A new generation of high-shock accelerometers with extreme survivability performance

Tom Kwa, George Pender, James Letterneau, Keith Easler

National Defense Industries Assn 53rd Fuze Conference
May 21, 2009

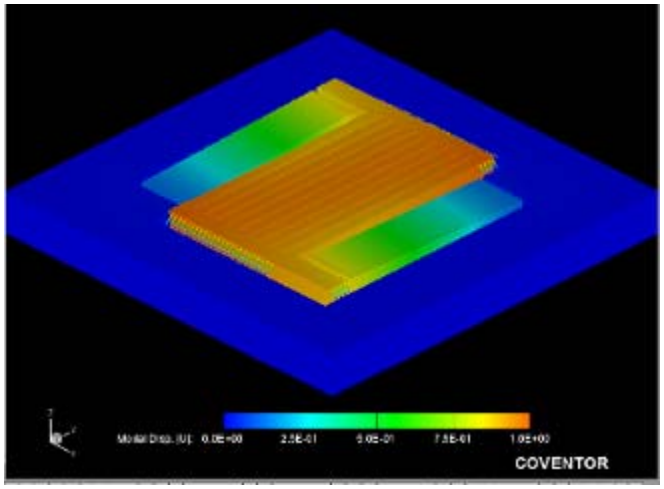
Presentation by Randy Martin

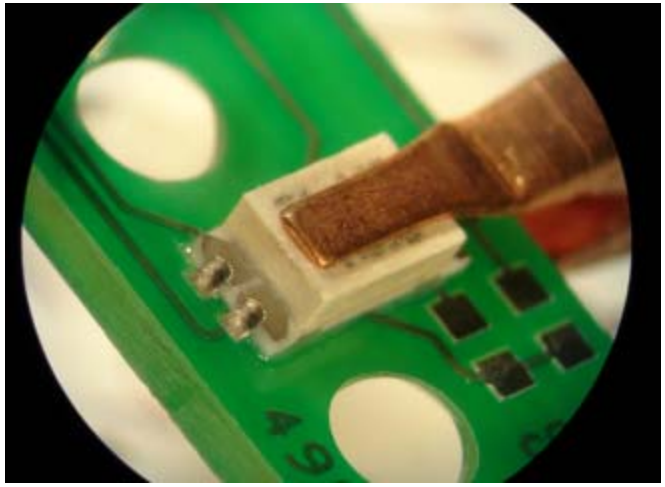
Endevco Corporation
30700 Rancho Viejo Road
San Juan Capistrano, CA 92675

MEGGiTT

Next generation high-shock accelerometer fuze application requirements

- Survivability and Reliability
- Small footprint
- Surface mountable
- Low power consumption
- Short warm-up time
- High resonance frequency
- High input resistance
- Light damping





MEGGiTT

Performance parameter design targets

Range = 20 kg	Next generation	Previous Generation
Survivability	6 times range	3 times range
Size (footprint)	25 mm^2	100 mm^2
SMT	Yes	No
Power	4 mW (5 V)	150 mW (10 V)
Warm-up drift	10 g	50 g
Resonant freq	100 kHz	350 kHz
Input resistance	6500 Ω	650 Ω
Gas Damping	Yes	No
Over-range stops	Yes	No

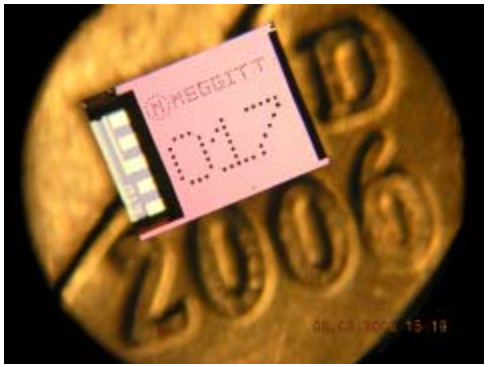
MEGGiTT

Survivability enhancements

- Mechanical stops prevent damage to die from high-g over-range inputs
  - Base and lid serve as stops (z-axis) – walls for x, y
  - Approximately 3 times full-scale range (> for x, y)
- Light damping attenuates resonance (Q-killer) to prevent damage due to ‘ringing’
  - Mechanism is squeeze-film gas damping
  - 0.05 nominal (can be adjusted) – gap, core mod
  - Additional benefit is preventing saturation of signal conditioning circuitry
  - Mechanical equivalent of electrical filter

