

Wilcoxon Research Vibration Product Training

Low Frequency Measurements

What is Low Frequency?

■ Low Frequency

< 10 Hz (600 cpm)

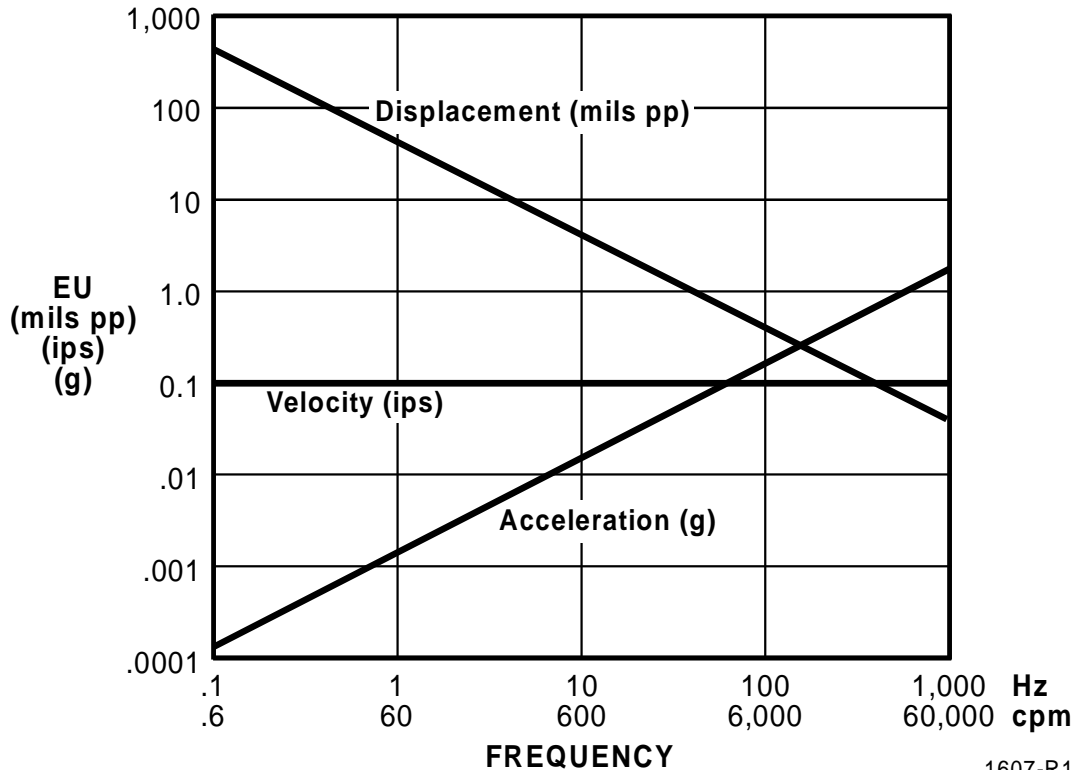
- Low Speed Machine Tools
- Cooling Towers
- Paper Machine Rolls
- Yankee Dryers

■ Very Low Frequency

< 1 Hz (60 cpm)

- Slow Speed Agitators
- Repetative Tooth Faults
- Surge Conditions

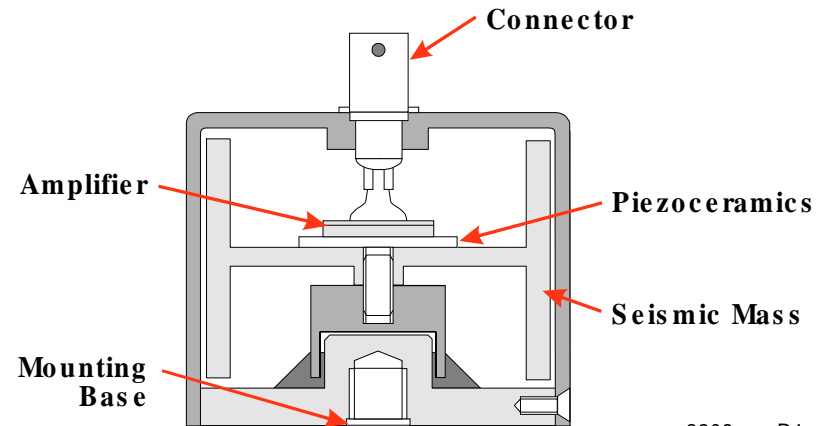
Low Frequency Vibration



- Very Little Vibration Amplitude in terms of Acceleration is Produced at Low Frequencies
- Much Larger Amplitudes are produced in terms of Displacement

