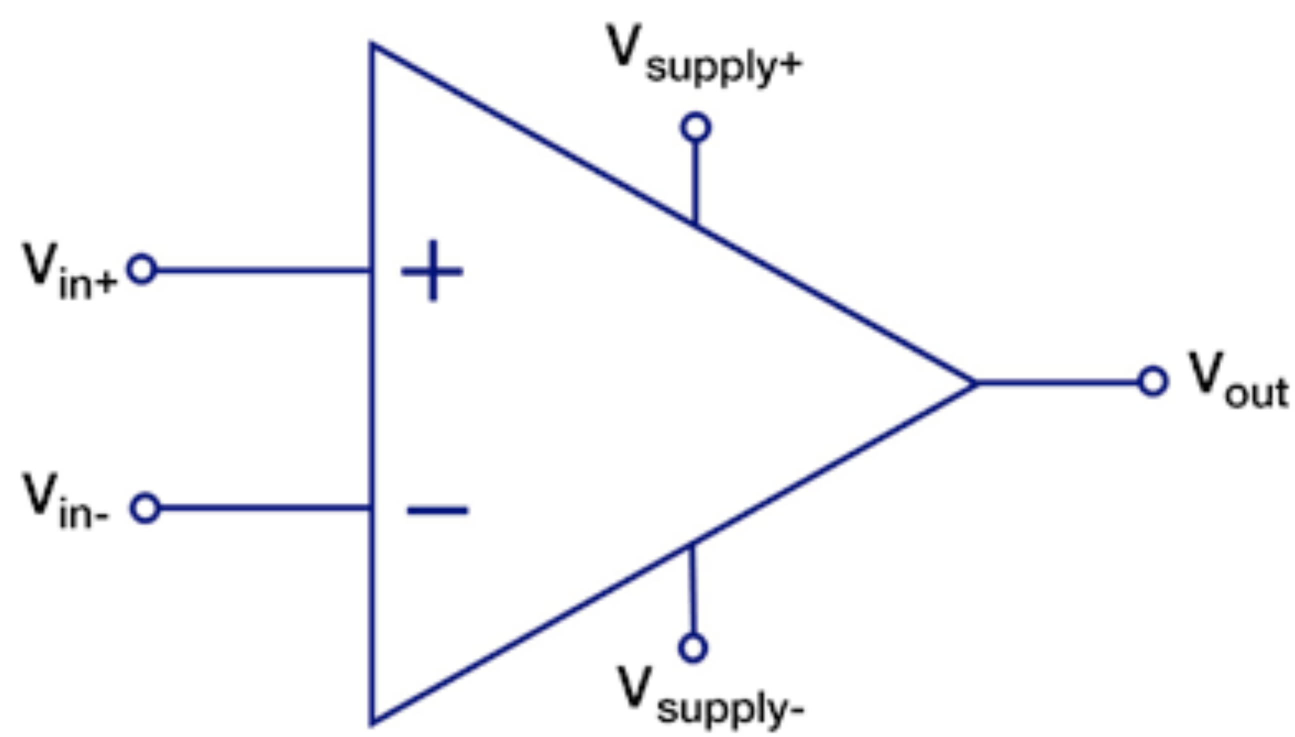
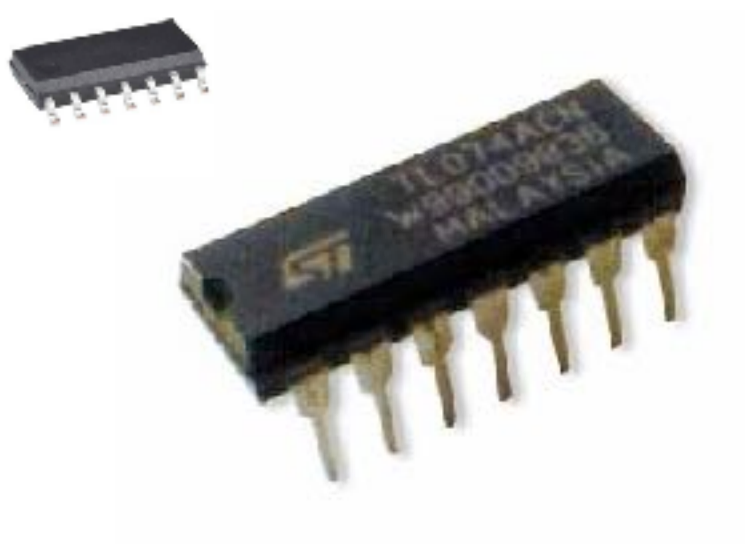
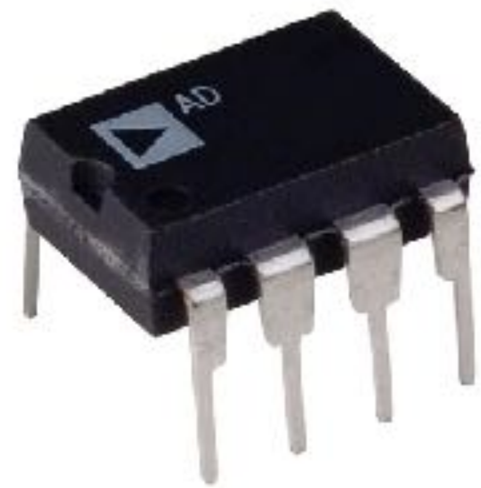
Sensors, Microcontrollers and Actuators

