USING SDI ACCELEROMETERS

SDI's analog ±2G surface mount accelerometers and all modules built with them are capable of accurately measuring tilt. Their exceptionally low noise performance provides improved accuracy over similar products.

CALCULATIONS

At room temperature: $Vout = Bias + a \times ScaleFactor$

or $V = B + a \times S$

In tilt applications, $a = g\,cos(\theta)$
where theta is the angle between the sensitive axis and gravity measured in radians.

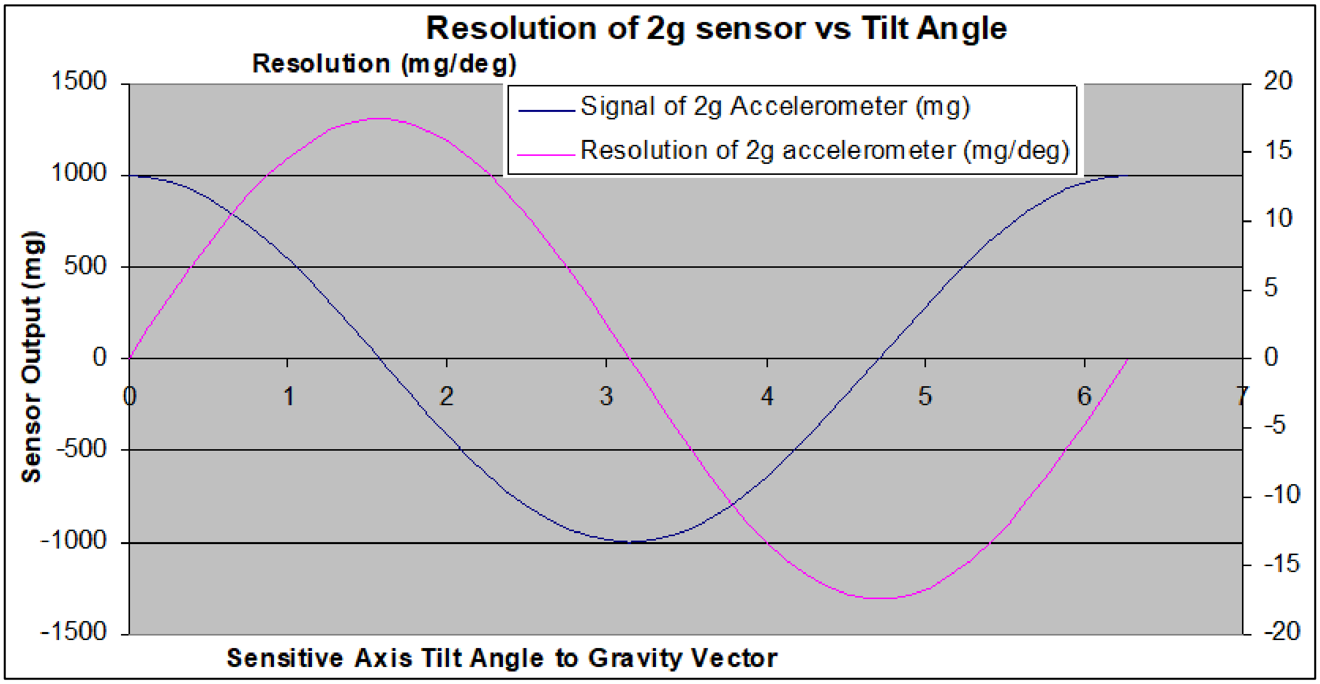
This gives $V = B + S \times g \times cos(\theta)$

The resolutions of the sensor is change in output, V, for a given change in input, theta, $R = \frac{dV}{d\theta}$

making $R = -g \times S \times sin(\theta)$

RELATIONSHIP BETWEEN SIGNAL OUTPUT V AND RESOLUTION

In the graph below, the resolution is maximum when the signal V is minimum. That is, in the so called zero-g position when the sensitive axis is orthogonal to the gravitational acceleration, the sensitivity is at its highest. Inversely, when the sensor is in the +1 or -1 g position, i.e. when the sensitive axis is parallel to the gravitational acceleration, and the signal is maximum, the resolution is at a minimum (zero).



Note that this relation is exactly the same for any 2g sensor, regardless of manufacturer: the maximum resolution of a 2g accelerometer by definition is 17.453 mg/deg and occurs when the sensitive axis is perpendicular to the gravity vector.