MEMS die design enhancements

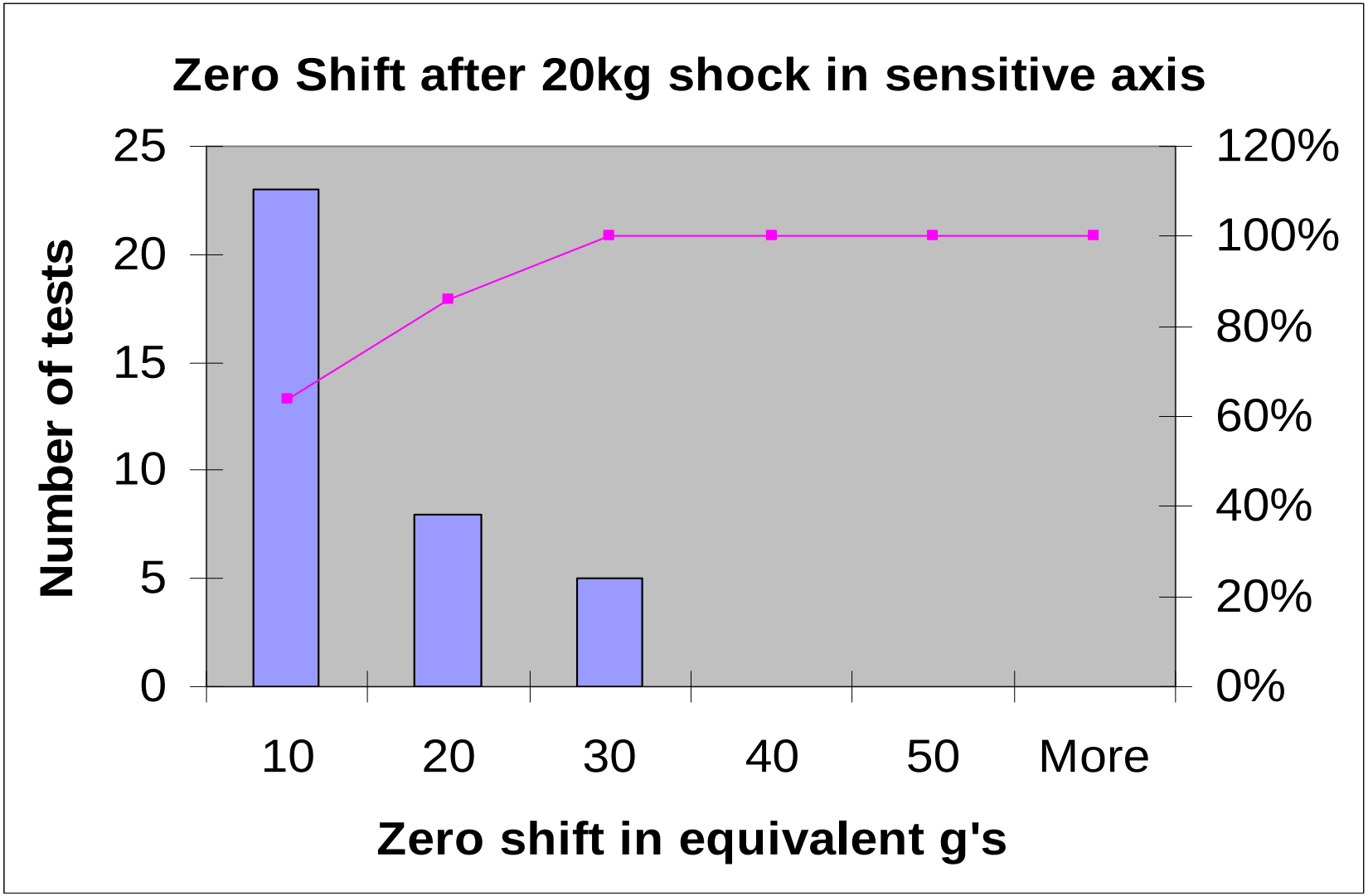
- 'Teed' gauge process
  - Developed for Auto Crash test market
  - Provides robust mechanism for a production environment MEMs-based Piezoresistive strain concentrators (US Patent Nos. 6,988,412 and 7,146,865)
- Higher resistance, lower power
- Improved warm-up characteristics
- Single-sided wire bonding on tri-stack
- Deep Reactive Ion Etch (DRIE)
- MEMS die manufactured by Endevco at our SV facility



