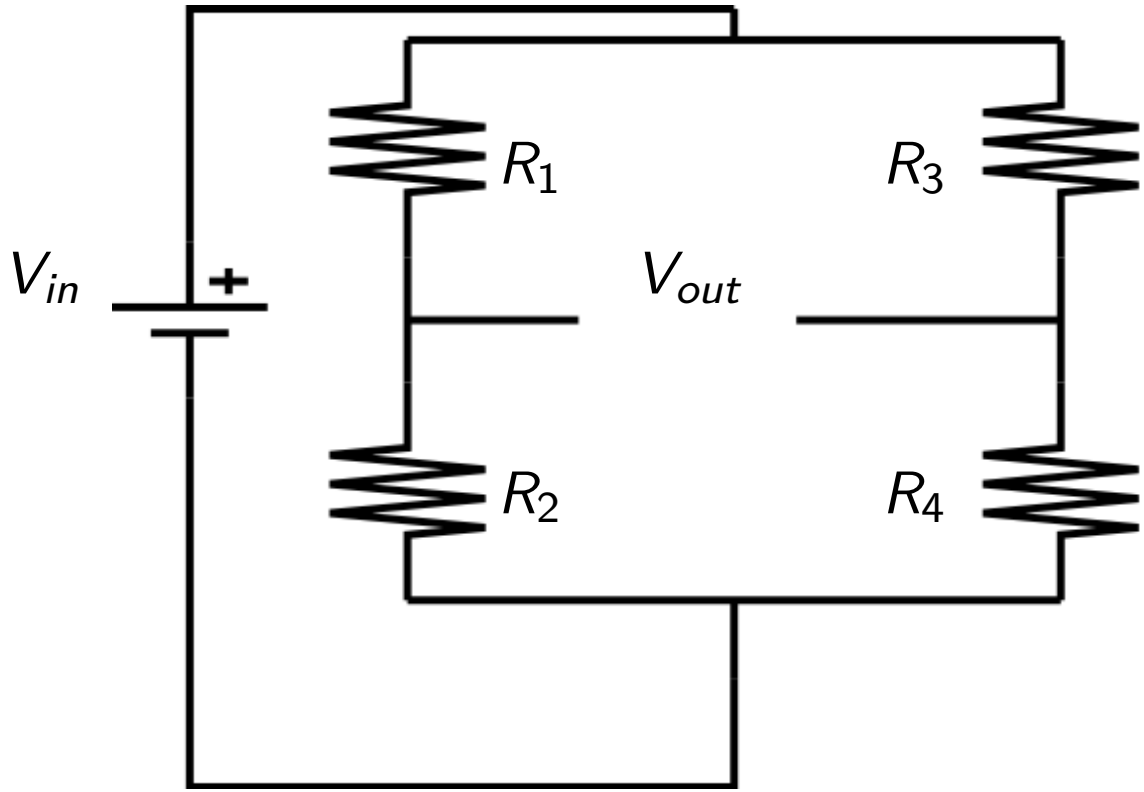
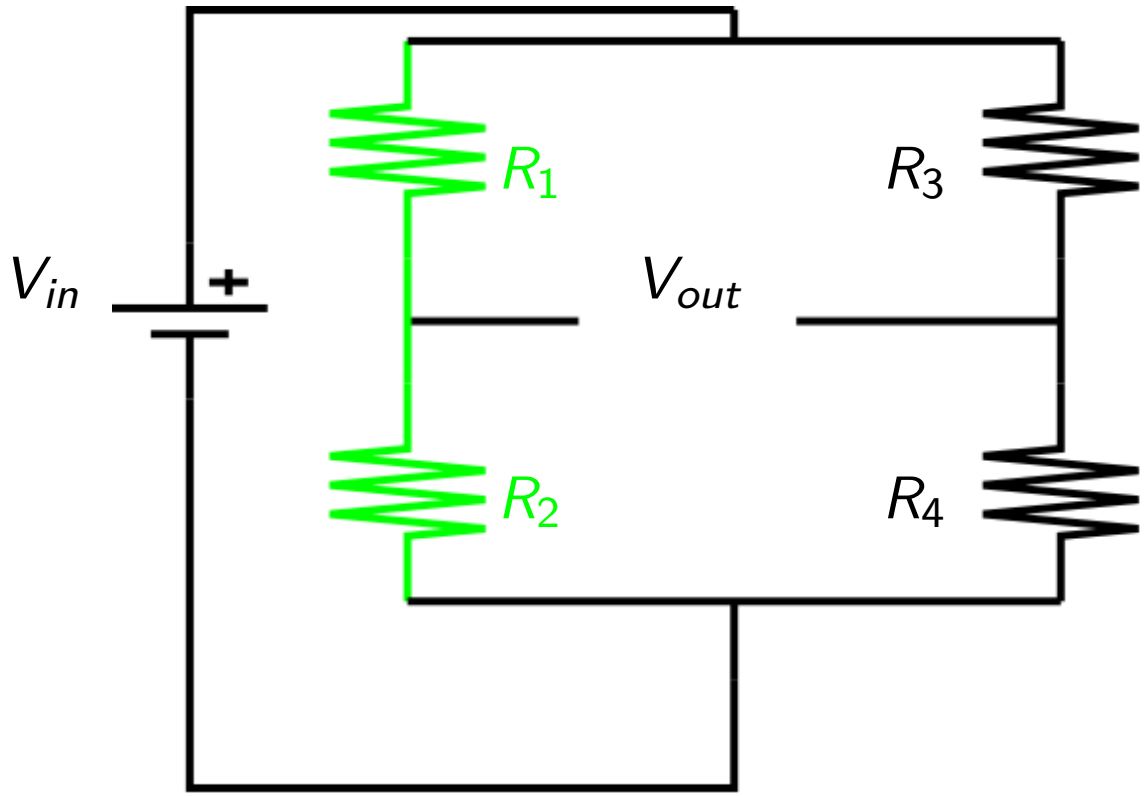
