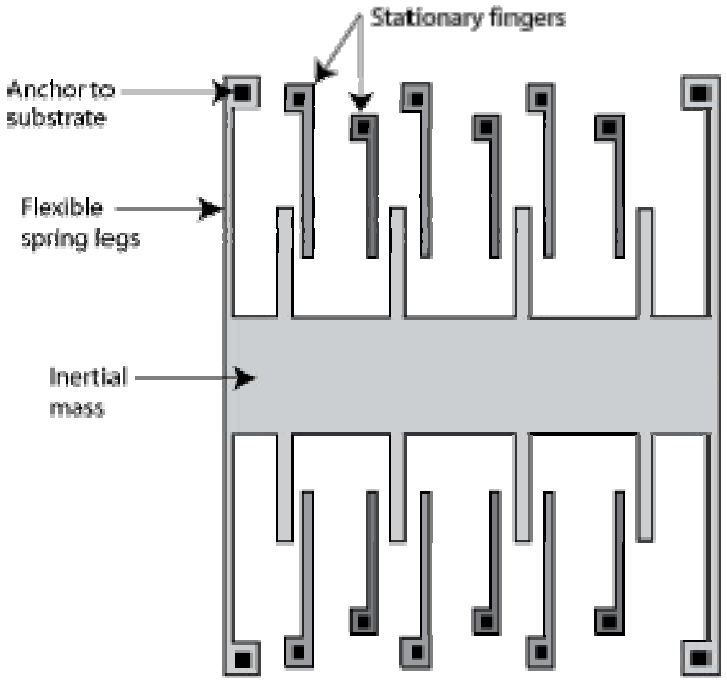
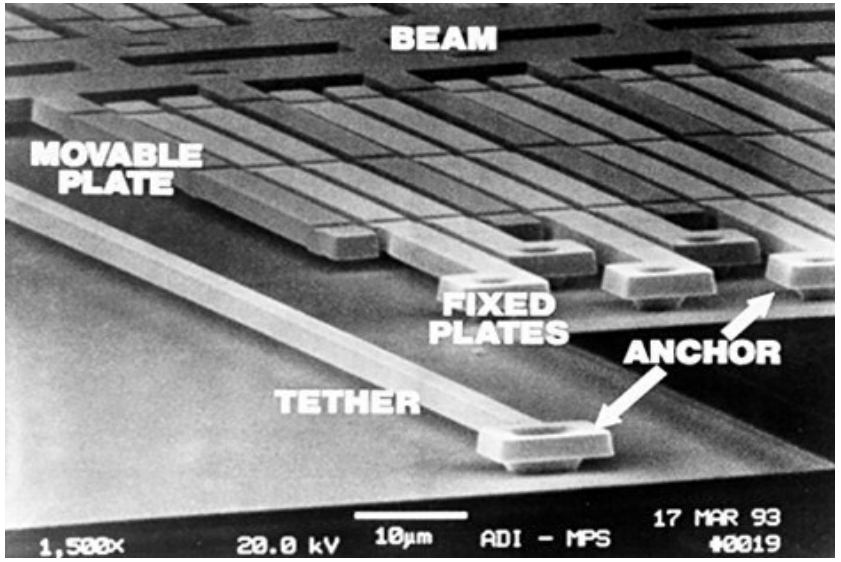
Inertial Sensors