Endevco MEMS, Sunnyvale, CA

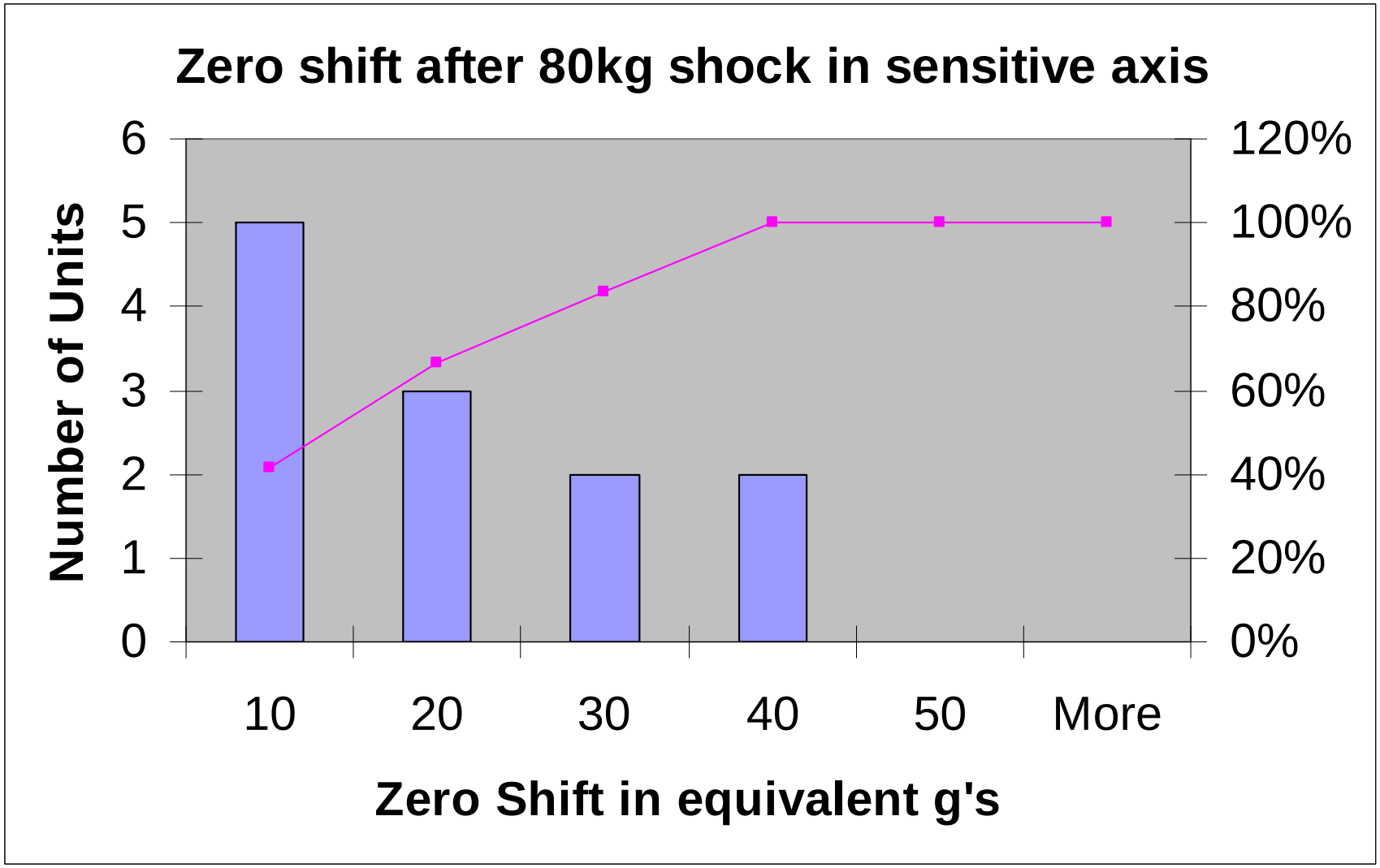
MEGGITT

Zero Shift Over Shock Data (1 of 3)



