Special Sensor Report:

Analog Devices Accelerometer

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Robot: Equilibrium
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Introduction:

The purpose of equilibrium is to balance itself on two wheels. Balancing will be accomplished by determining relative position to gravity. This can easily be accomplished by using an Analog Devices Accelerometer. The Analog Devices ADXL203 was chosen to perform this duty.

What is it?

The Analog Devices ADXL203 is a "high precision, low power, complete single and dual axis accelerometers with signal conditioned voltage outputs, all on a single monolithic IC. The ADXL203 can measure both dynamic acceleration (e.g. vibration) and static acceleration (e.g. gravity)." For this case, typically, static acceleration will be measured. However, this may not always be the case, as vibration could occur going over bumpy surfaces.

This accelerometer can readily be used as a tilt sensor, as I am doing in this case. The accelerometer is most sensitive to tilt when it is parallel with the ground, which for Equilibrium, will be upright position. The output is an analog voltage, but can easily be converted into an angle in degrees if desired, using: ASin(Ax/1g), where Ax is the current analog voltage and 1g is the voltage when the accelerometer is tilted all the way over.

The output of the ADXL203 is an analog voltage, proportional to acceleration (in this case tilt). When the accelerometer is level, its output is 50% of the input voltage. As it tilts, the voltage varies proportionally.

Why this one?

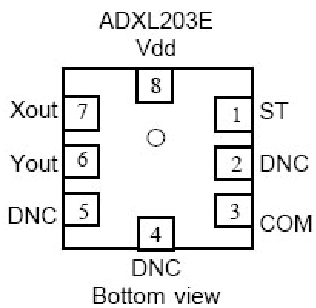
Although there are other manufacturers of accelerometers, I chose the Analog Devices part #ADXL203 for a few reasons:

1. Simple to use
2. Small package
3. Sensitive
4. Low power consumption
5. Best of all: FREE

The ADXL203 is very simple to use. It requires almost no additional parts, only a couple of readily available capacitors, to set bandwidth. Also, the package size is ridiculously small (Too small for me), only 5mm x 5mm x 2mm, with eight leads. On this particular model, only 5 pins are even used. The ADXL203 is highly sensitive also, as it will respond to about 1° of tilt. This particular accelerometer uses very little power, drawing only 700µA @ 5V. That is incredibly good. Best of all, the ADXL203 (and other models) are available FREE from: http://www.anglog.com.

Specs

Pin descriptions



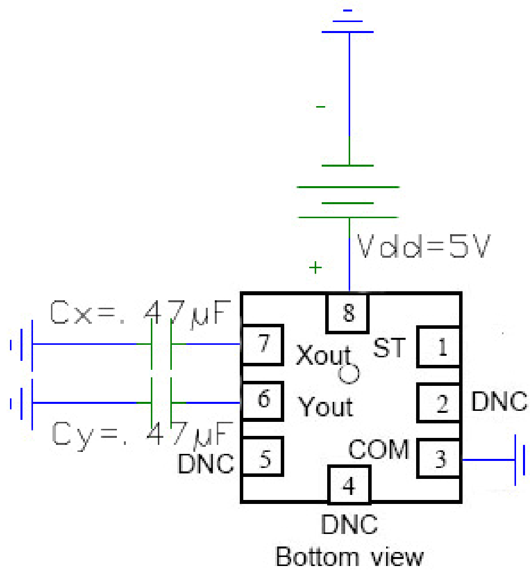
Pin	Name	Description
1	ST	Self Test
2	DNC	Do not connect
3	COM	Common
4	DNC	Do not connect
5	DNC	Do not connect
6	Y_{OUT}	Y channel output
7	X_{OUT}	X channel output
8	Vdd	+5V

The below table shows what value of capacitor to pick for the bandwidth used. You should try to use the lowest bandwidth possible, as this gives you the highest resolution. For my case, 10 Hz is plenty, as I only plan on determining position about 4-5 times per second.

Capacitor	Bandwidth
10 Hz	0.47 µF
50 Hz	0.10 µF
100 Hz	0.05 µF
200 Hz	0.027 µF
500Hz	.01µF
5kHz	.001µF

This is the schematic that will be used for Equilibrium.