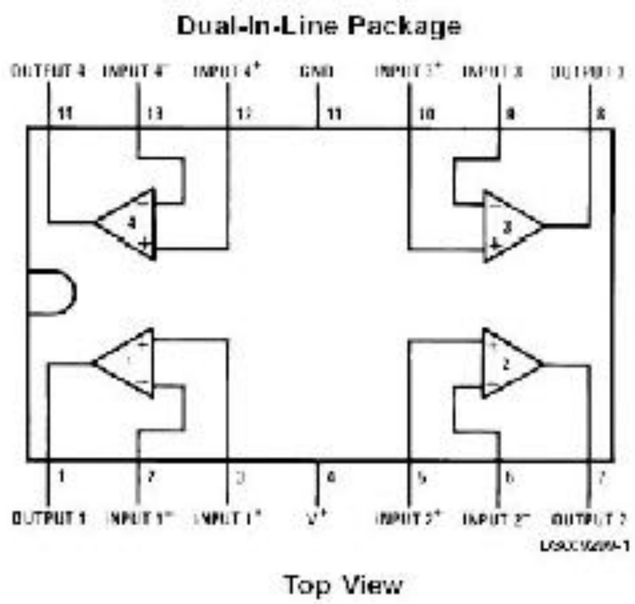
Operational Amplifiers

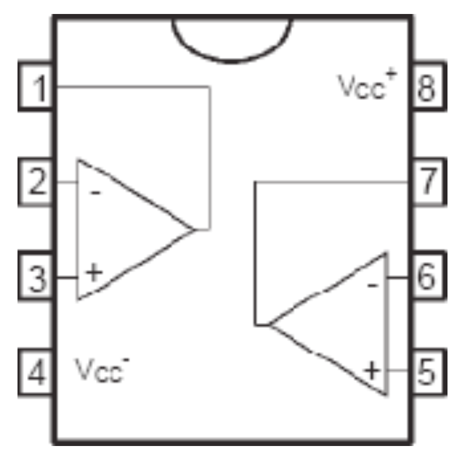


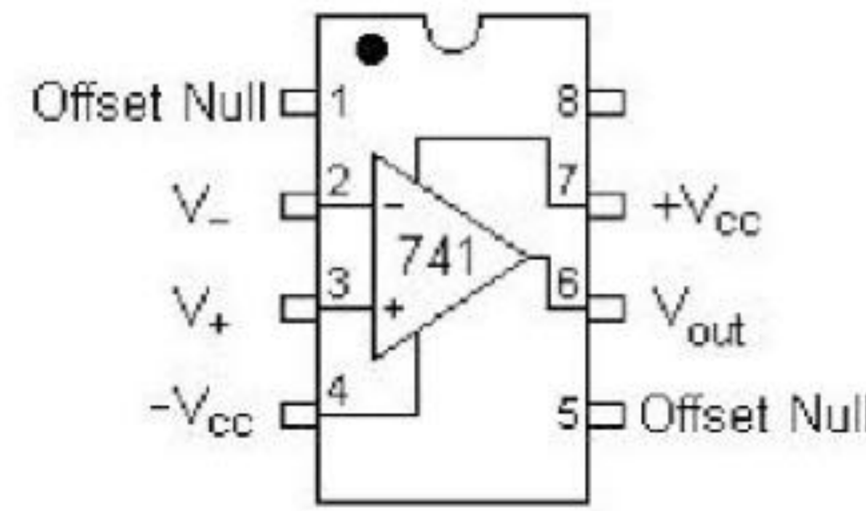
Package and pin-out











Quad opamp

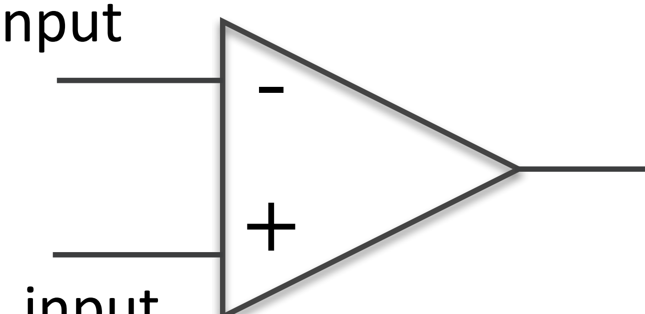
Dual opamp

Single opamp

Operational amplifiers

An OPAMP is an **ideal** electronic building block:

1. The opamp has a very high amplification (infinite)



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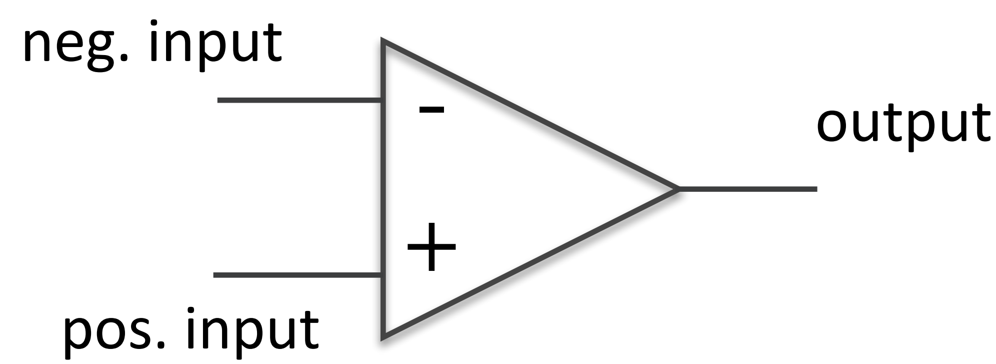

2. The input impedance (resistance) is very high ... so *the input-current is incredibly low (= zero).*

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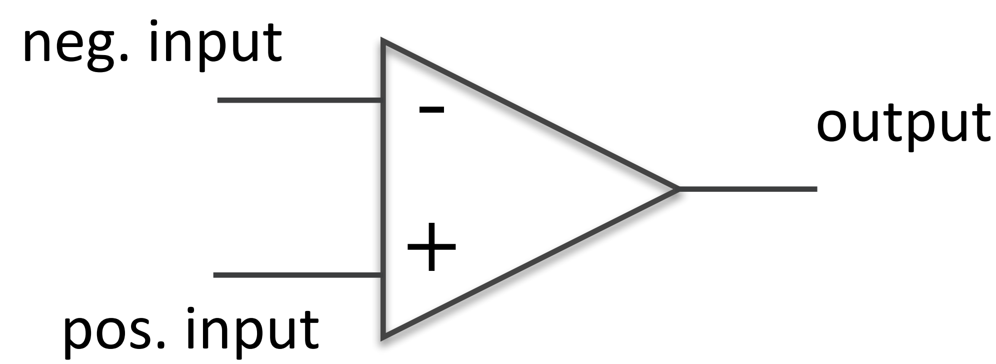
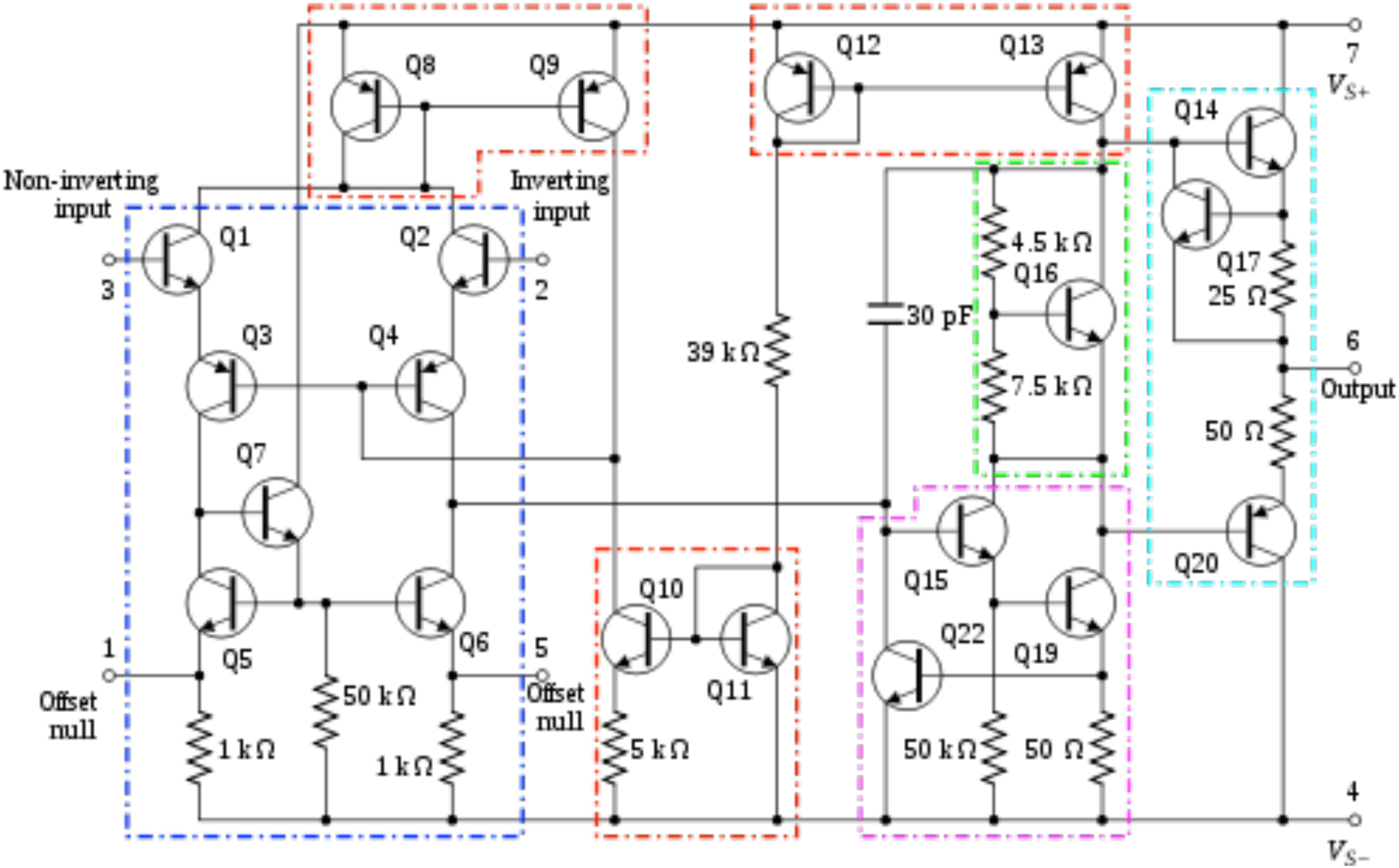


2. The input impedance (resistance) is very high ... so *the input-current is incredibly low (=zero).*

3. The output impedance is very low ... so *the opamp can deliver high currents*

Inside the Opamp ...