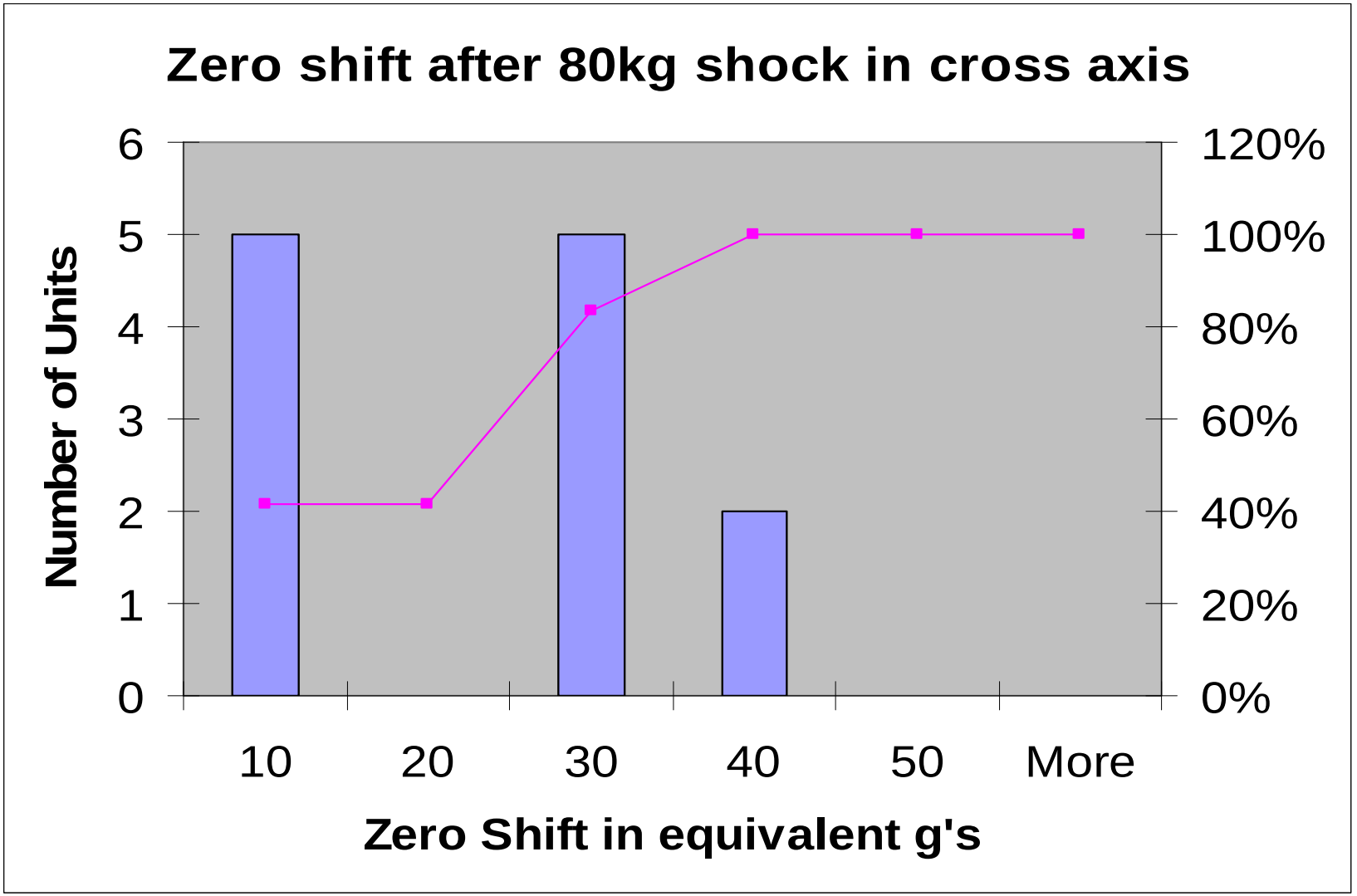
MEGGiTT

Zero Shift Over Shock Data (2 of 3)



