Electronics
Uses of Differential Amplifier Circuits

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Differential amplifier
Differential amplifier circuit

Uses of Differential Amplifiers
Differential Signals
Signals which never reach zero
Signals which vary in the wrong direction
Scaling fixed voltages

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\[ V_{out} = \frac{V_1 R_2}{R_1 + R_2} \left( 1 + \frac{R_f}{R_3} \right) - V_2 \frac{R_f}{R_3} \]
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\[ \therefore V_{out} = \frac{R_f}{R_1} (V_1 - V_2) \]
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If all resistors are equal, \( V_{out} = V_1 - V_2 \)
Uses of Differential Amplifiers

1. Differential signals
   - Example: Wheatstone bridge

2. Signals which never reach zero
   - Example: voltage divider

3. Signals which vary in the wrong direction
   - Similar to “inverting” a signal in a single supply configuration
Uses of Differential Amplifiers

1. differential signals
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   e.g. Wheatstone bridge
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   e.g. voltage divider

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   similar to “inverting” a signal in a single supply configuration
Differential Signals

Some circuits produce pairs of outputs, e.g., Wheatstone bridge. The difference between the outputs is the quantity of interest. A differential amplifier allows you to subtract one signal from another signal.
Differential Signals

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Differential Signals

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e.g. Wheatstone bridge
- The *difference* between the outputs is the quantity of interest
- A differential amplifier allows you to subtract *one signal from another signal*
Wheatstone bridge with differential amplifier
Wheatstone bridge with differential amplifier

single-ended output
Signals which never reach zero
Signals which never reach zero

- Some circuits produce signals which never reach zero
**Signals which never reach zero**

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e.g. voltage divider
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Signals which never reach zero

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- A differential amplifier allows you to subtract a fixed voltage from the signal
Uses of Differential Amplifier Circuits

Voltage divider with differential amplifier
Voltage divider with differential amplifier

voltage to be subtracted
Signals which vary in the “wrong” direction
Signals which vary in the “wrong” direction

- Some circuits produce signals which vary opposite to the desired direction
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In a dual supply configuration, an inverting amplifier could be used, but this works with a single supply as well.
Inverting signal variation with differential amplifier
Inverting signal variation with differential amplifier

voltage to subtract signal \textit{from}
Scaling fixed voltages

\[ V_{\text{out}} = V_1 \frac{R_2}{R_1} + \frac{R_2}{R_3} (1 + \frac{R_f}{R_3}) - V_2 \frac{R_f}{R_3} \]

Simplified if \( R_f = R_2 \) and \( R_1 = R_3 \)

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If all resistors are equal, \( V_{\text{out}} = V_1 - V_2 \)

If the fixed voltages are not what you want, you can adjust the resistor values instead.
Scaling fixed voltages

\[ V_{out} = \frac{V_1R_2}{R_1+R_2} \left( 1 + \frac{R_f}{R_3} \right) - V_2 \frac{R_f}{R_3} \]
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