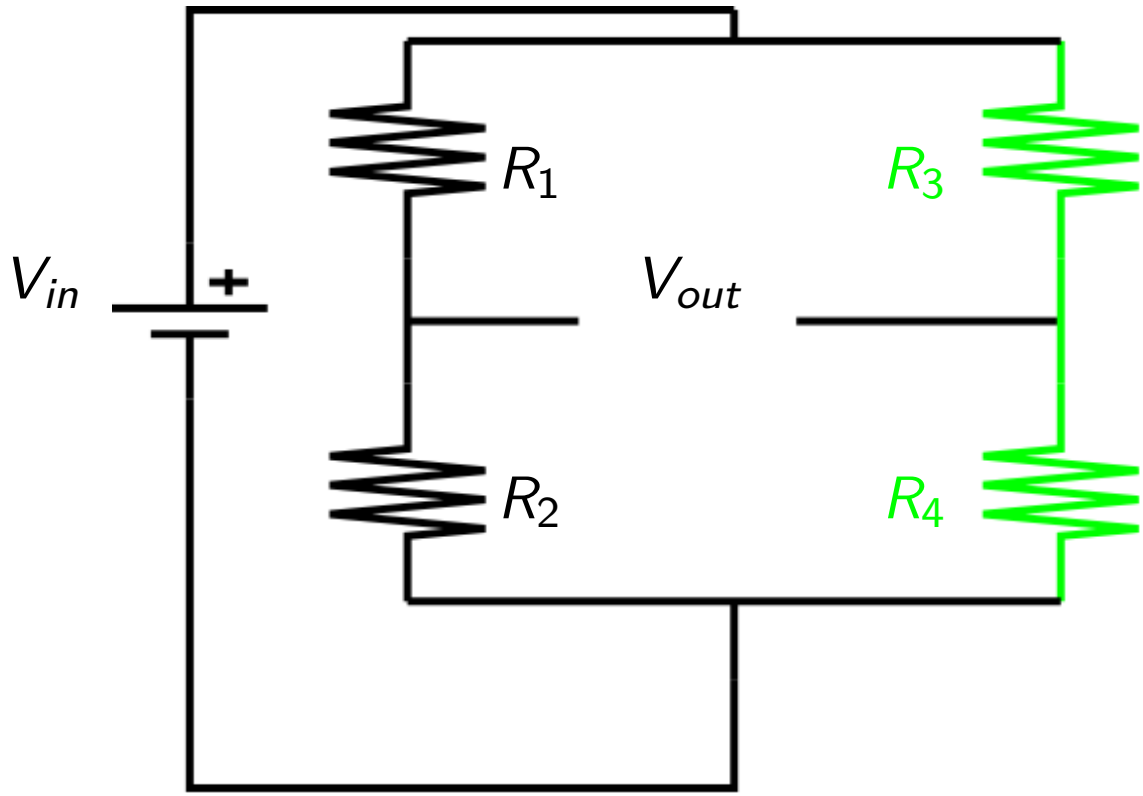