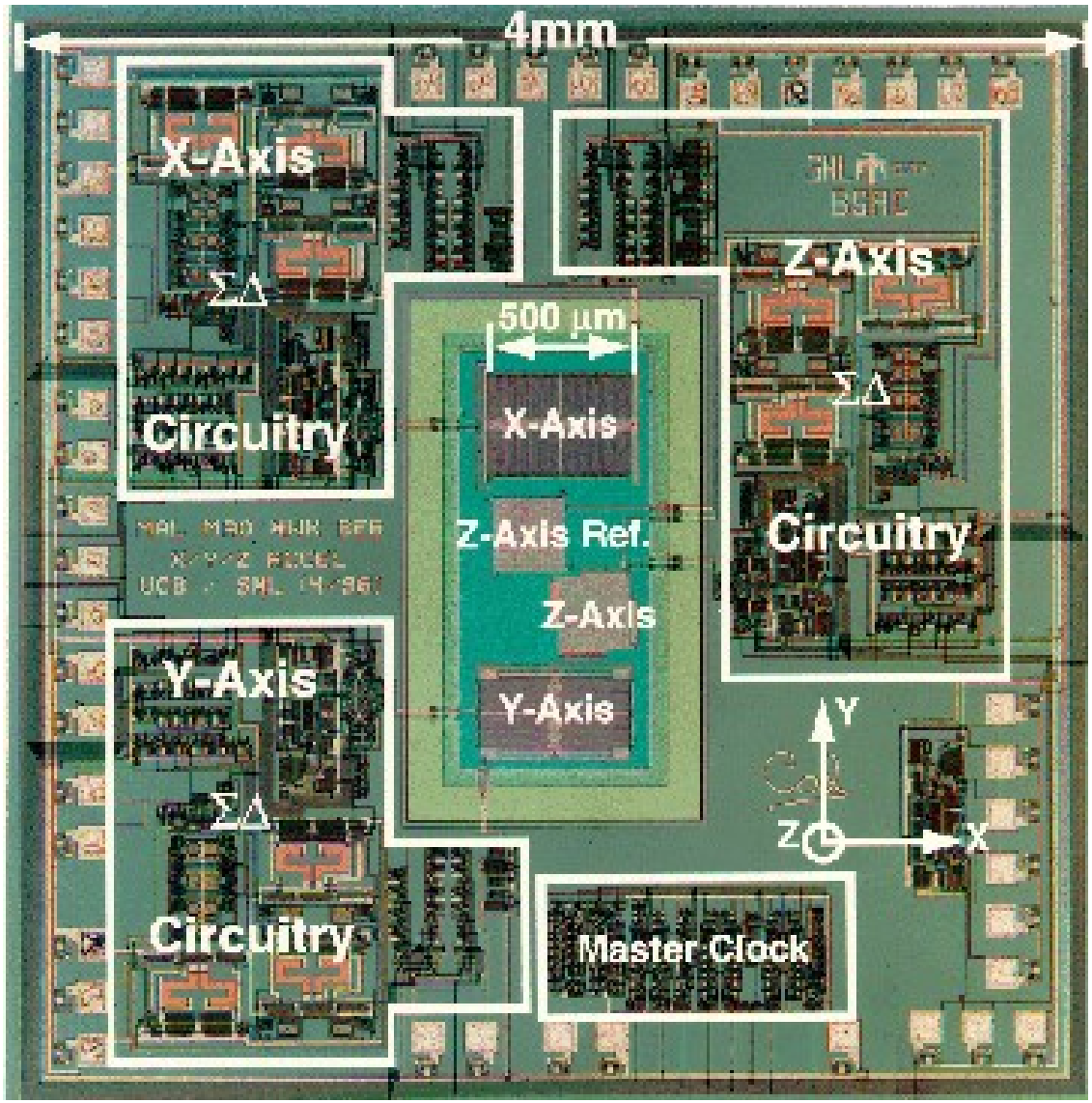
MEMS technology

- Micro Electro Machine Systems



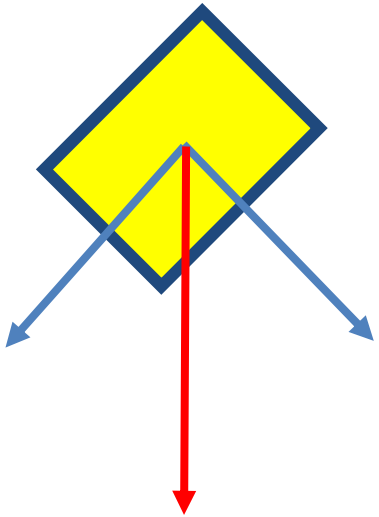


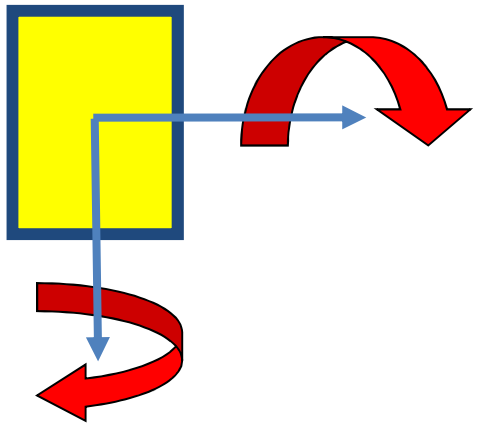
