Human shaking action - preliminary assessment

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A brief study was performed to determine the approximate range of frequency and acceleration level achieved during the action of shaking an object (e.g. small bottle). The intent was to determine approximate target performance of a piezo film sensor capable of triggering a logic input from such an event.

Initially, a calibrated reference accelerometer (B&K 4371, with Type 2635 Pre-amplifier set to 0.2 Hz lower limiting frequency) was mounted onto a small block, and shaken with various degrees of vigour.

It was found that increased shaking action created higher amplitude acceleration signals, with frequency also increasing with increasing manual effort.

Typical results:

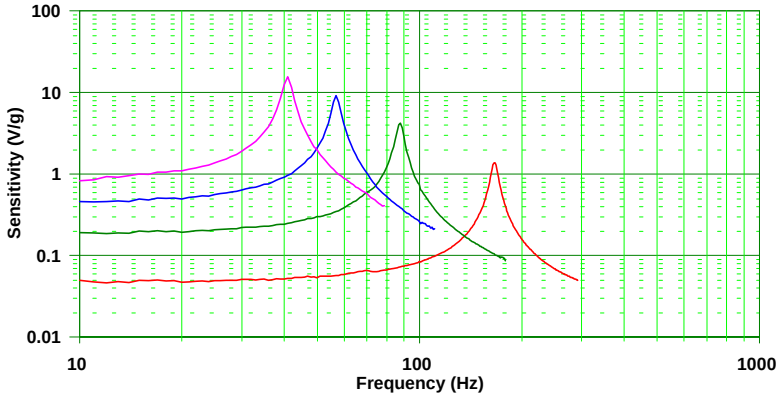
Effort	Fundamental Freq	Acceleration pk-pk
Light	4 Hz	10 g
Moderate	5 Hz	12 g
Hard	7 Hz	25 g

From these data, it can be seen that a sensor with approx 0.3 to 0.4 V/g sensitivity should be sufficient to create a signal extending rail-to-rail for 3V CMOS logic input. It is likely that such an input could be triggered by lower level swings centered on mid-rail voltage, but the above sensitivity would offer good margin of confidence.

Practical Sensor Design

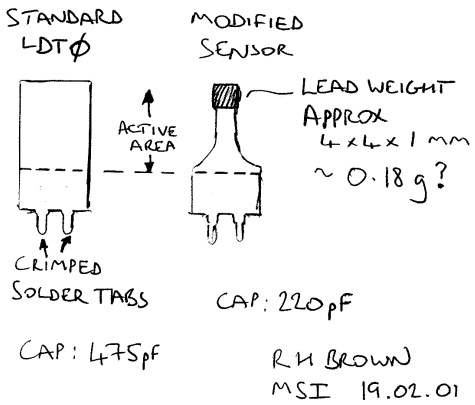
A standard MSI component (LDT0-028K, p/n 1002794) was known to offer the following response curves, for different added mass at tip of sensor:

LDT0 Sensitivity: Effect of Added Mass
(Figure 1)



It can be seen that a sensitivity in the region of 0.5 V/g can be reached at baseline, when a resonance peak at around 58 Hz is achieved by adding mass to the tip.

This part, however, is relatively large (25 x 13 mm approx). A sample of this component was cut down, leaving a central strip approximately 3.5 mm wide electrically connected. A tracing of the standard and modified components is shown below:



Although the device was not calibrated, various shaking actions were performed using the sensor connected to a 100 M resistive load, giving low frequency -3 dB roll-off at 7.5 Hz. A higher value would be preferred, but a 100 M x100 'scope probe was quick and easy way to test the device. 220 M or 470 M would be more suitable values.

A resonance was seen at 27.5 Hz using this assembly, lightly clamped between fingers (checked by giving hand an impulse, and taking FFT of resulting transient waveform).

Shaking at various frequencies, by hand, the following responses were obtained:

Frequency	pk-pk voltage
5 Hz	12 V
6 Hz	29 V
7 Hz	62 V

Conclusion:

The laminated piezo film sensor described above possessed easily enough sensitivity to detect hand shaking action using high impedance CMOS input. It is likely that the mass could be further reduced, and/or beam dimensions altered, to provide an optimised device.

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