Here it's redrawn to show the two voltage dividers.



Here's one voltage divider.



Here's the other voltage divider.

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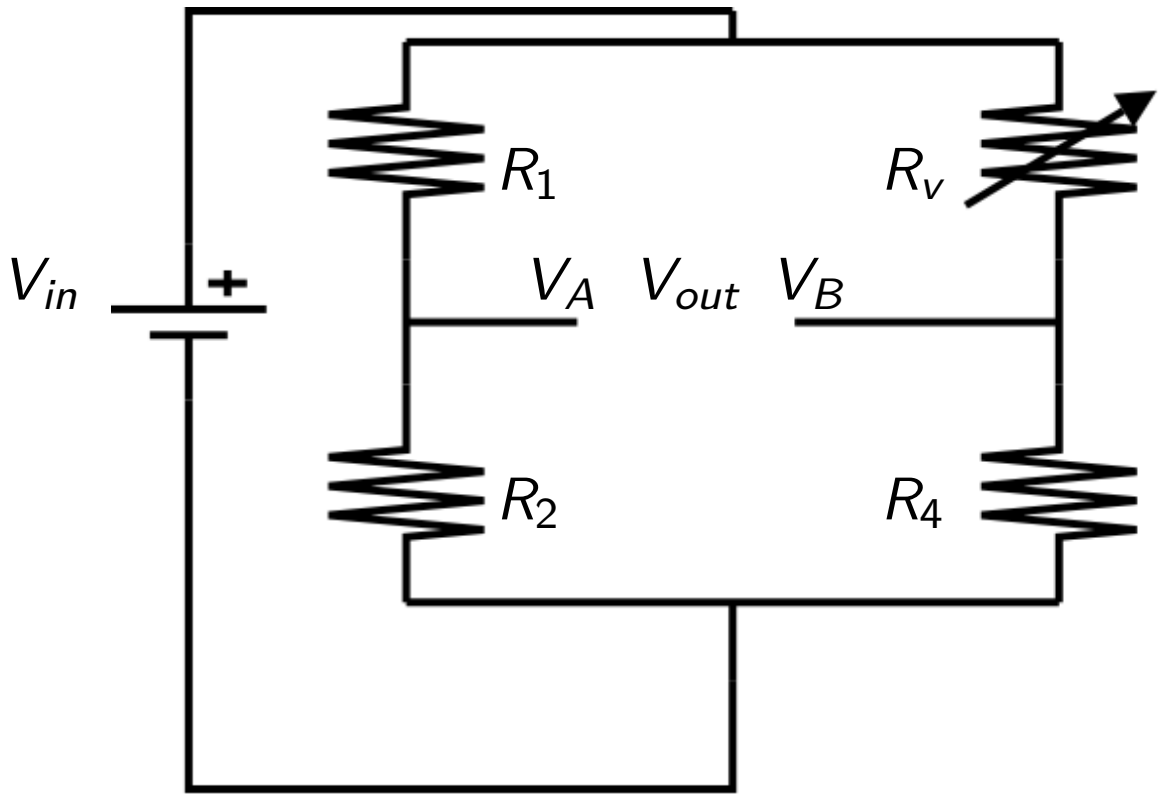
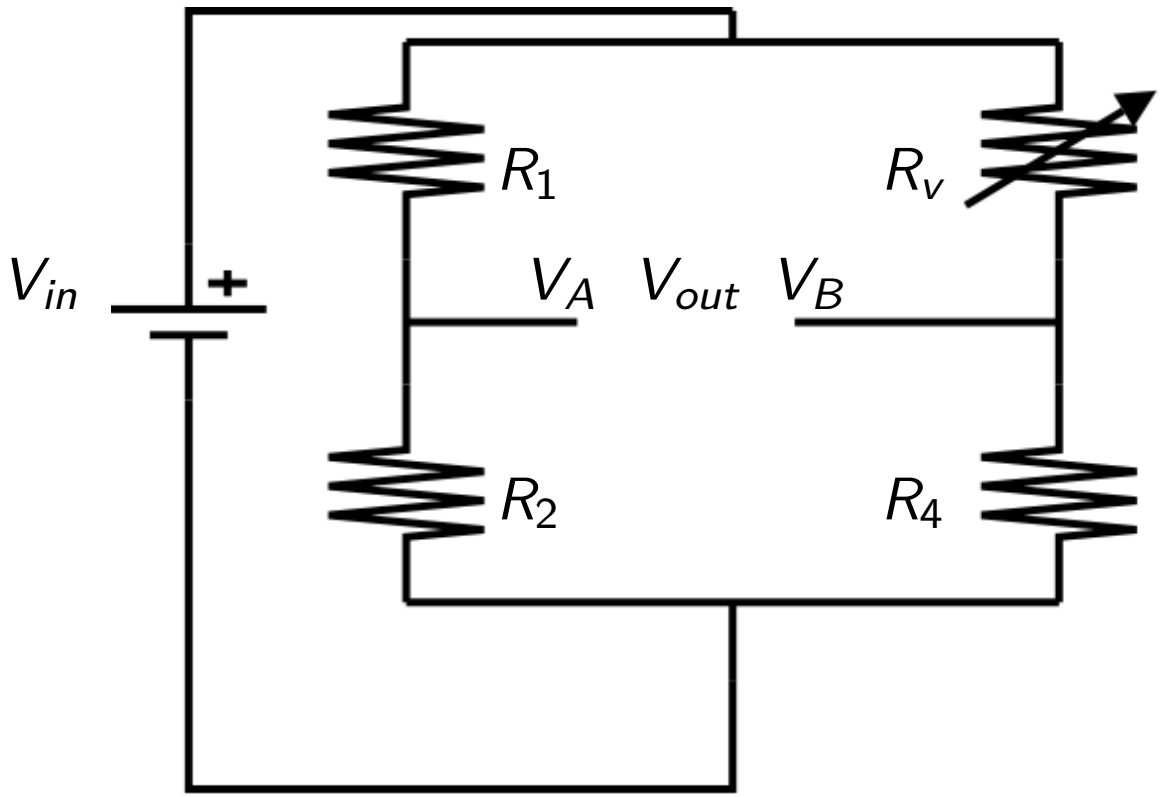
The circuit is very sensitive to small changes in the variable resistor.


R_1
R_v
V_{in}
+
V_A
V_{out}
V_B
R_2
R_4



The variable resistor could be in any of the four positions; this is one example.

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Wheatstone bridge options

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  differential op amp circuit with voltage followers on the inputs

