

Vibration product training

Low frequency measurements

What is low frequency?

- **Low frequency**

< 10 Hz (600 cpm)

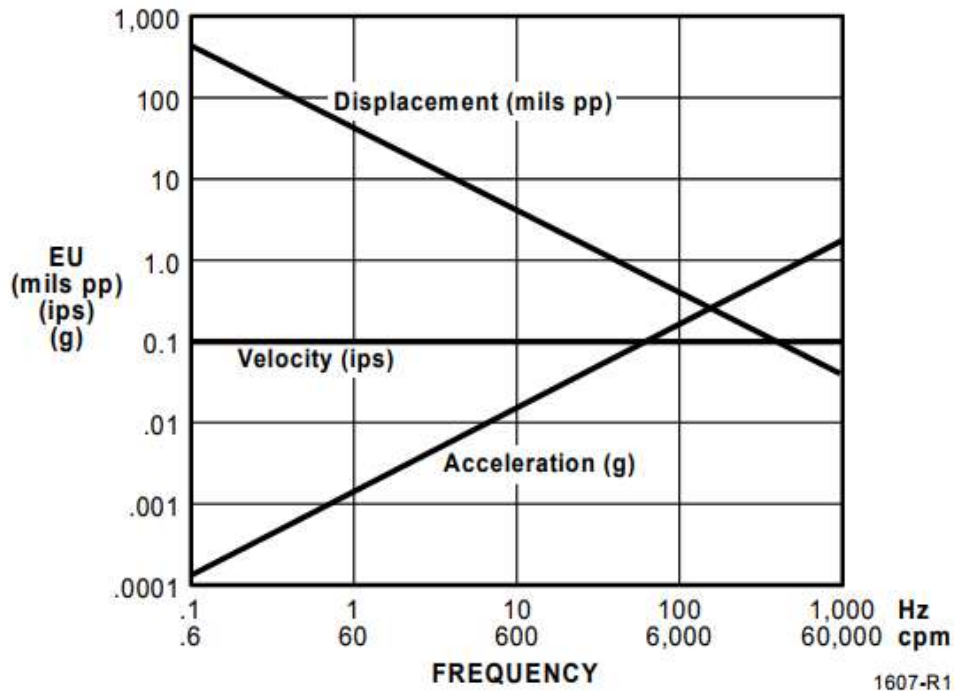
- Low speed machine tools
- Cooling towers
- Paper machine rolls
- Yankee dryers

- **Very low frequency**

< 1 Hz (60 cpm)

- Slow speed agitators
- Repetitive 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**

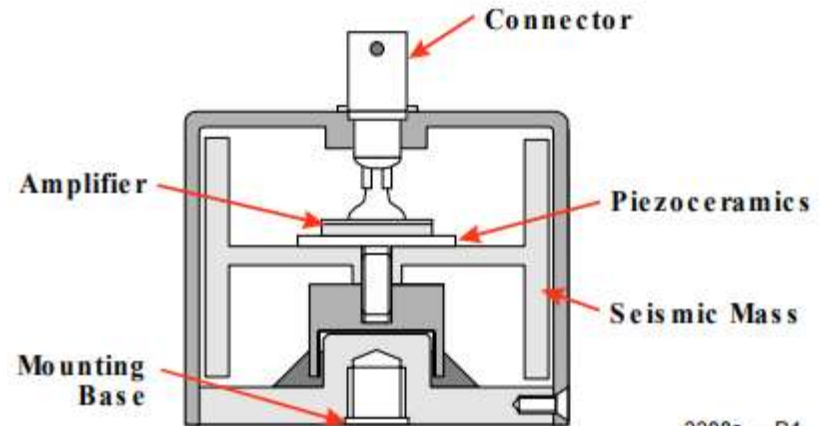
- Must use PZT
- Must use “quiet” electronics

