Wearable Sensor Patch:
- **Component Side**
  - Power cap
  - AD8232
  - CC2540
  - sig. cond.
  - SoC, 12 bit & gain
  - 8 channels

- **Sensor Side**
  - Thermistor
  - Vias & Au/Cu interface
  - ECG electrodes

**Set 2 TVs**
- **Component Side**
  - Substrate: 2" × 2", 50 µm thick Kapton® PI.
  - Electrical circuit: 2 µm thick Cu.
  - Solder: Sn63Pb (reflow temp: 205 °C) or Sn42Bi (reflow temp: 175 °C).
  - Improved solder pad design.

**Set 2 TVs (Sensor Side)**
- Mandrel pushing against sensor side
- Original (left) and improved (right) solder pad design

**Test Vehicles (TV) for Bend Testing:**

<table>
<thead>
<tr>
<th>Device ID</th>
<th>Cu thickness (µm)</th>
<th>PI thickness (µm)</th>
<th>Solder used</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5 A2</td>
<td>6</td>
<td>50</td>
<td>Sn63Pb</td>
</tr>
<tr>
<td>M5 B2</td>
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<td>50</td>
<td>Sn63Pb</td>
</tr>
<tr>
<td>M6 A1</td>
<td>6</td>
<td>50</td>
<td>Sn42Bi</td>
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<tr>
<td>M6 B1</td>
<td>6</td>
<td>50</td>
<td>Sn42Bi</td>
</tr>
<tr>
<td>M9 A2</td>
<td>2</td>
<td>125</td>
<td>Sn63Pb</td>
</tr>
<tr>
<td>M9 B2</td>
<td>2</td>
<td>125</td>
<td>Sn63Pb</td>
</tr>
<tr>
<td>M10 A1</td>
<td>2</td>
<td>125</td>
<td>Sn42Bi</td>
</tr>
<tr>
<td>M10 B1</td>
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<td>Sn42Bi</td>
</tr>
<tr>
<td>Phase 1</td>
<td>2</td>
<td>50</td>
<td>Sn63Pb</td>
</tr>
</tbody>
</table>

**Bend Testing Procedure:**
1. Microscopy and imaging of 20 solder joint locations of AD8232 chip to document manufacturing defects.
2. 1000 bend cycles on 4"–0.5" radius mandrels.
3. Microscopy and imaging after each stage to study and document new defects/failures.

**Results:**
- Mandrel pushing against sensor side
- Original (left) and improved (right) solder pad design
- Crack through Cu trace

**Conclusions:**
1. Most robust configuration: 6 µm Cu, 50 µm PI, Sn42Bi solder. Only configuration with zero defects after fabrication.
2. Sn42Bi solder reduces stresses due to CTE mismatch.
3. Improved solder pad design increases robustness.
4. FEA results correlated closely with experimental results.

**Reference:**