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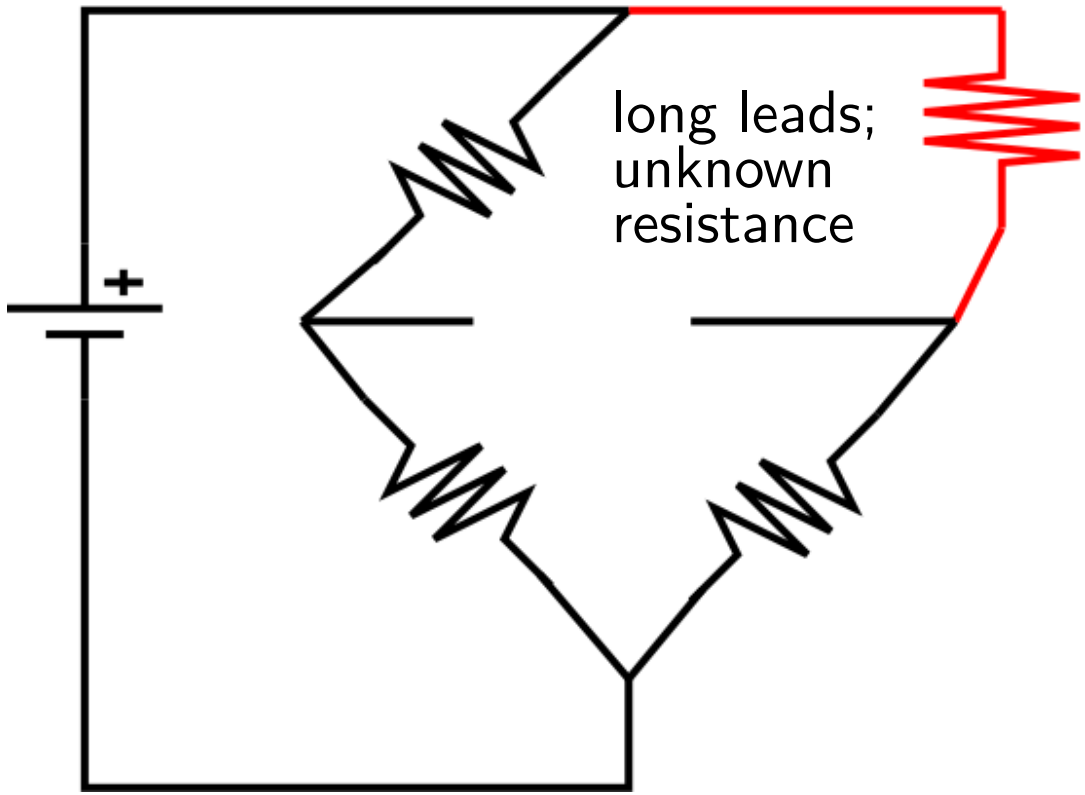
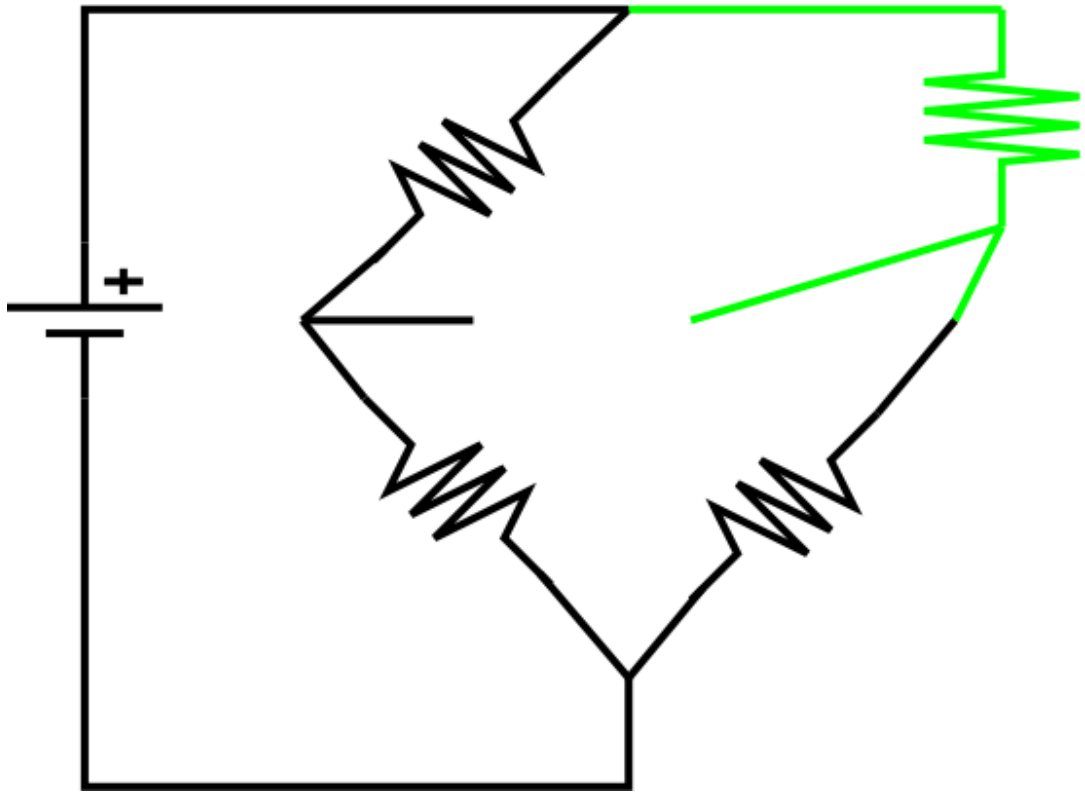