- **High sensitivity**

- Must overcome monitor noise

- **Environmental protection**

- Overload protected
- Resists thermal transients
- Low strain sensitivity



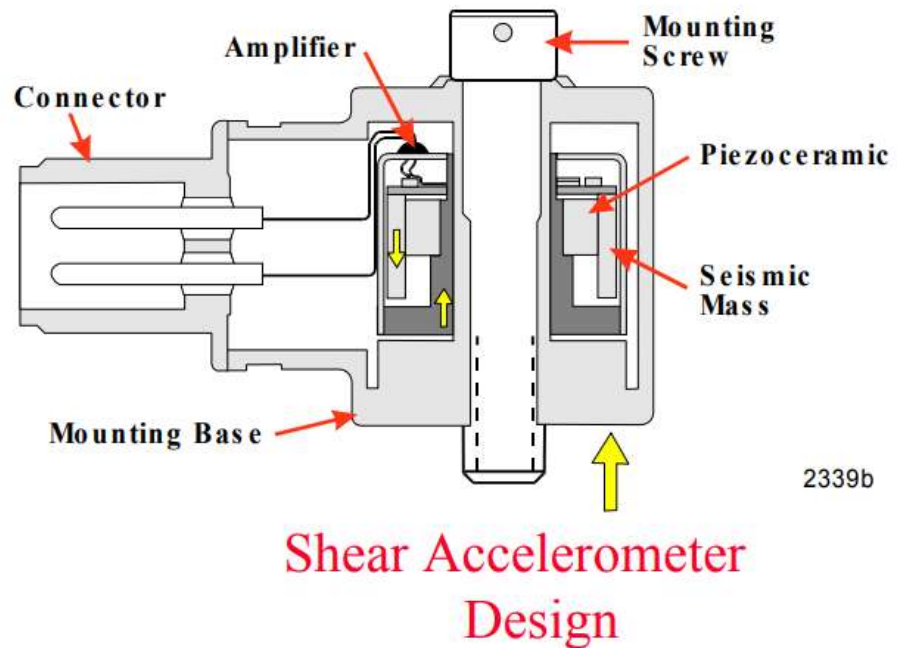
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Piezoceramic materials

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

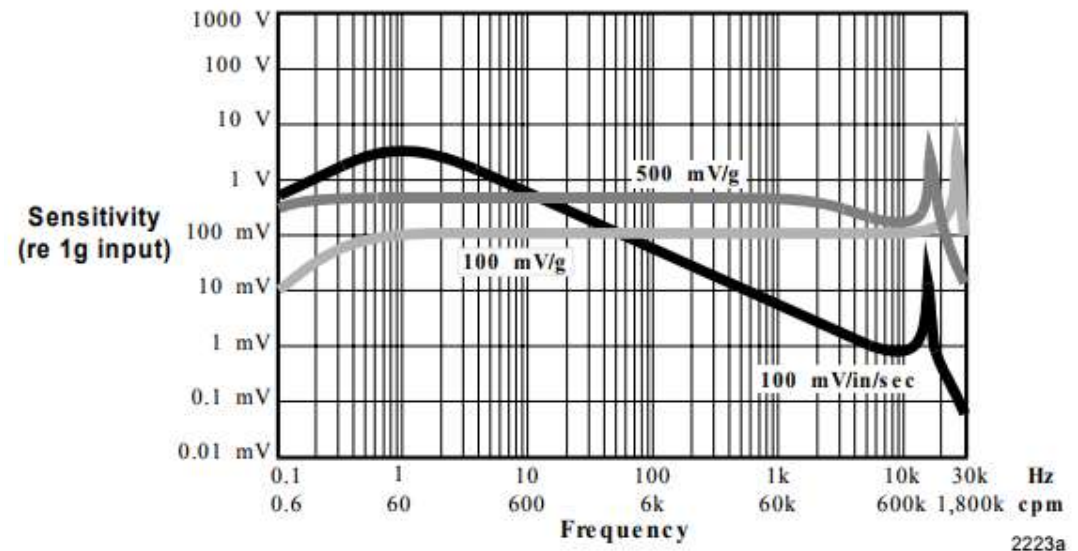
- Charge sensitivity is the fundamental output before the amplifier
- Charge sensitivity increases with the size of the seismic mass and sensitivity of the piezoelectric material



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

- Electronics 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)

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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

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