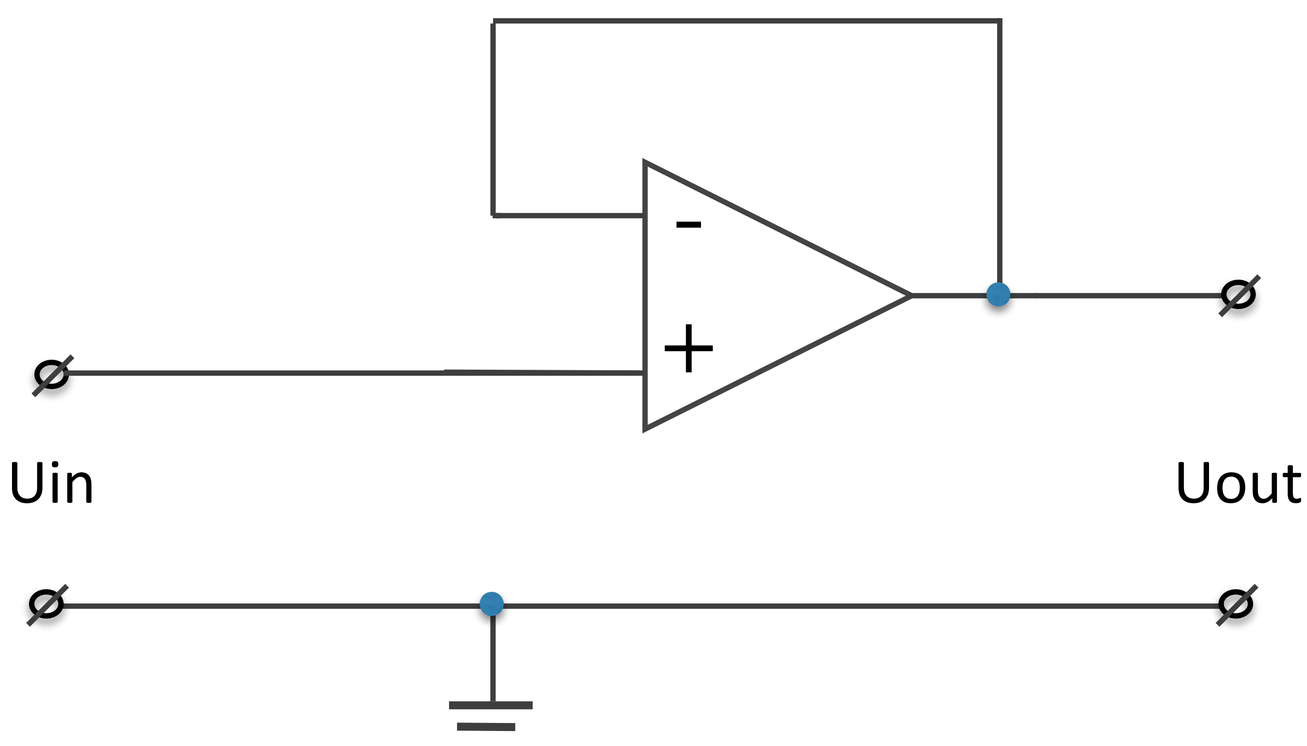
Some practical circuits, used in sensor world ...

Signal Buffer

Suppose you have to connect your sensor to more circuits, or sharing it with others, or driving it over long cables (installation). In that case it's wise to make use of buffers. Buffer circuits (in this case follower) act as buffer between the sensor output (week fragile signal) and the "outside world".

Au=Amplification=1 (= 0dB)

Uin = Uout

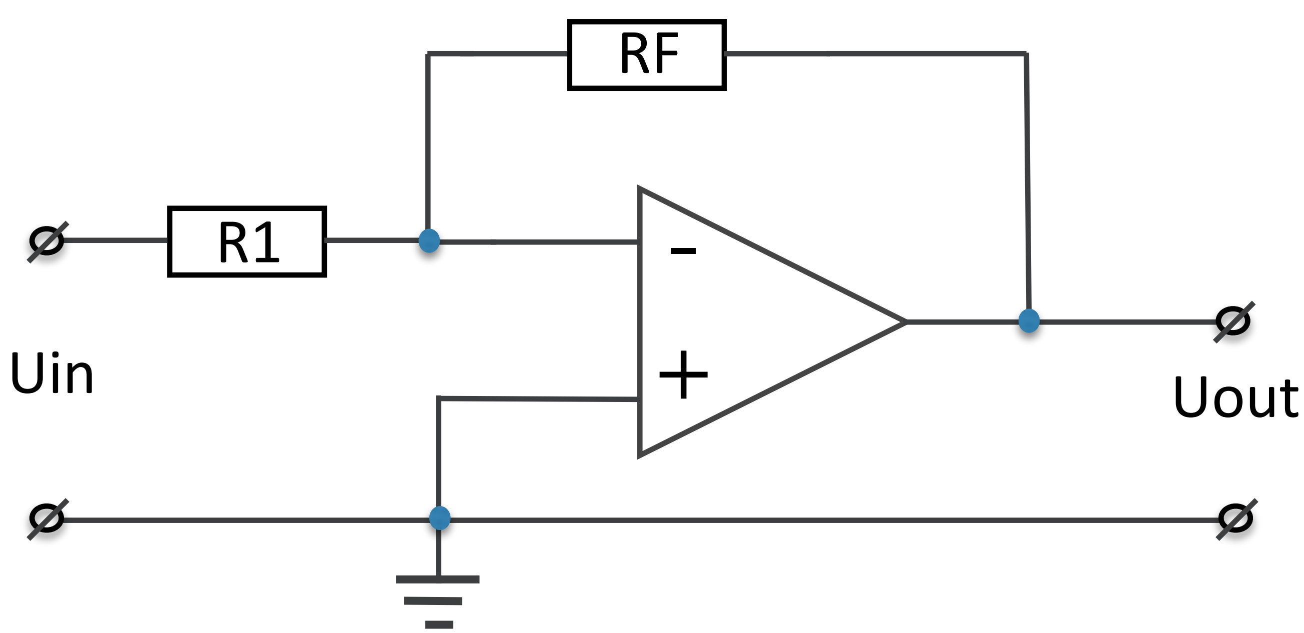


Some practical circuits, used in sensor world ...

Inverting Amplifier

Most common amplifier circuit. The combination (ratio) of Rf and R1, determine the amount of amplification. Because the signal is connected to the negative input, the **output values will be inverted!**

$$Au = \frac{Uout}{Uin} = -\frac{RF}{R1}$$



$$Uout = Au * Uin$$

$$Uout = -\frac{RF}{R1} * Uin$$

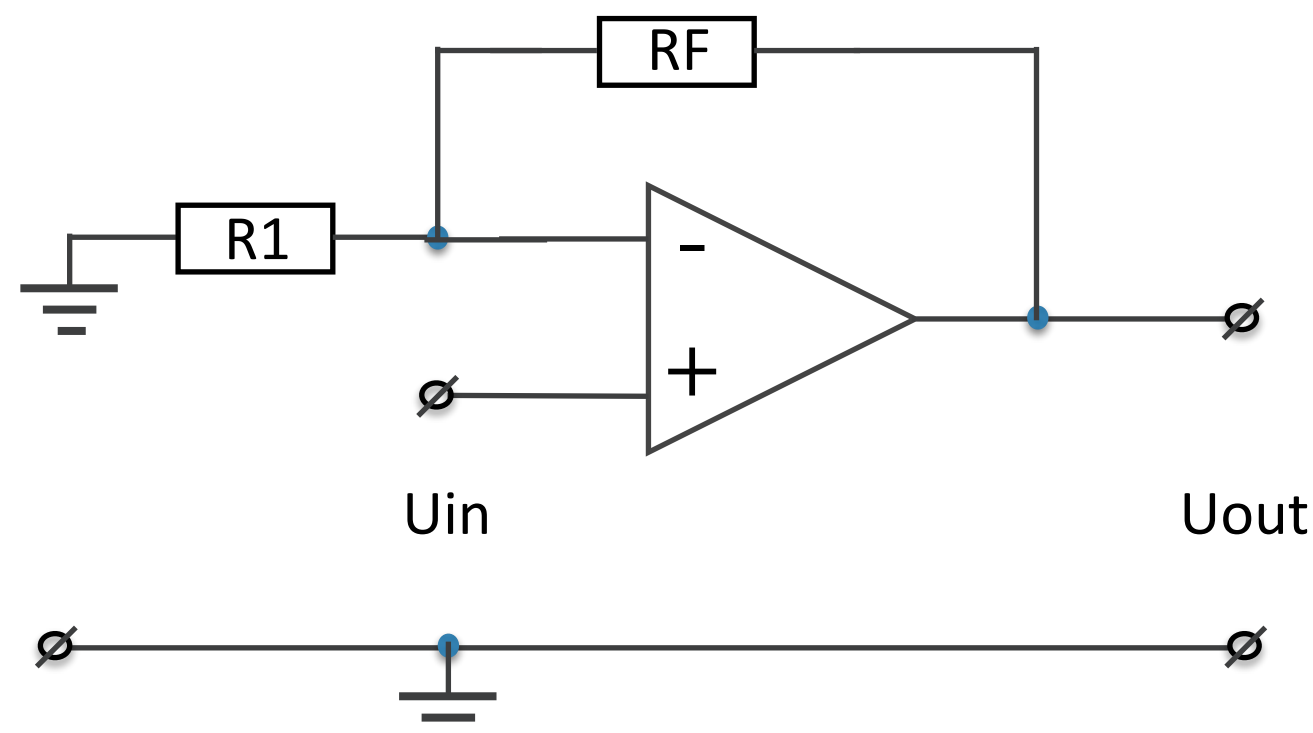
Some practical circuits, used in sensor world ...

