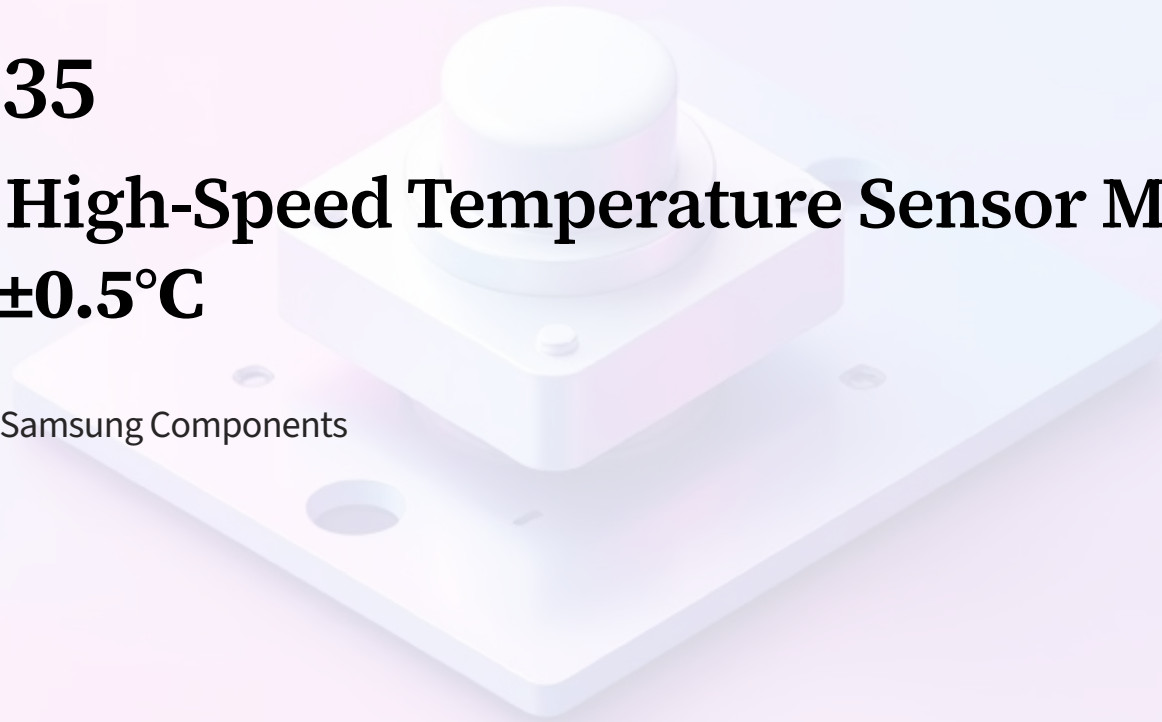


SwiftSense T235

**Ultra-Low Power High-Speed Temperature Sensor Module
with accuracy of $\pm 0.5^{\circ}\text{C}$**

Powered by Authentic TI, Murata, and Samsung Components



Features

Aluminum Core Advantage

Built on a **Metal Core PCB (MCPCB)** for superior thermal conductivity. While standard green fiberglass (FR4) PCBs act as insulators, our Aluminum substrate transfers heat to the sensor in **under 2 seconds**, enabling real-time thermal protection.

Thermal Design Optimization

The PCB is engineered with **sufficient extra free area** around the sensor and a completely flat bottom layer to ensure maximum surface contact and superior heat transfer from the target system to the sensing element.

Precision Performance

Powered by a high-grade TI TMP series analog sensor providing a typical accuracy of **$\pm 0.5^{\circ}\text{C}$** across a range of **0°C to $+70^{\circ}\text{C}$** . And **$\pm 2^{\circ}\text{C}$** across a full range of -40°C to $+150^{\circ}\text{C}$

Key Specifications

Applications

- **BMS & Battery Packs:** Instant detection of "Hot Spots" in lithium cells to prevent thermal runaway.
- **Industrial Motors:** Overheat protection for motors and pumps.
- **IoT Wireless Nodes:** High accuracy with minimal power drain for remote environmental monitoring.
- **Power Electronics:** Monitoring MOSFET and Transformer temperatures.
- **Hobbyist Projects:** High-reliability weather stations and 3D printer chamber monitoring.