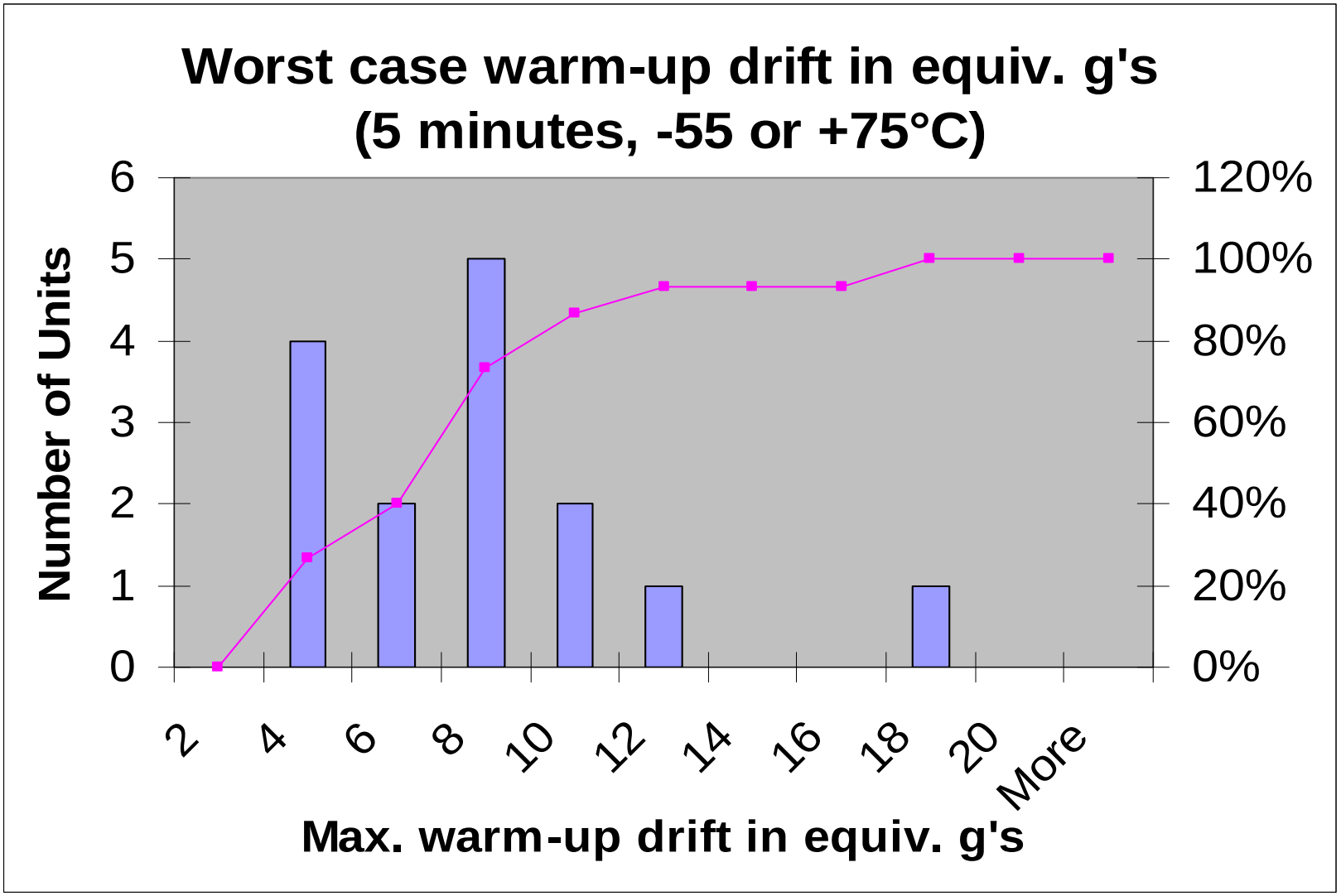
MEGGiTT

Zero Shift Over Shock Data (3 of 3)