Non-inverting Amplifier

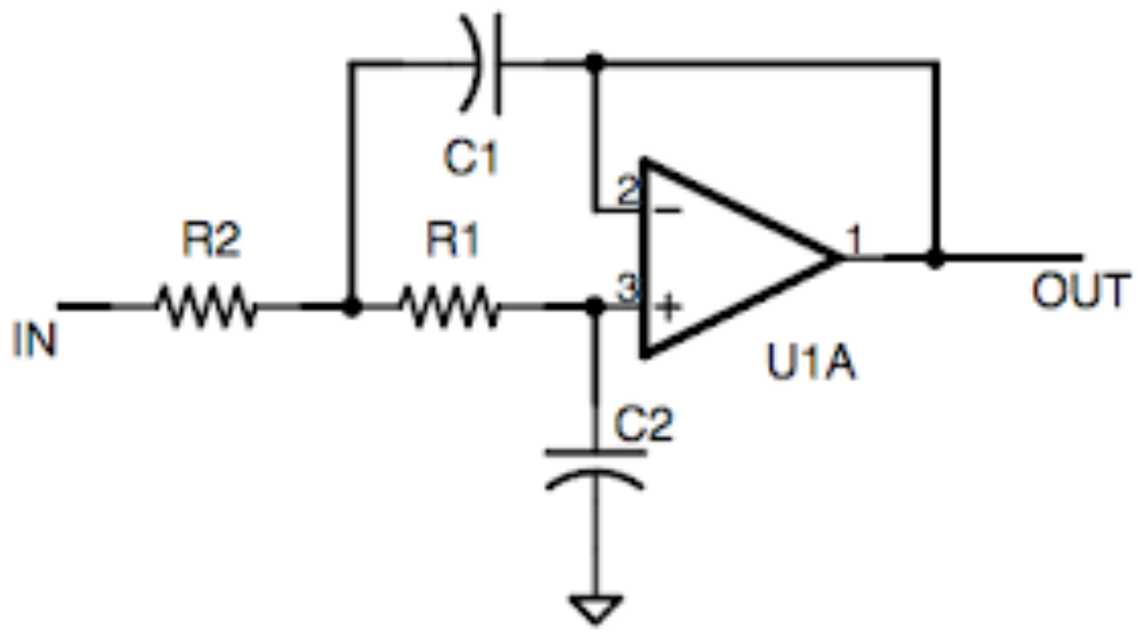
When the signal is connected to the positive input of the opamp, the amplified output is not inverted. The amplification of a non-inverting amplifier is always more than 1.

$$Au = \frac{Uout}{Uin}$$

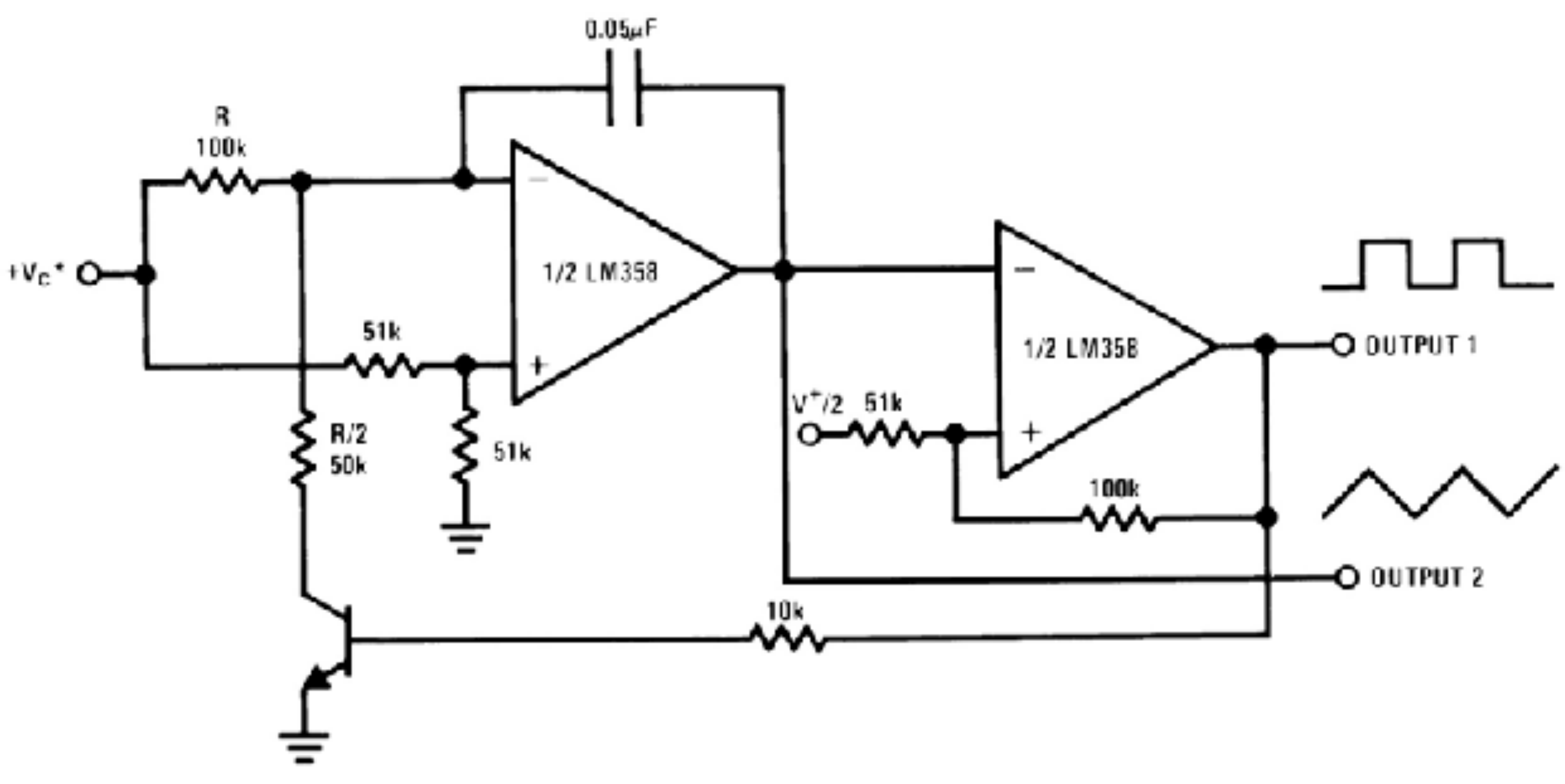
$$Uout = \left(1 + \frac{RF}{R1}\right) * Uin$$