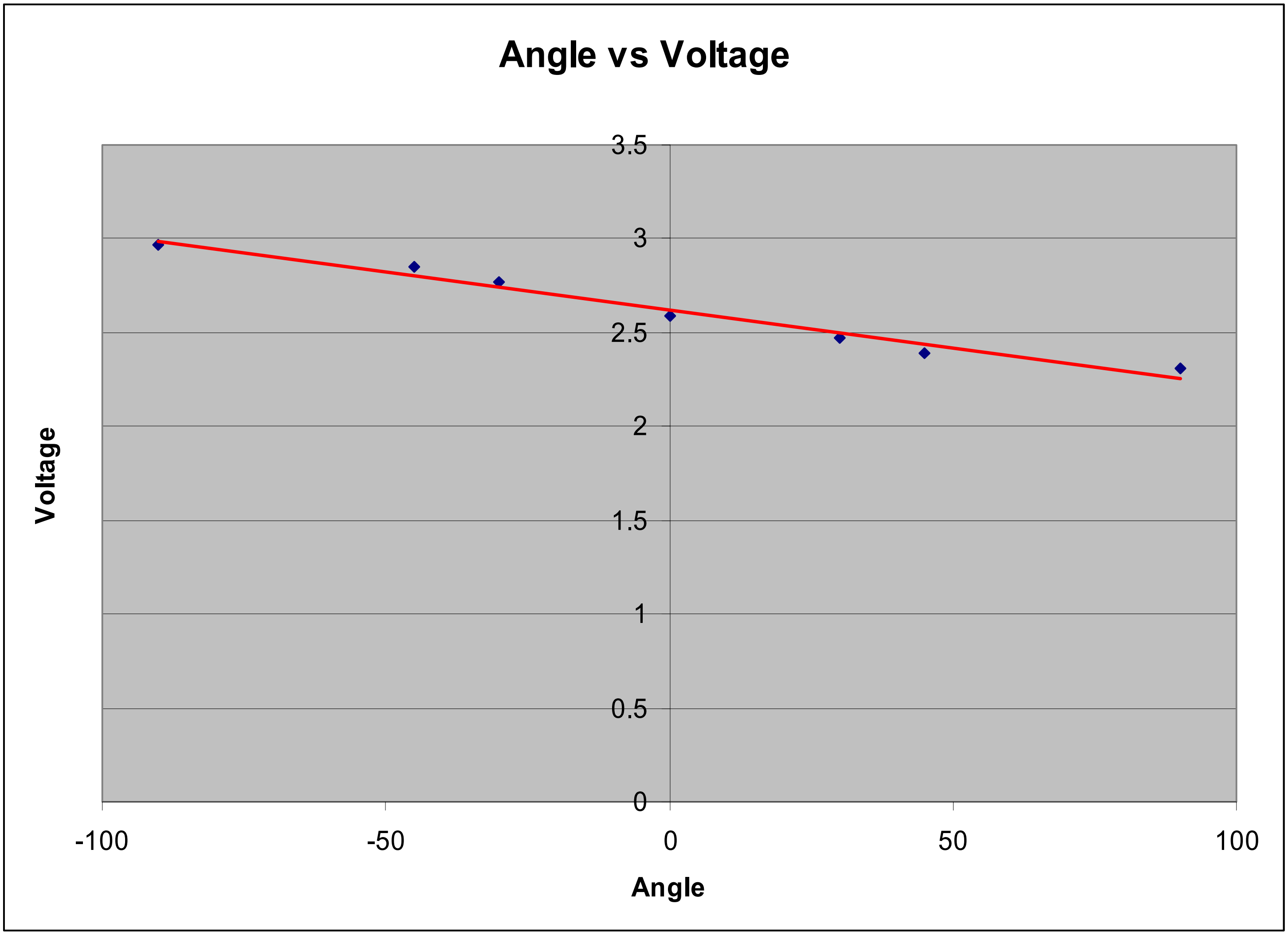
As can be seen from the table above, the capacitors chosen allow a bandwidth of 10Hz. Also, not shown, there is a decoupling capacitor of about .1µF between power and ground. The ST, or self test, pin is not used in this case. It is only set high when you wish to test the functionality of the accelerometer. Otherwise, it can either be set to ground or just left floating.



Angle vs. Voltage

I wired up the accelerometer, using the above circuit, and approximated some angles (visually). I then measured the corresponding voltages. The table below shows these values. The graph then shows that the relationship is approximately linear. This is a good thing. Again, the angles were determined visually and may not be highly accurate.

Input:	**5.05V**
Angle	**Voltage**
-90	2.97
-45	2.855
-30	2.77
0	2.59
30	2.475
45	2.388
90	2.31


Angle vs Voltage
Voltage
Angle
3.5
3
2.5
2
1.5
1
0.5
0
-100
-50
0
50
100

References:

Analog Devices ADXL103/203 Single/Dual Axis Accelerometer Data Sheet:
http://www.analog.com/UploadedFiles/Data_Sheets/133690353ADXL103_203_pra.pdf