MEMS accelerometer – block diagram



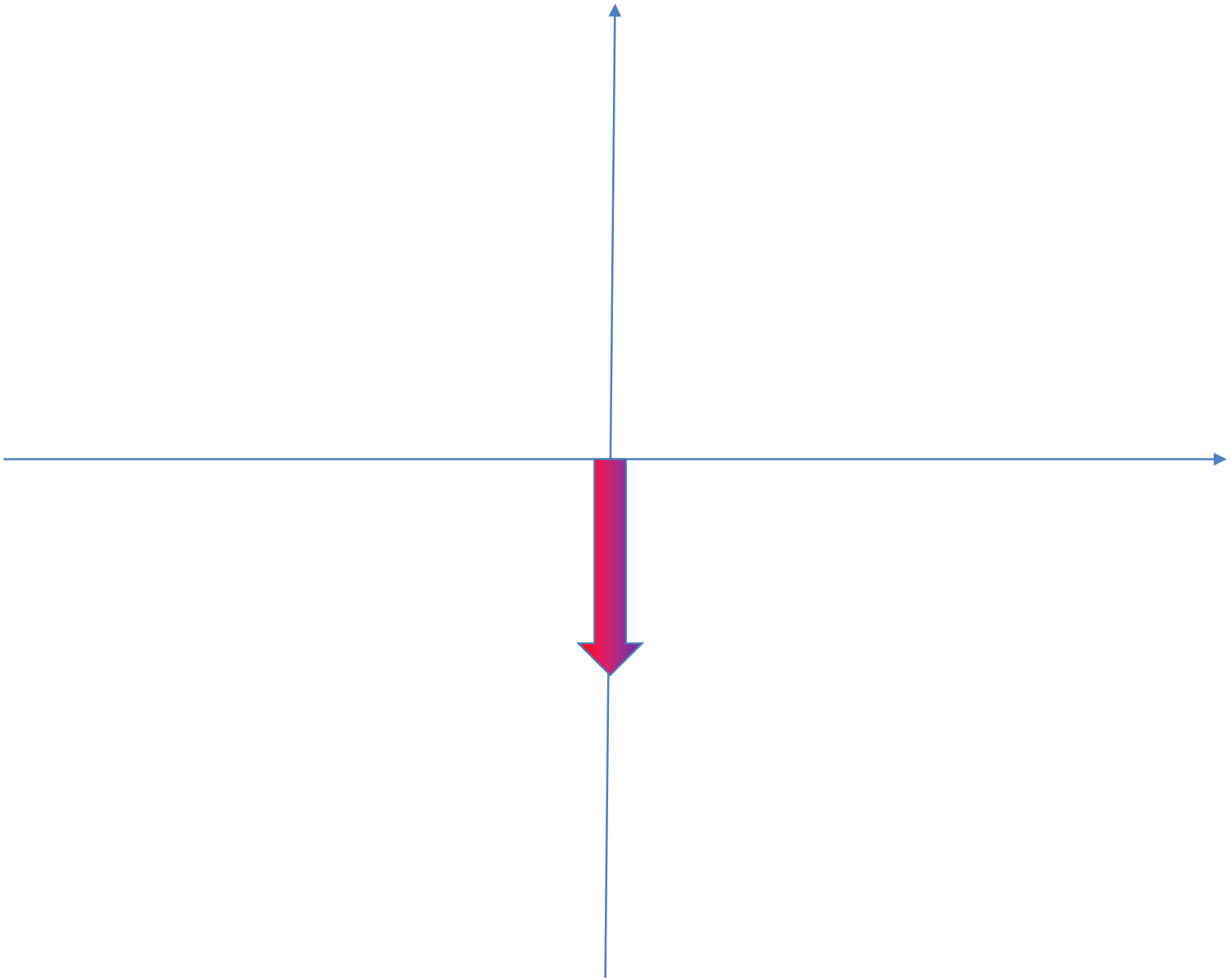
Inertial Sensors

- MEMS technology
  - MEMS accelerometers
  - MEMS Gyroscopes





Acc Components



Inertial Sensors

- Range