Some random examples …

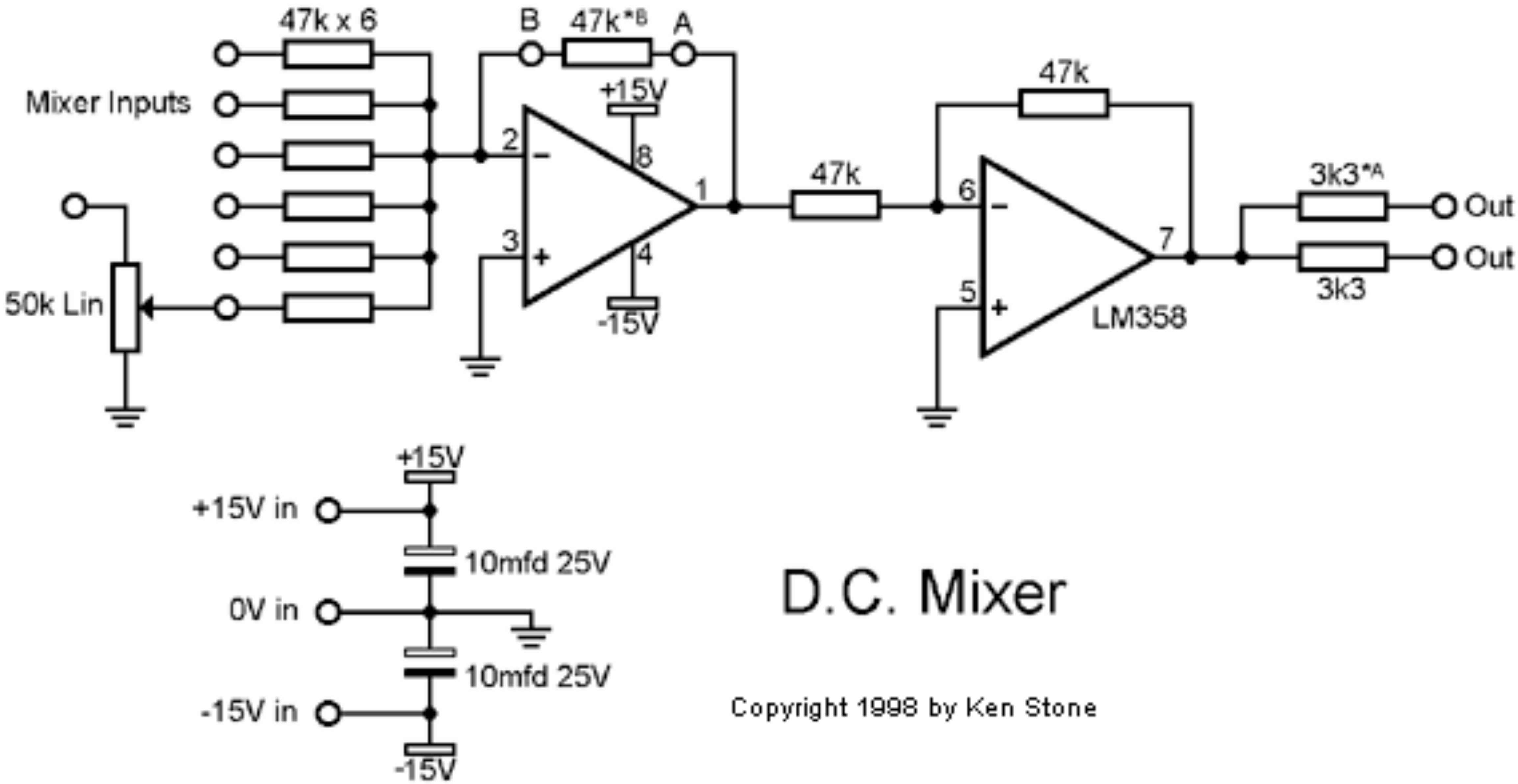


Active filter (LPF)

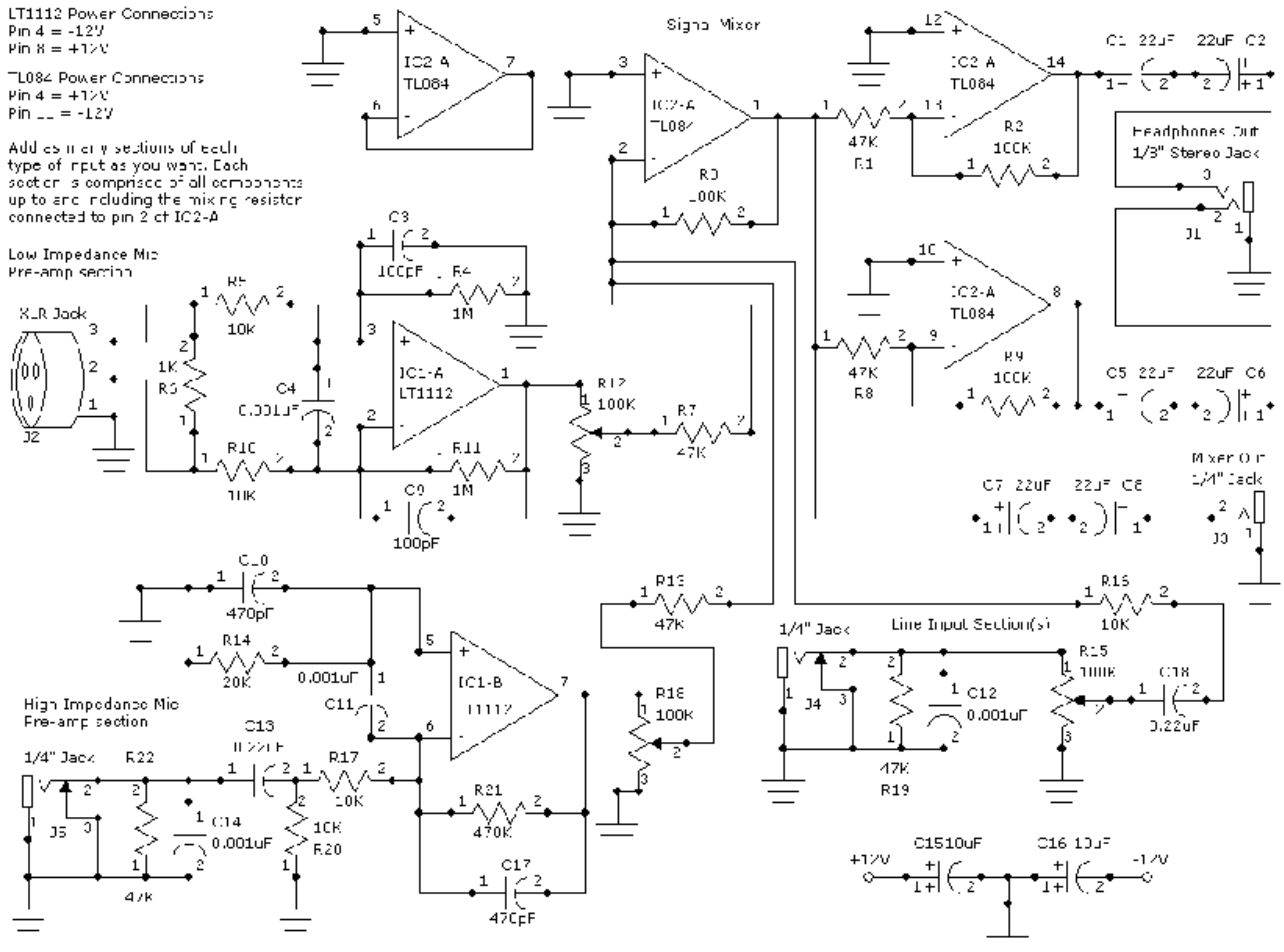


Voltage Controlled Oscillator

Some random examples …

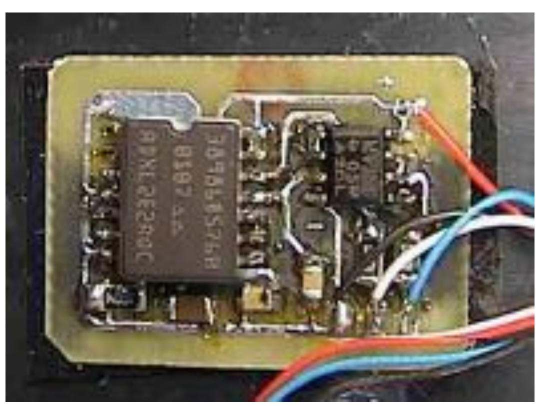


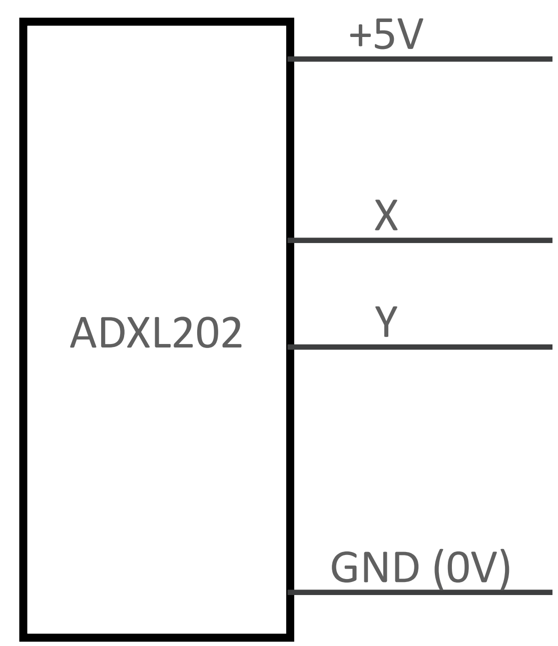
Some random examples …



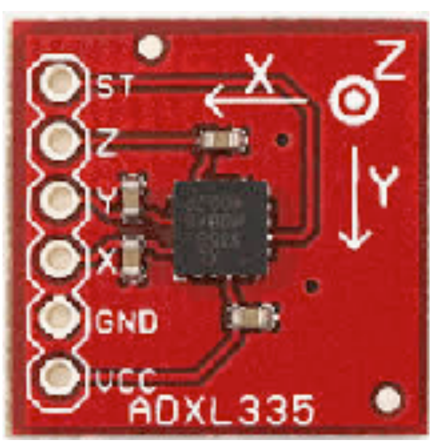
Amplify (condition) the output of an accelerometer