Uncompensated

Lead wire compensation



No current flows in measurement lead; similar resistance in both other leads

Temperature compensation

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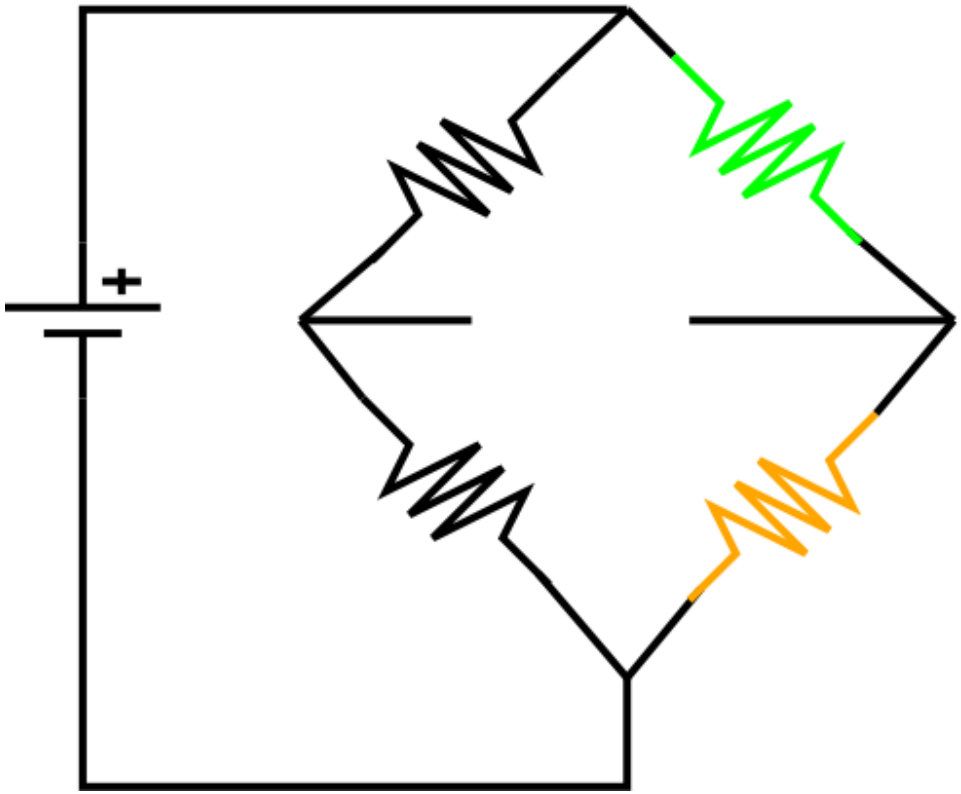

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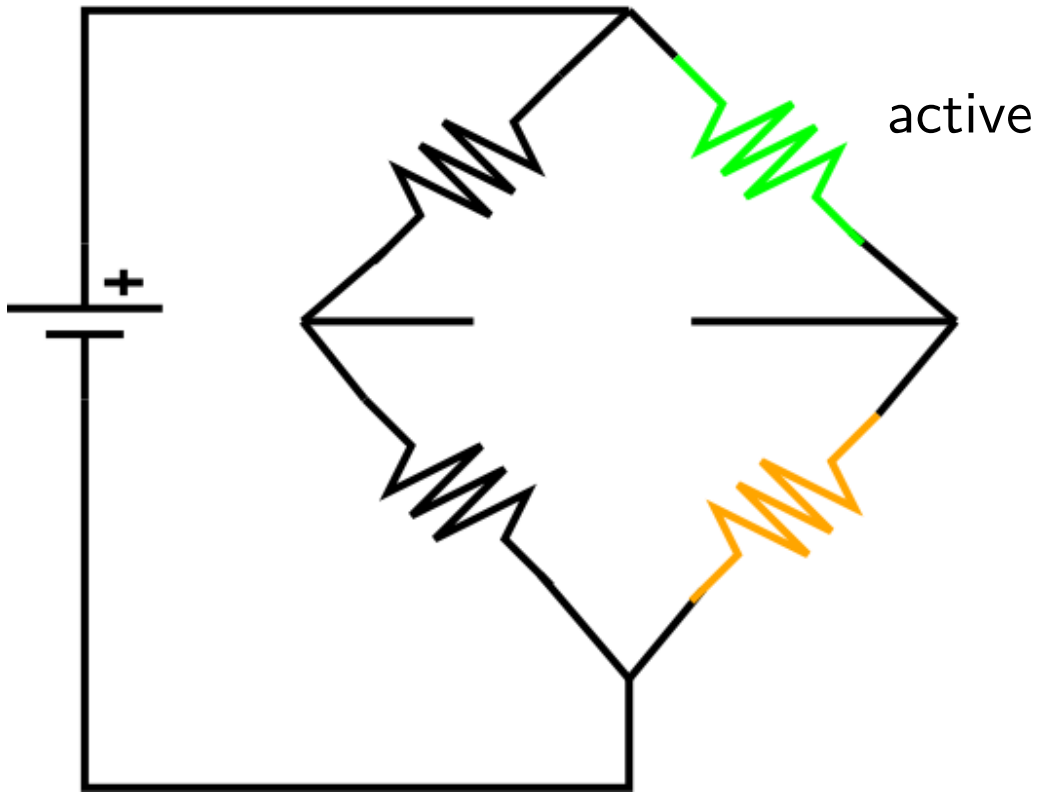