Low Frequency Accelerometer Considerations

- Low Noise
 - Must Use PZT
 - Must use “Quiet” Electronics
- High Sensitivity
 - Must overcome monitor noise
- Environmental Protection
 - Overload Protected
 - Resists Thermal transients
 - Low Strain Sensitivity

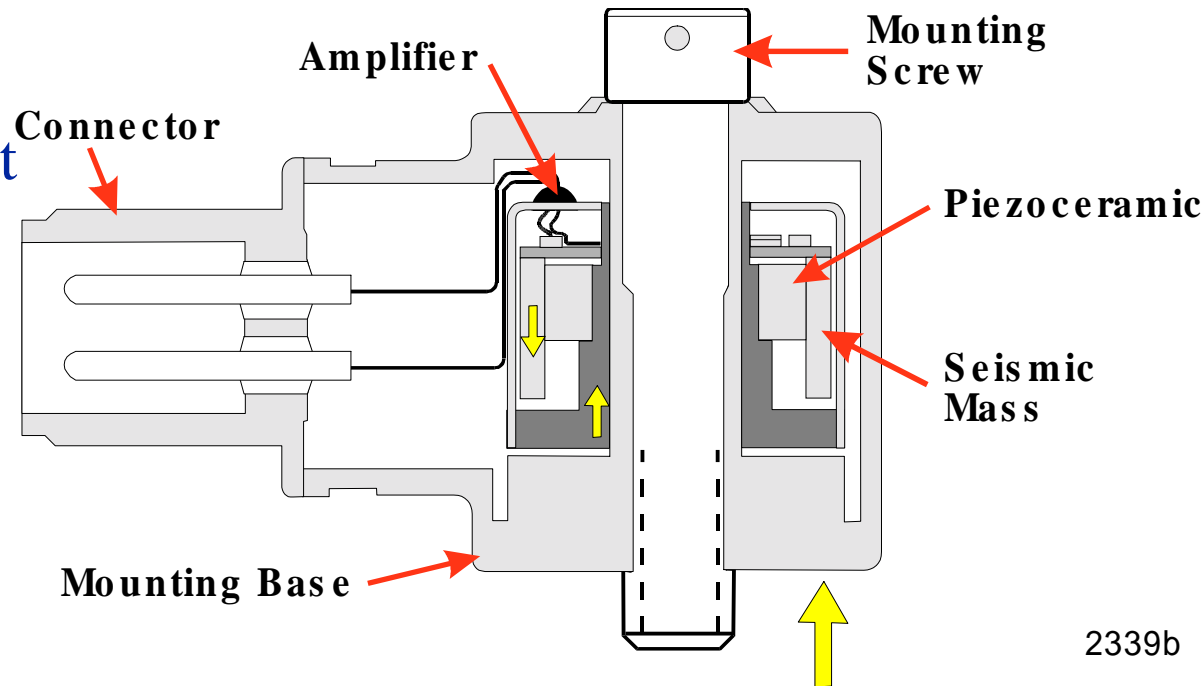


Piezoceramic Materials

| Piezoelectric Material | Charge Per Unit Force in pc/N (compression) |
|--------------------------------|--|
| Lead Zirconate Titanate (PZT) | 350 |
| Lithium Niobate | 21 |
| Polyvinylidene Flouride (PVDF) | 22 |
| Quartz | 2.2 |

Charge Sensitivity

- Charge sensitivity is the fundamental output before the amplifier
- Charge sensitivity increases with the size of the seismic mass and sensitivity of the piezoelectric material