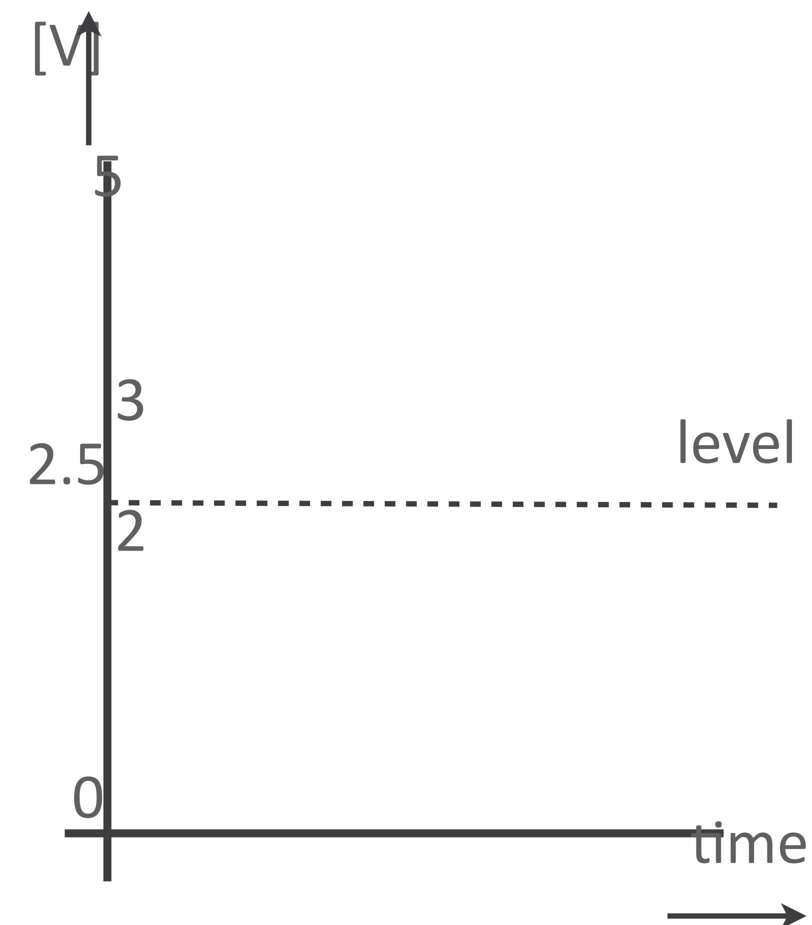
Let’s try to connect a accelerometer; an ADXL202. What is an accelerometer?
An **accelerometer** measures the proper acceleration it experiences relative to freefall. Single- and multi-axis models are available and can a.o. be used to sense orientation, vibration and shock. The ADXL202 is a dual axis model with two outputs, X and Y.





Amplify the output of an accelerometer





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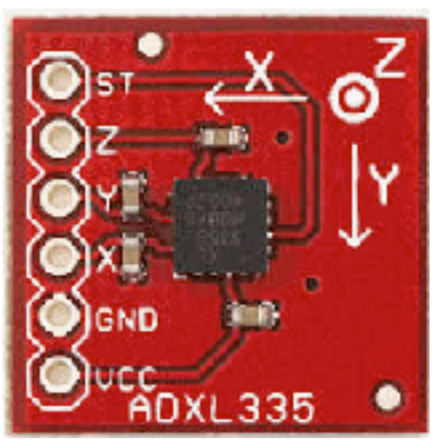