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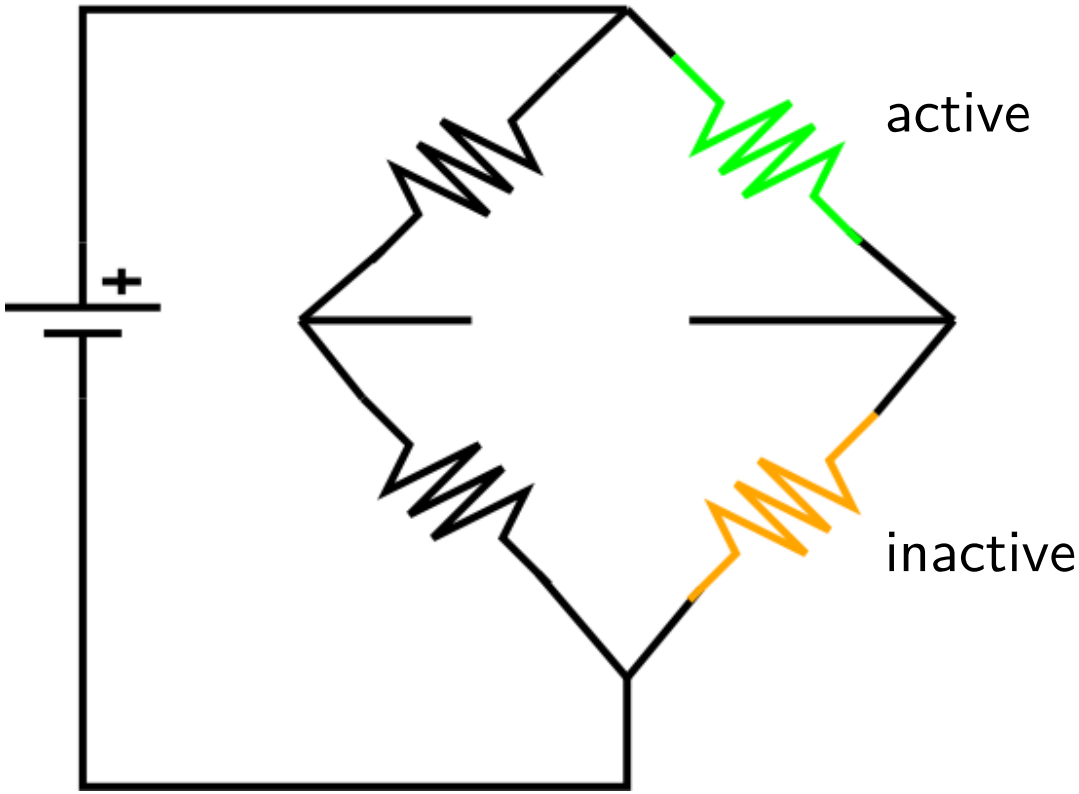

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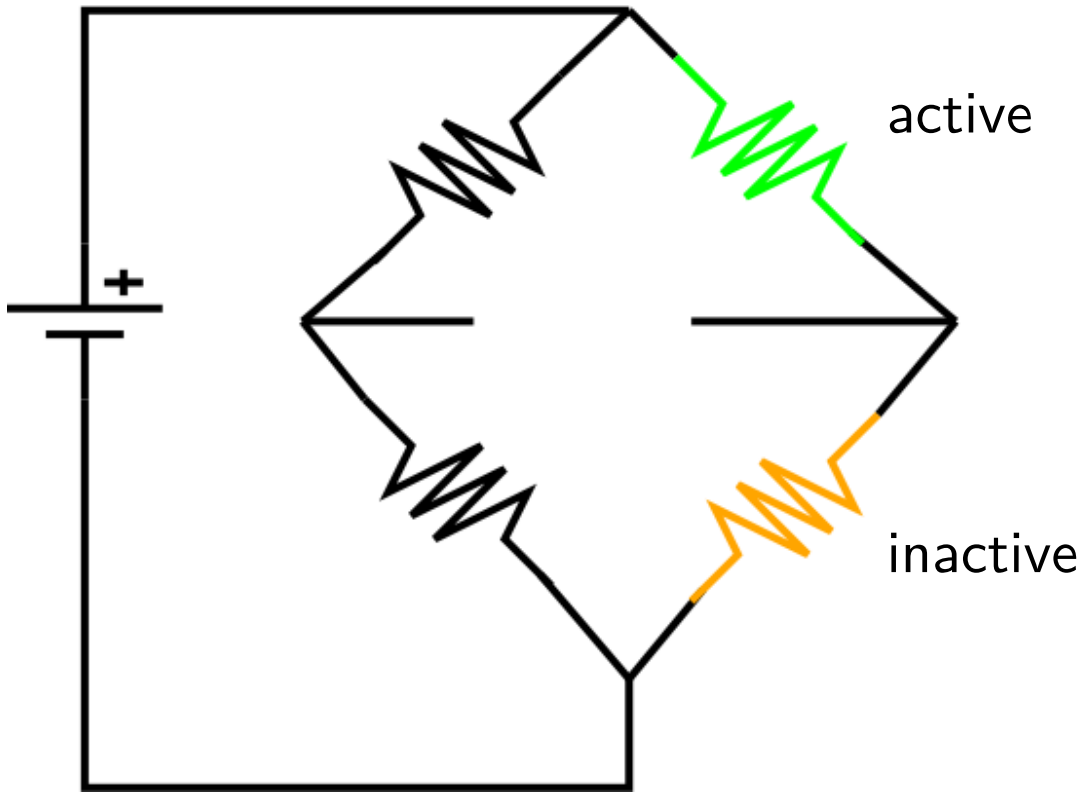