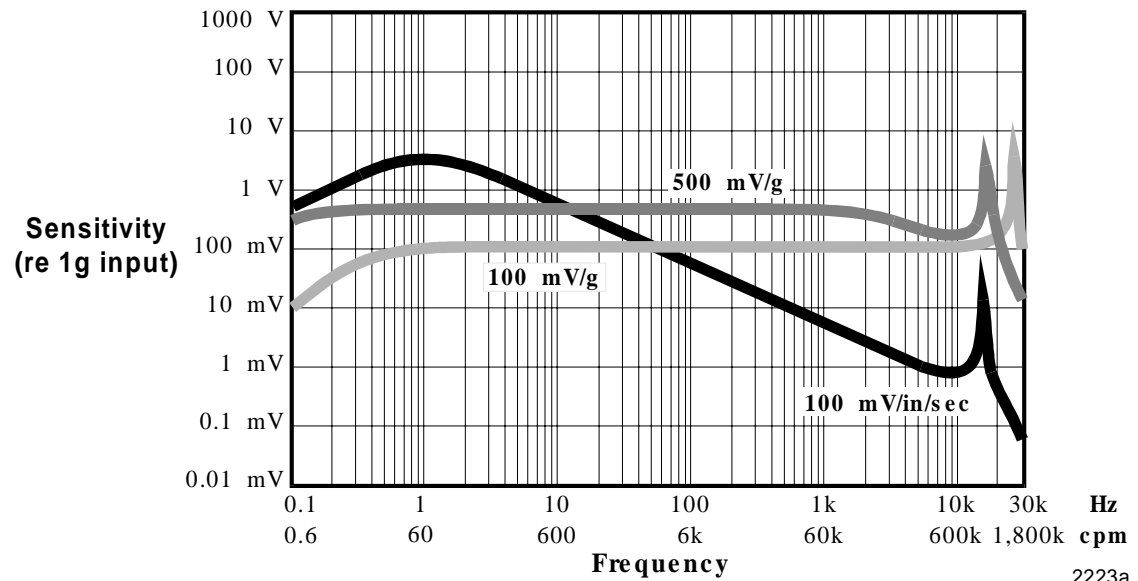


**Shear Accelerometer
Design**

Instrument Noise Considerations

Sensor voltage sensitivity is set by the amplifier

- High sensor sensitivity overcomes instrument noise
- High sensitivities and low resonance increases overload
- Attenuated response improves overload and reduces dynamic range problems



Sensor response levels

Electronic Sensor Noise

- Electronic Sensor Noise can be Improved by using more Lines of Resolution
- The Cost is greater Measurement Time

| Lines of Resolution | 400 | 800 | 1600 | 3200 | 3200 |
|--|--------------------|--------------------|--------------------|---------------------|-------------|
| Electronic Spectral Noise of a Low Frequency Sensor (1 $\mu\text{g}/\text{Hz}$) | 0.16 μg | 0.11 μg | 0.79 μg | 0.056 μg | |
| Measurement Time Per Data Set | 40 sec | 80 sec | 160 sec | 320 sec | (5.3 min) |
| Measurement Time for Four (4) Averages Without Overlapping | 160 sec | 320 sec | 640 sec | 1,280 sec | (21.3 min) |
| Measurement Time for Eight (8) Averages Without Overlapping | 320 sec | 640 sec | 1,280 sec | 2,560 sec | (42.7 min) |

High Sensitivity

Reminder - very little motion in terms of acceleration is produced at low frequencies

| | 1.5 Hz (90 cpm) | 10 Hz (600 cpm) | 100 Hz (6,000 cpm) | 10,000 Hz (60,000 cpm) |
|--|----------------------------|----------------------------|-------------------------------|-----------------------------------|
| Displacement (mils) | 32 | 5 | .5 | .05 |
| Velocity (ips) | .3 | .3 | .3 | .3 |
| Acceleration (g) | .007 | .05 | .5 | 5 |
| 100 mV/g Accelerometer (V) | .0007 | .005 | .05 | .5 |
| 500 mV/g Accelerometer (V) | .0035 | .025 | .25 | 2.5 |
| 100mV/ips Piezo Velocity Transducer (V) | .03 | .03 | .03 | .03 |