  - ± 2g
  - 1g == Vcc/4, e.g. 3V/4=0.75V

- Example, phone at 45 degrees

  - X_g = 1g * cos(π/4) → X= 1.5V + 0.75 V * cos(π/4) = 2.03V
  - Y_g = -1g * sin(π/4) → X= 1.5V - 0.75 V * sin(π/4) = 0.97V

Analog Accelerometers

- ADXL335
  - 3 axis ±3g sensing

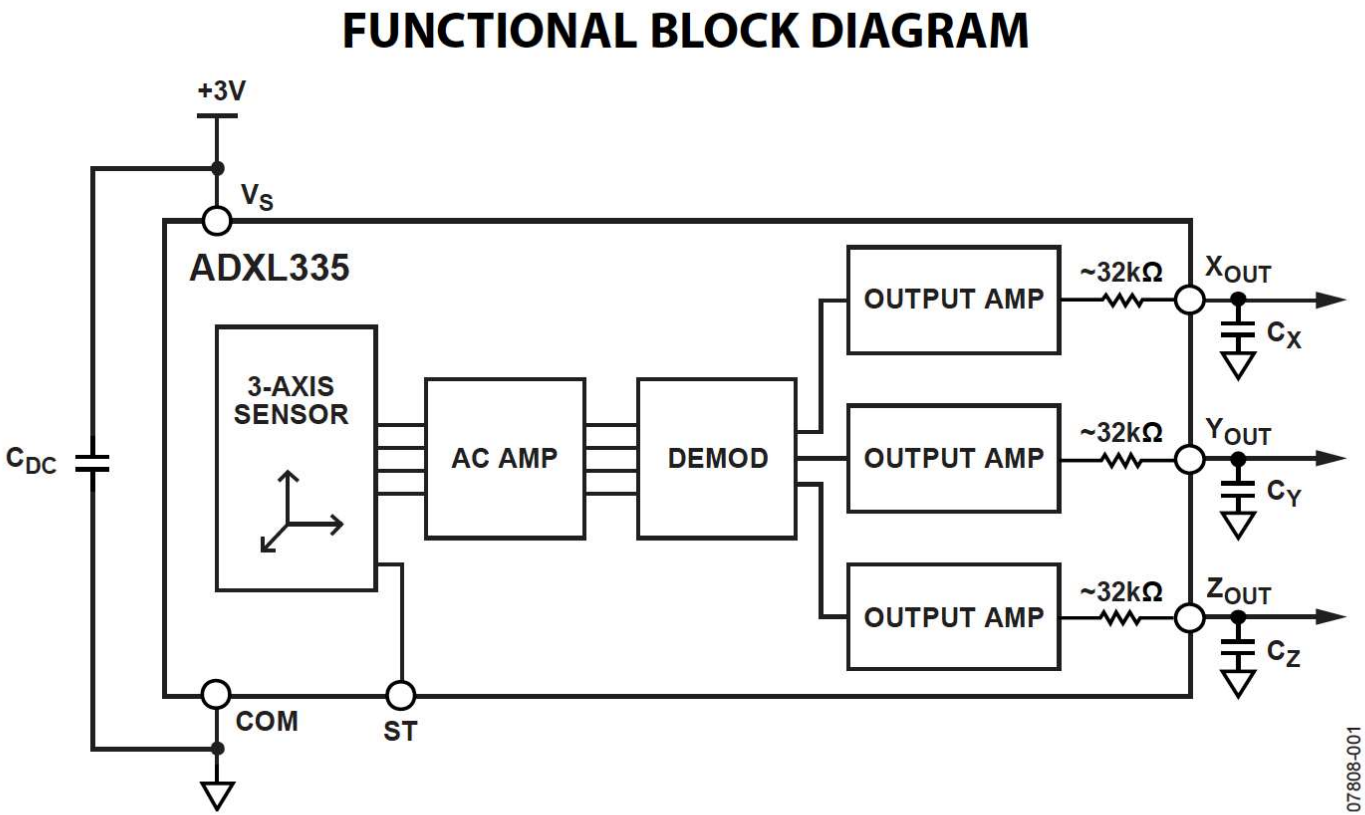
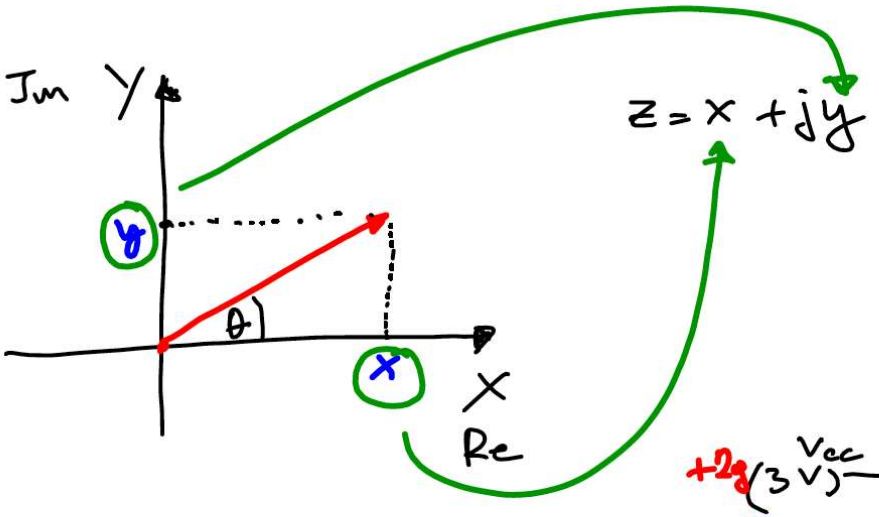
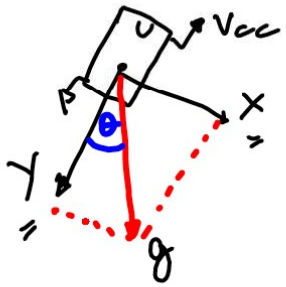