Temperature response of non-active sensor similar to active sensor

Doubling sensitivity

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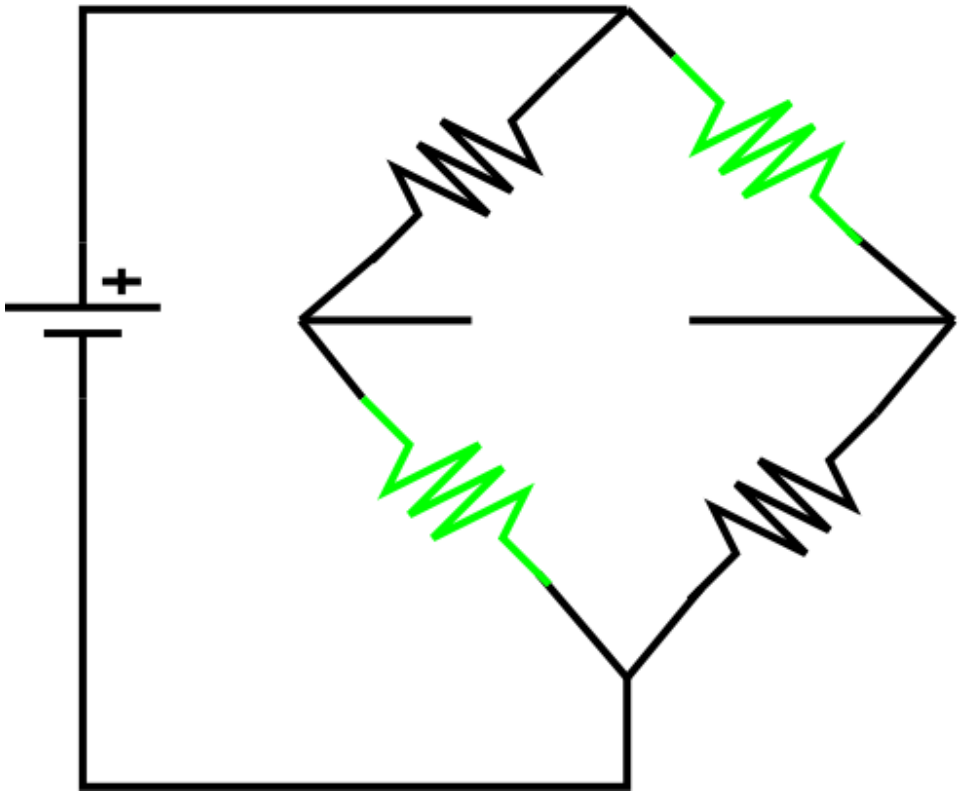

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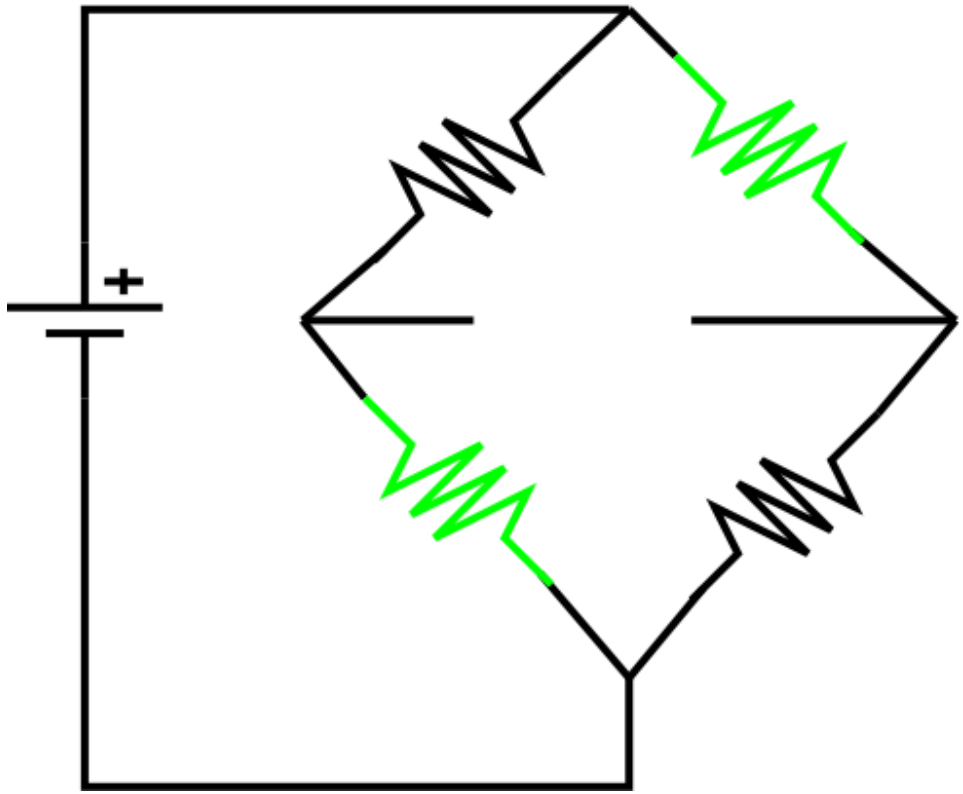

Sensors in diagonal positions produce opposite responses.

Wheatstone bridge current limit

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  thus current controlled by R_s (fixed) rather than R_t (variable).