COMPARING RESOLUTION BETWEEN DIFFERENT MANUFACTURERS

The first, and most critical parameter to consider is noise. The 1521 noise figure is $7\mu g/\sqrt{Hz}$, for a 2G accelerometer. This parameter is best in class. With this noise level, a typical noise error for a 1Hz bandwidth measurement would be:

$$0.007mg/17.4\frac{mg}{degree} = 0.0004°$$

If a manufacturer's 2G sensor has a noise spec of $20\mu g/\sqrt{Hz}$, then the equivalent error would be four times as great, or $0.020mg/17.4\frac{mg}{degree} = 0.0012°$.

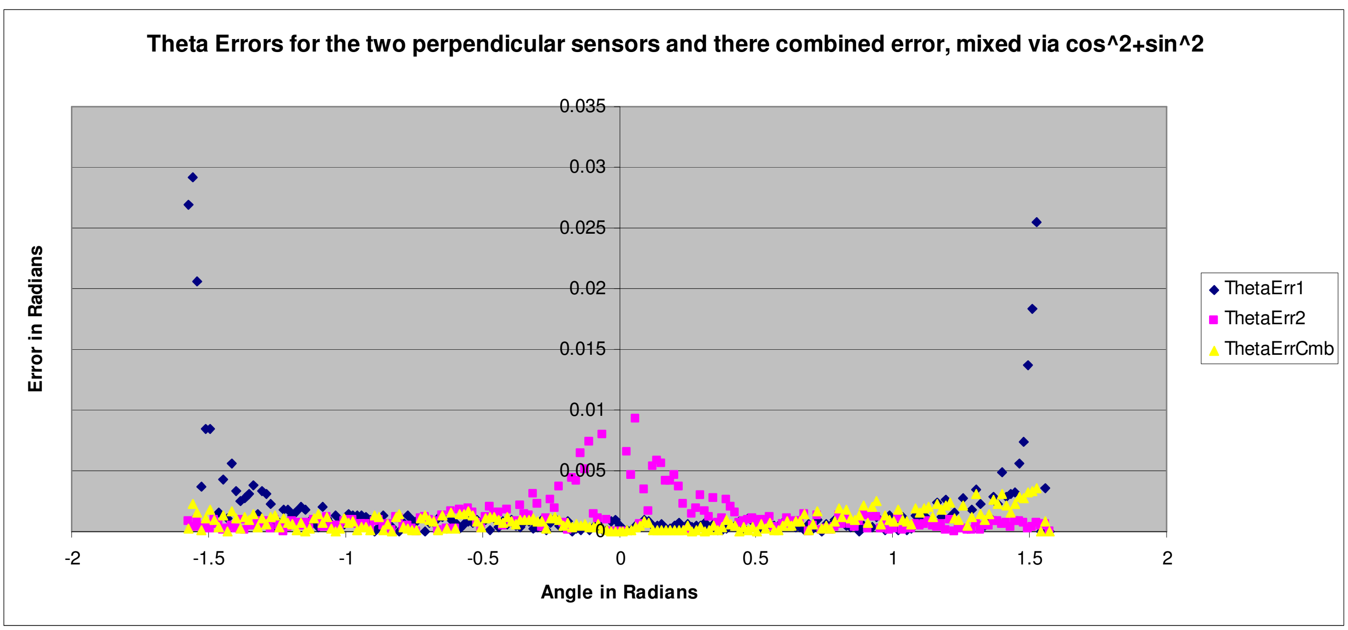
In effect, the SDI 2G accelerometer is three times more accurate.

Note that by using two sensors mounted perpendicular the sensitivity vs angle curve can be flattened. Each sensor will have its own estimate of the angular error. Say sensor A is mounted with the sensitive axis in line with the gravity vector, and the sensor B with its sensitive axis perpendicular to gravity. Then we will have two separate estimates of theta one from sensor A and one from sensor B.

If these estimates are combined according to the formula

$\theta_{est} = \theta_A\, cos^2(\theta_A) + \theta_B\, sin^2(\theta_B)$

Then the combined error can be flattened over the actual input error. The chart below shows a simple excel simulation of this. The errors for the estimates of theta for sensor A and B are plotted in purple and blue respectively. Note that the error from sensor A is maximum when theta is zero and the sensor is in the +1 g position but goes down as the sensor is turned to the zero g position.



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