Figure 1.

Analog Accelerometers





$+2g$ (V_{cc} 3 V) —— 3 V

ANALOG $0g$ —— 1.5 V

V_{cc} - 3V

$-2g \to 0$ —— 0 V

$\pm 2g$

$\frac{V}{a} \Rightarrow$ sensitivity $S = \frac{3V}{4g} = 0.75\left[\frac{V}{g}\right]$

$V \Rightarrow 2.25V \Rightarrow a = \frac{V - V_{0g}}{S} = \frac{2.25V - 1.5V}{0.75\frac{V}{g}} = \frac{0.75V}{0.75\frac{V}{g}} = 1g$

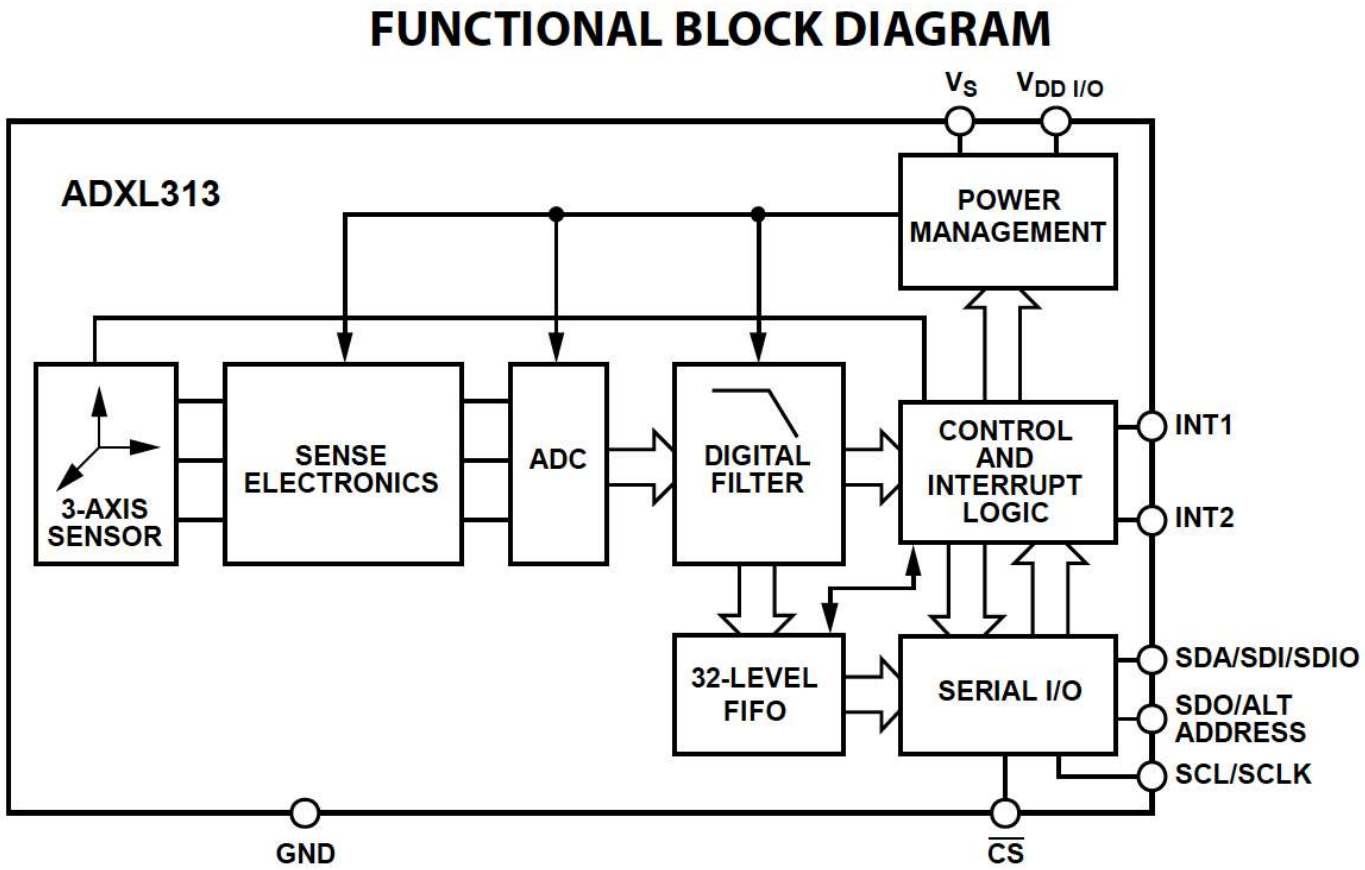
$V_x = 1V \Rightarrow a = \frac{(1 - 1.5)V}{0.75\ \frac{V}{g}} = \frac{0.5}{0.75} a_x = -0.67g$

$V_y \Rightarrow$ ..... $a_y = ...$

$\theta = \text{atan}\frac{a_x}{a_y} = ...$

Digital Accelerometers

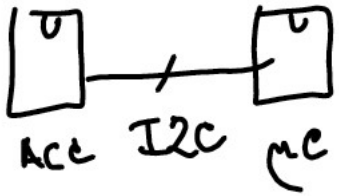
- ADXL313
  - 3 axis
  - ±0.5g, ±1g, ±2g, and ±4g sensing



Digital Accelerometers

DIGITAL ACCELEROMETERS

10bit PRECISION



±2g

$2^{10}-1=1023 \rightarrow +2g$

$0 \rightarrow -2g$

$s = \frac{1023}{4g} \approx 256 \left[\frac{counts}{g}\right]$