Reducing current

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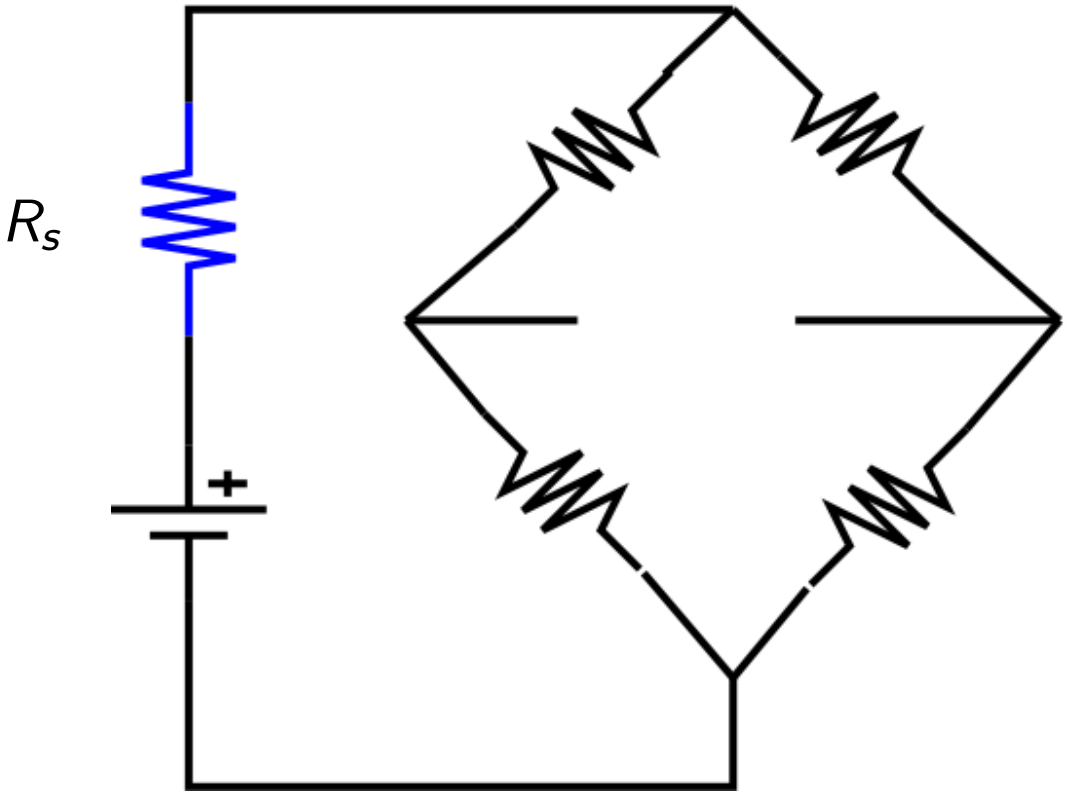

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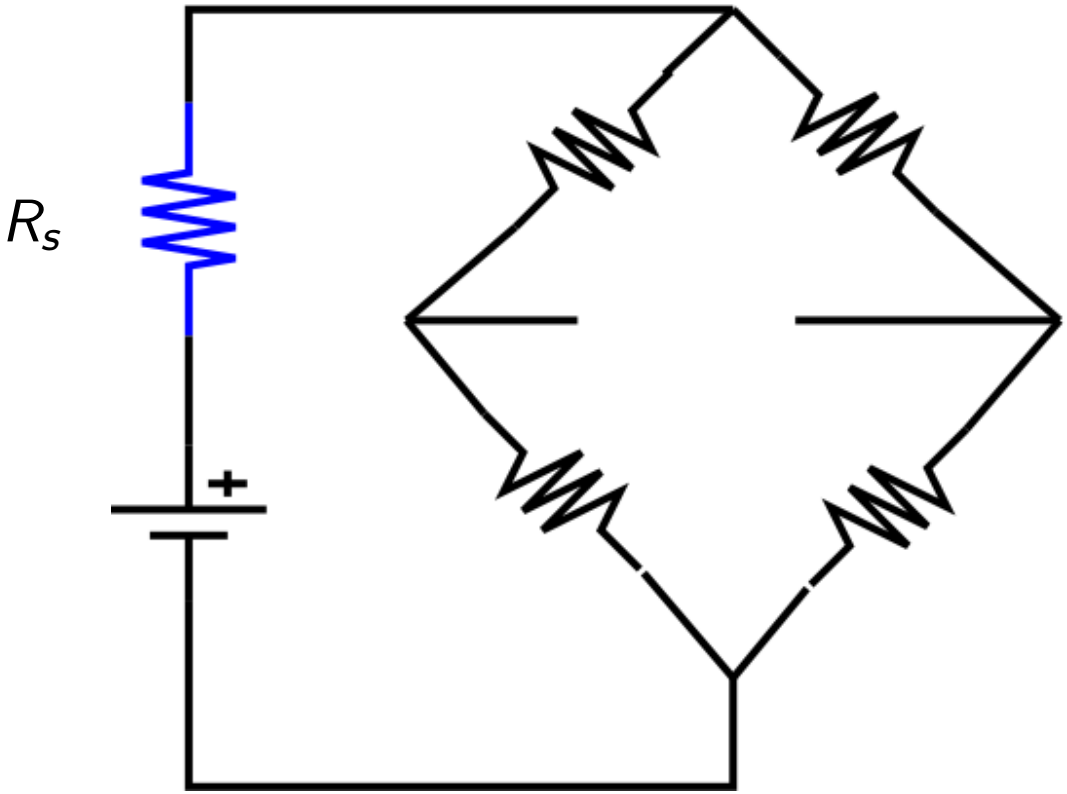

This is useful if the voltage supply is fixed.