Features

- Ultra-Compact Heat Flux Sensor
- Compatible with Standard SMT Manufacturing
- Zero Current Consumption
- Minimal Thermal Invasiveness
- Low Impedance
- Low Noise
- Attractive OEM Pricing

Typical Applications

- Fitness and Health Wearables
- Non-Invasive Core Body Temperature Monitoring
- Energy Expenditure Estimation
- Miniaturized Calorimetric Solutions

Description

The gSKIN-XU is an ultra-compact, low-noise thermoelectric heat flux sensor. The sensing technique relies on highly integrated Bi2Te3 thermopiles enclosed in a reflow-solderable SMD package. The XU sensor does not require any power source or bias current for its operation and therefore does not suffer from self-heating effects. The sensor output is a low-impedance bipolar analog voltage signal, comparable to a thermocouple output. Digitalization can be performed directly with a high-resolution ADC. ADCs with lower precision (e.g. ADC included in MCUs) can also be used if combined with a low-offset pre-amplification stage (Fig. 1).

Fig. 1: Typical application circuit
### Sensor Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>gSKIN® XU 22 9C</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detector Type</td>
<td>Thermoelectric - passive</td>
<td>-</td>
</tr>
<tr>
<td>Surface Material (Sensing Area)</td>
<td>Copper and polyimide</td>
<td>-</td>
</tr>
<tr>
<td>Sensing Area</td>
<td>2 x 2</td>
<td>mm</td>
</tr>
<tr>
<td>Sensor Thickness</td>
<td>0.4</td>
<td>mm</td>
</tr>
<tr>
<td>Absolute Thermal Resistance</td>
<td>-198</td>
<td>K/W</td>
</tr>
<tr>
<td>Electrical Connection</td>
<td>Bottom side SMD solder pads</td>
<td>-</td>
</tr>
</tbody>
</table>

### Electrical Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity (Factory) @ 25°C</td>
<td>0.7</td>
<td>2.0</td>
<td>µV/(W/m²)</td>
</tr>
<tr>
<td>Calibration Error</td>
<td>-5</td>
<td>+5</td>
<td>%</td>
</tr>
<tr>
<td>Sensitivity Drift</td>
<td>-</td>
<td>0.25</td>
<td>%/°C</td>
</tr>
<tr>
<td>Heat Flux Resolution</td>
<td>1.0</td>
<td>1.6</td>
<td>W/m²</td>
</tr>
<tr>
<td>Electrical Resistance</td>
<td>1</td>
<td>10</td>
<td>Ohm</td>
</tr>
</tbody>
</table>

*Assuming ADC LSB resolution of 2 µV

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current at Any Pin</td>
<td>-10</td>
<td>10</td>
<td>mA</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>-50</td>
<td>80</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>-50</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>Heat Flux Range (Thermal Destruction Limit)</td>
<td>-150</td>
<td>150</td>
<td>kW/m²</td>
</tr>
<tr>
<td>Compressive Clamping Force</td>
<td>-</td>
<td>0.5</td>
<td>Kgf</td>
</tr>
</tbody>
</table>

### ESD Considerations

Due to its electrical, geometric, and physical properties, XU sensors are not sensitive to ESD surges.


**Sensitivity Bin**

Due to variations in the production process, each sensor has a different sensitivity. Every sensor is characterized at the factory and assigned to a bin according to its “raw” sensitivity value (factory sensitivity).

The sensitivity bin is part of the product name:

XU-070501-X-CT where “X” stands for the sensitivity bin designation.

**IMPORTANT NOTE:**

There is no possibility of producing a specific bin on demand. All orders over 1000pcs (=1 reel) will always consist of several reels of different sensitivity bins. One reel only consist of sensor of only one sensitivity bin.

**Thermal Integration**

Please contact greenTEG for advice on thermal integration and thermal characterization.

**Reel Labelling**

Each reel is shipped in a DryLock bag meeting the requirement EIA 541. Each reel is provided with a label on both the external packaging as well as on the reel itself.

The QR-code encodes Article Number, Sensor Lot Number, Sensitivity Bin, and Quantity on reel, separated by semicolons.

Example: A-044802;LN012605;J;282

Fig. 2: Reel labelling
Sensor laser marking

Each individual sensor module is laser marked with an unique alphanumeric sensor ID. The sensor ID is unique and has the following format:

Upper line: 1 or 2 letters followed by 2 digits  e.g.  “R24” or “AB05”
Lower line: 6 digits  e.g.  “002263” or “010029”

Fig. 3: Sensor top laser marking
Mechanical Information

Recommended Footprint

Layout Considerations
Layout requirements strongly depend on intended use and mechanical constraints of the final device. Please contact greenTEG for advice on thermal integration guidelines best fit to your project.

Reflow and Assembly Guidelines

Pre-bake
The sensor is classified as MSL 6 (mandatory bake before use). Prebake of the reel prior to soldering reduces risk of thermomechanical stress and sensor damage, especially if there is uncertainty regarding prior storage conditions. Recommended prebake process is 2-4h vacuum bake at 60°C right before reflow. If vacuum is not available, increase baking temperature to 65-70°C and increase duration to 4-6h.
NOTE: Reel is only resistant to temperatures up to 70°C (warping temperature: 77°C)

Solder Paste
The sensors can be soldered with standard lead-free SAC solder paste. No-clean and halide activated /water soluble solder paste has both been successfully used.

Reflow Profile
Recommended peak reflow temperature is 240°C or less, but temperatures up to 250°C can be tolerated if time at peak temperature is limited to 10 seconds. Recommended time above liquidus is 30-60 seconds.

Cleaning
Board cleaning after reflow is recommended to remove potentially corrosive flux residues. The sensor withstands mild aqueous flux cleaners (neutral to mildly alkaline pH). Alcohol based cleaners are compatible as well. Strongly alkaline cleaners must be avoided as polyimide components of the sensor might be attacked.