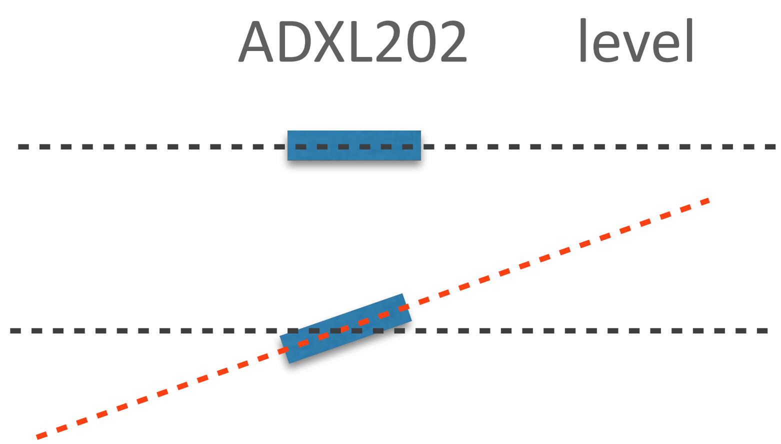

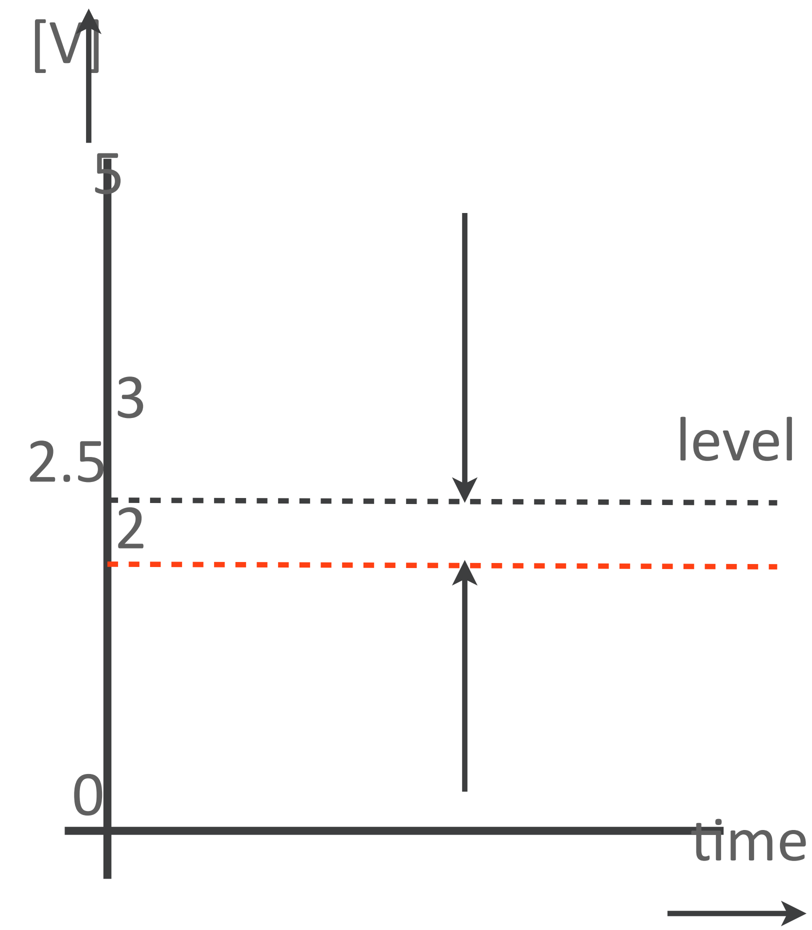

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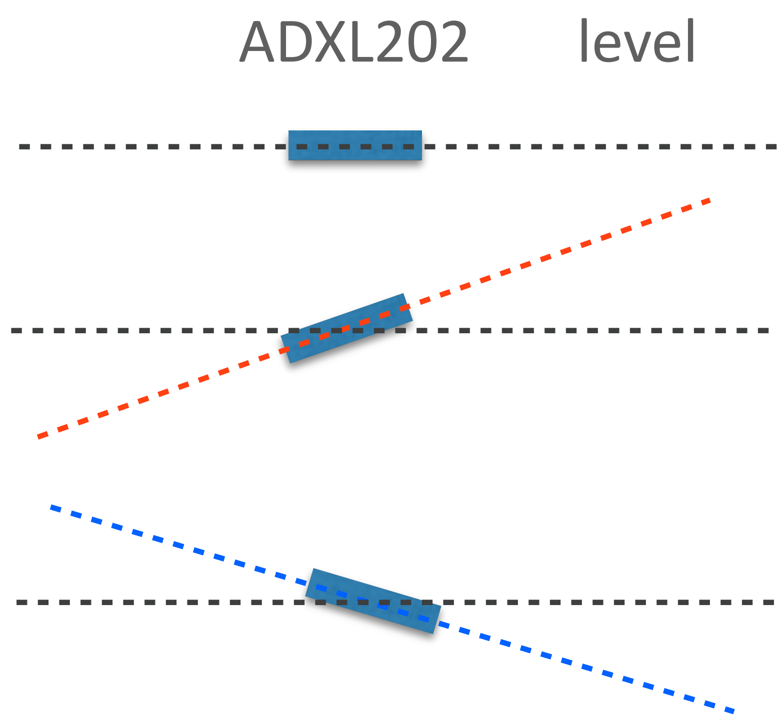
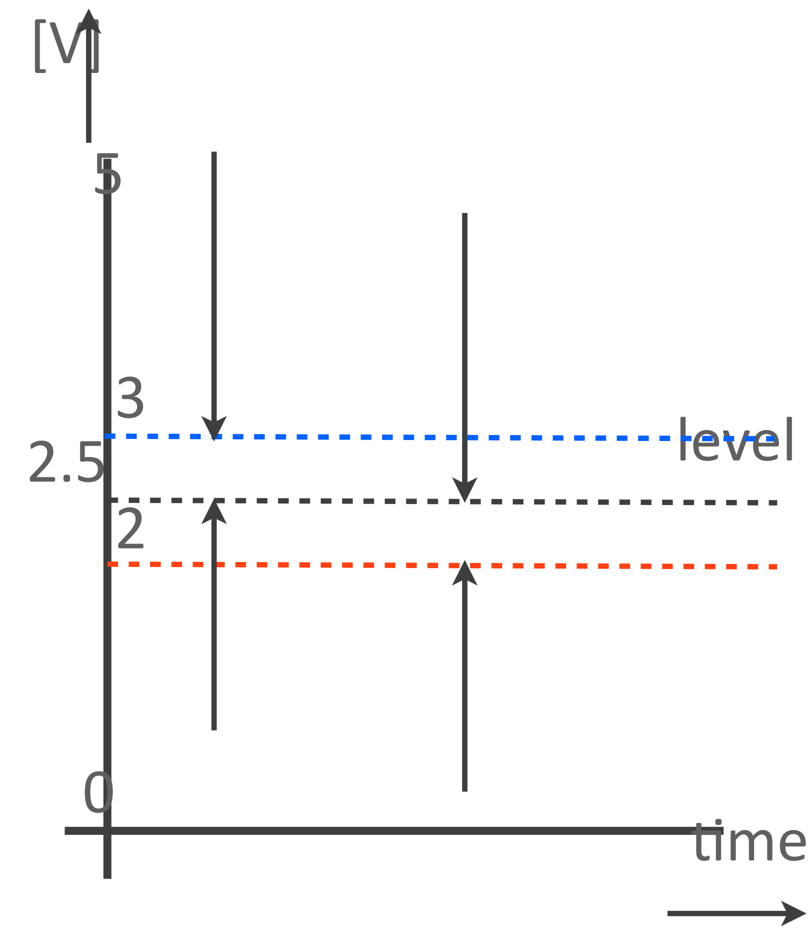
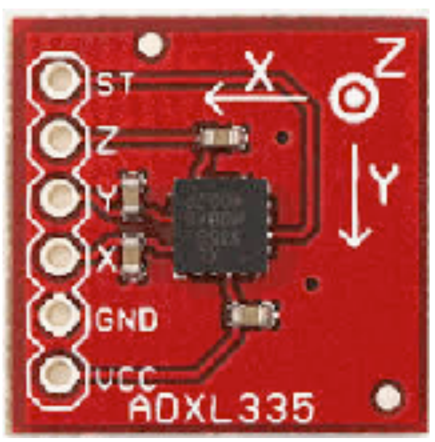
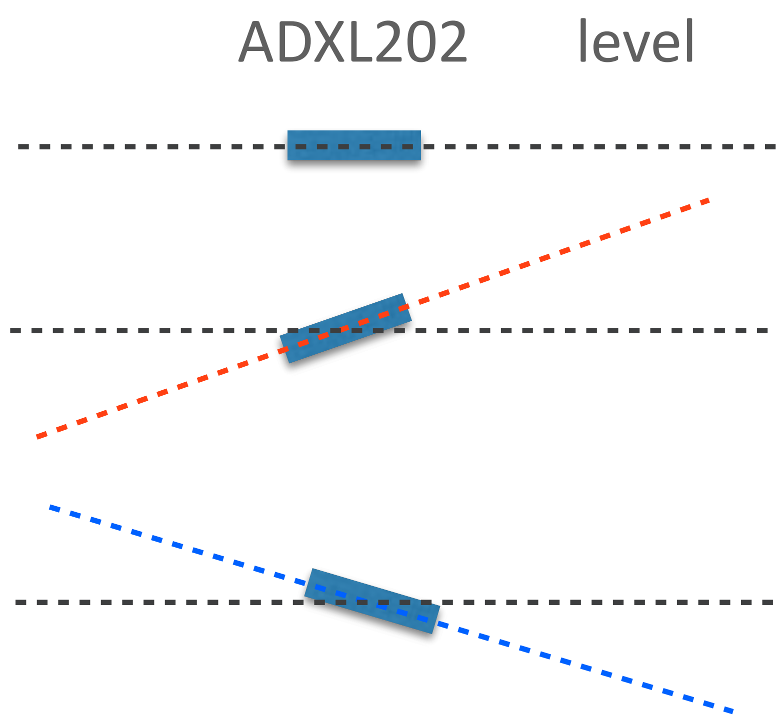


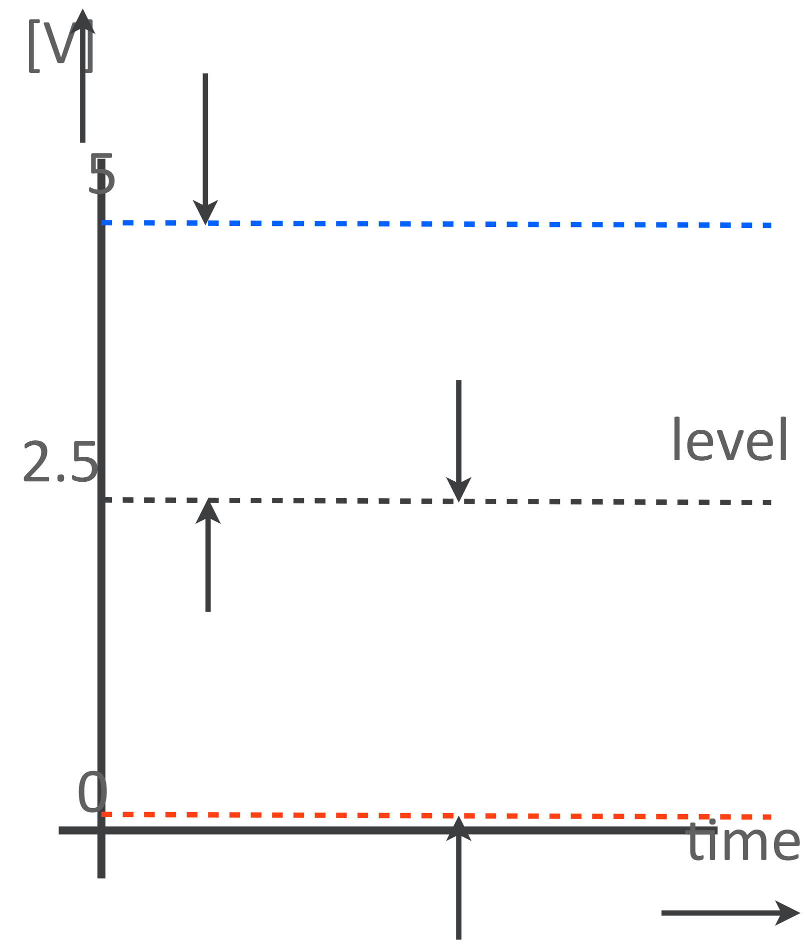


The voltage change (per rotation) is around 0,5V (500mV). This is enough to use the full scale (0-5V) of the Arduino. We have to amplify (condition) the signal.

