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

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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
Performance parameter design targets

<table>
<thead>
<tr>
<th></th>
<th>Next generation</th>
<th>Previous Generation</th>
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</thead>
<tbody>
<tr>
<td>Range = 20 kg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Survivability</td>
<td>6 times range</td>
<td>3 times range</td>
</tr>
<tr>
<td>Size (footprint)</td>
<td>25 mm²</td>
<td>100 mm²</td>
</tr>
<tr>
<td>SMT</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Power</td>
<td>4 mW (5 V)</td>
<td>150 mW (10 V)</td>
</tr>
<tr>
<td>Warm-up drift</td>
<td>10 g</td>
<td>50 g</td>
</tr>
<tr>
<td>Resonant freq</td>
<td>100 kHz</td>
<td>350 kHz</td>
</tr>
<tr>
<td>Input resistance</td>
<td>6500 Ω</td>
<td>650 Ω</td>
</tr>
<tr>
<td>Gas Damping</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Over-range stops</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
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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
Zero Shift Over Shock Data (1 of 3)

Zero Shift after 20kg shock in sensitive axis

Number of tests

Zero shift in equivalent g's

MEGGITT
Zero Shift Over Shock Data (2 of 3)

Zero shift after 80kg shock in sensitive axis

Number of Units

Zero Shift in equivalent g's

MEGGIT
Warm-up Drift Data

Worst case warm-up drift in equiv. g's
(5 minutes, -55 or +75°C)
Sensitivity and ZMO Test Data

Sensitivity in uV/g
(all die from the same wafer)

ZMO (all from same wafer)
FSO is approximately 170 mV
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 ksp/s, 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