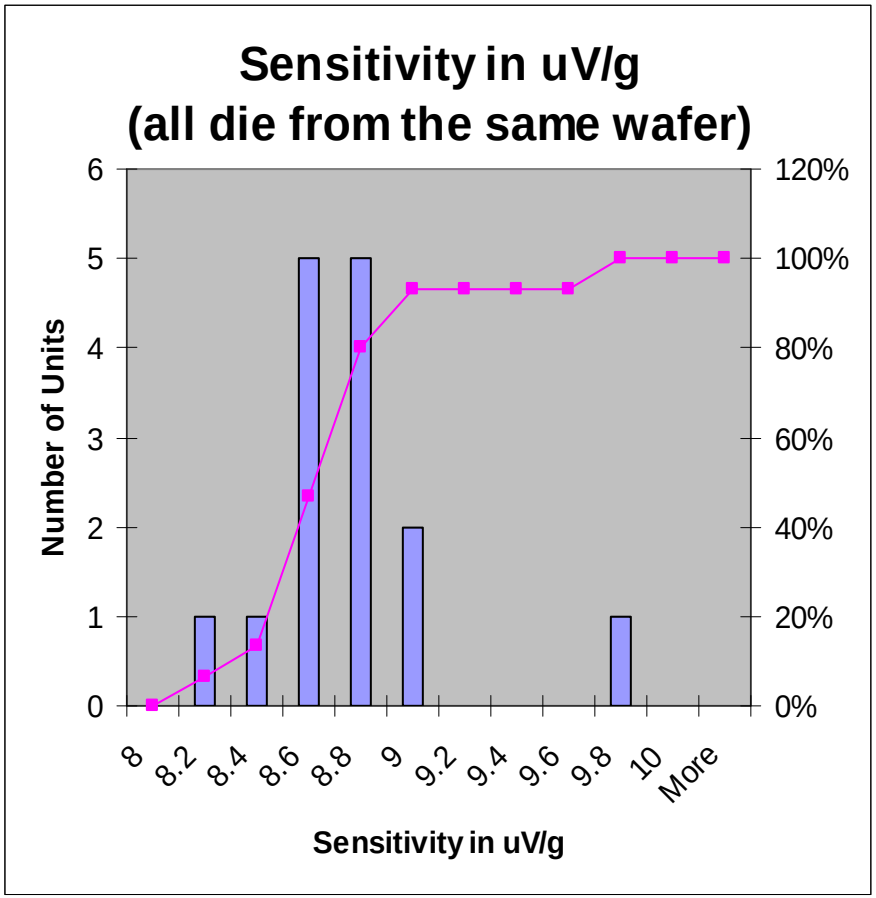
MEGGiTT

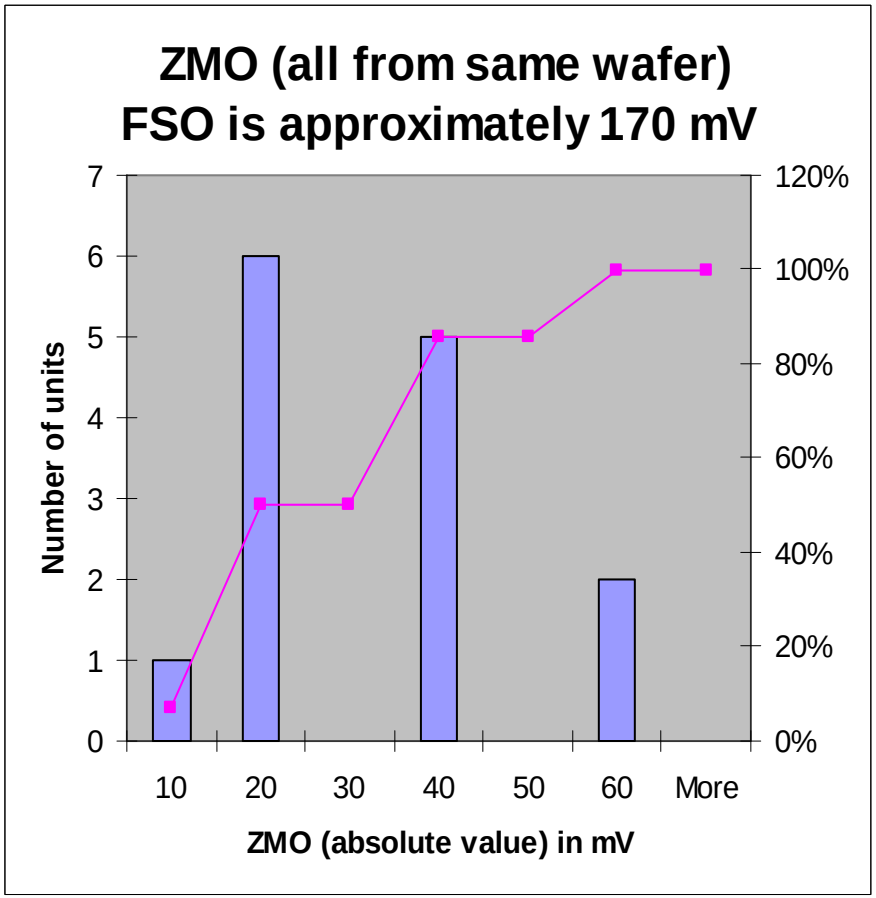
Warm-up Drift Data



MEGGiTT

Sensitivity and ZMO Test Data

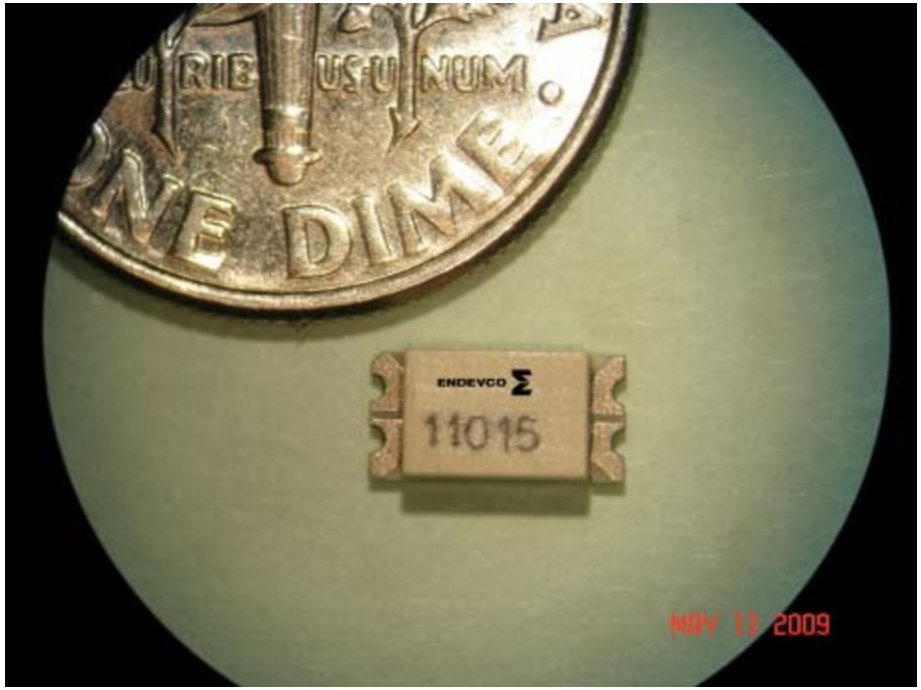




MEGGiTT

Test Data Summary for 20 kg accelerometer

- Sensitivity: 8.5 μV/g nominal (at 5 V excitation)
- ZMO: < ±100 mV (most units ±50 mV)
- Input resistance: 6.5 kΩ (±0.5 kΩ)
- Worst case warm-up drift: < 10 g's
  - 5 minutes, constant temperature: -55 C, +25 C, +75 C
- Noise:
  - < 5 μVrms (broadband);
  - 3 g-pk (settings below)
  - (AC coupled, 3 Hz-10 kHz BPF, 200 ksps, 200 ms window)
- Shift in ZMO over shock
  - 20 kg sensitive axis < 30 g
  - 80 kg sensitive axis < 40 g
  - 80 kg cross axis < 40 g



MEGGiTT