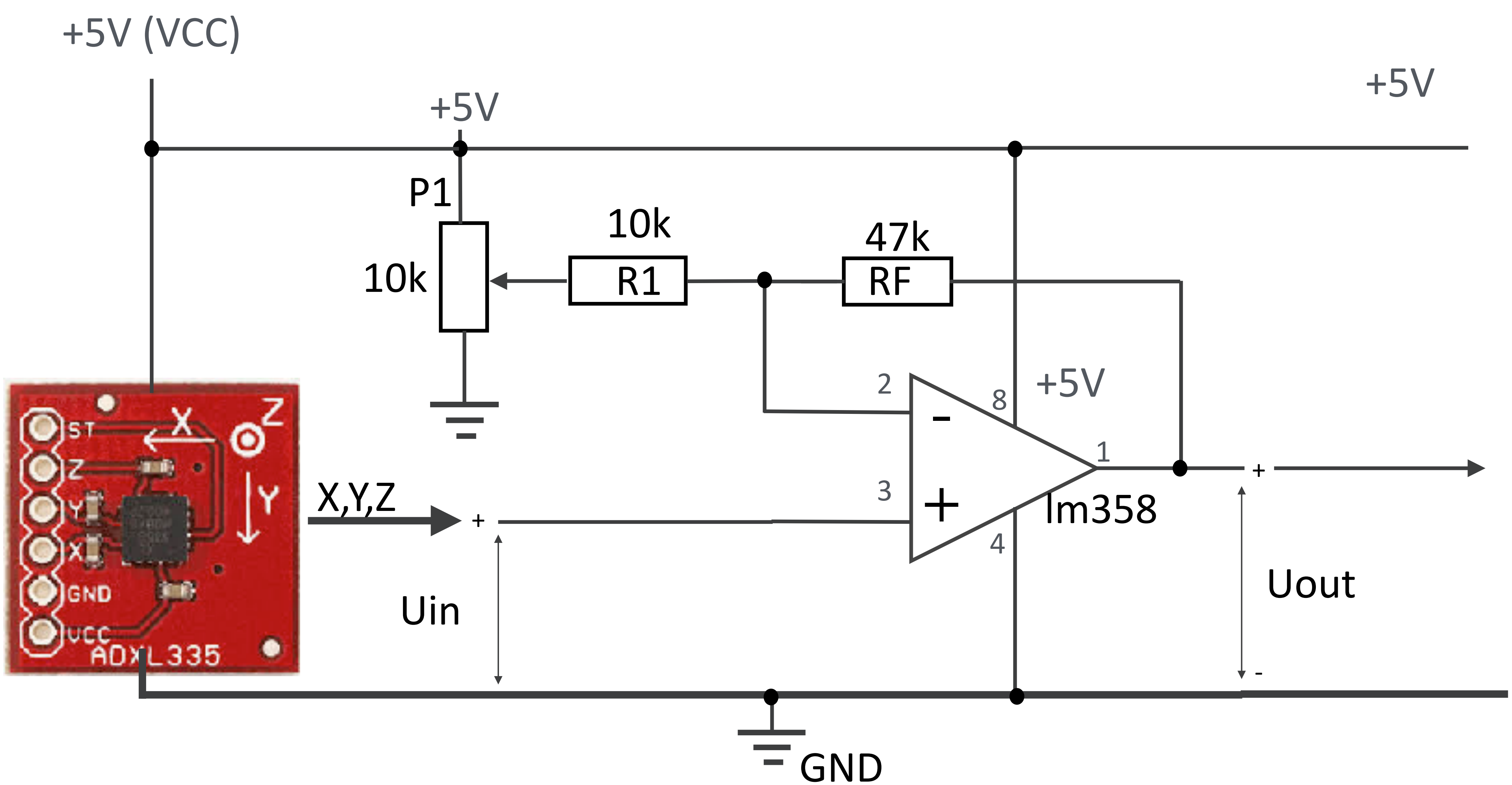
Amplify the output of an accelerometer







Non inverting amplifier (mono, so 1 signal only) with an offset trim (P1).



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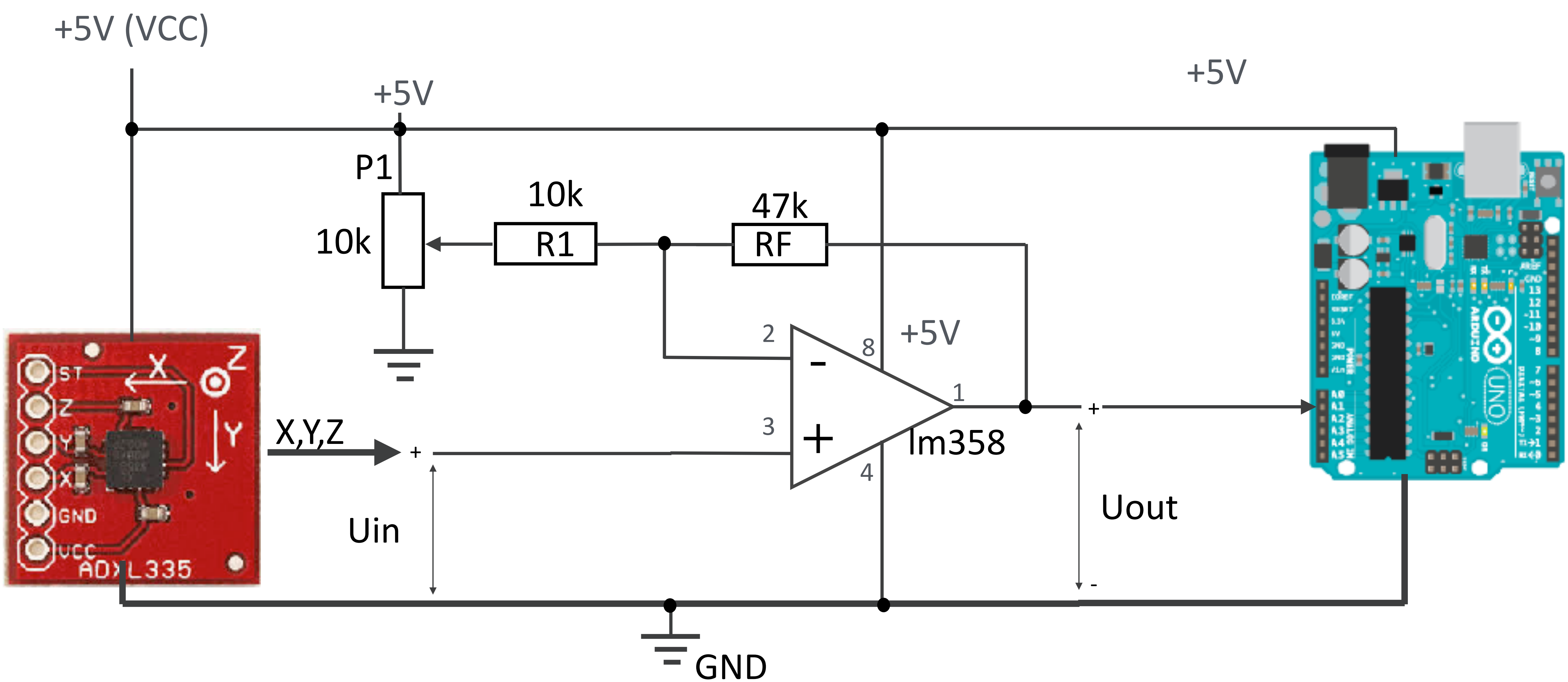

Sensors, Microcontrollers and Actuators

Opamps end.