Description

The SwiftSense T235 is a high-reliability analog temperature module. Unlike generic modules that use fiberglass (FR4), this module uses an **Aluminum PCB**. This allows the entire back of the module to act as a thermal interface; when pressed against a surface, it eliminates the "thermal lag" that causes standard sensors to respond too slowly to overheating. Whether you are preventing thermal runaway in **EV Battery Management Systems (BMS)**, monitoring high-performance **Industrial Motors**, or deploying **Ultra-Low Power IoT**, the **SwiftSense T235** provides the speed you need to act before a hotspot becomes a hazard. **Pure Analog Performance.** No I2C, no libraries, no hassle. Just a clean **10mV/°C linear output** that works seamlessly with your favorite microcontroller. Simply plug it in and start measuring.

Physical Design

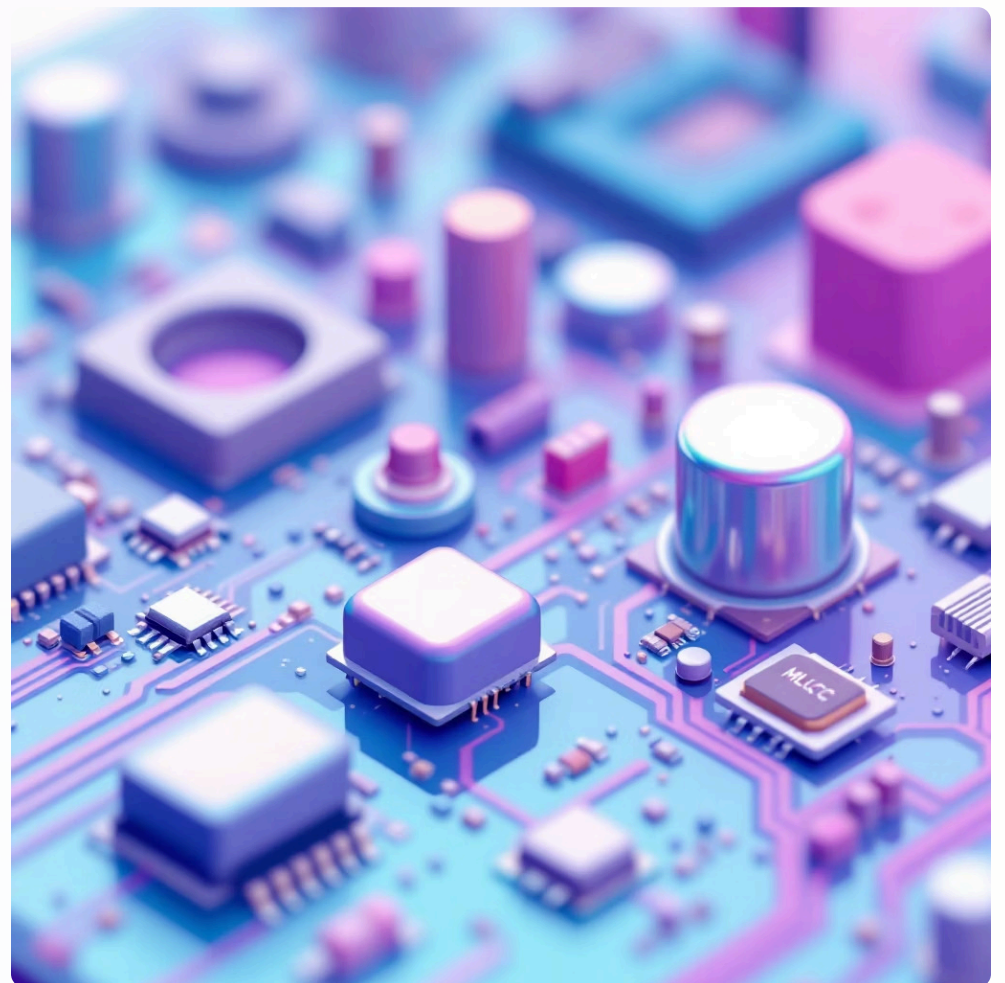
- **Small Form Factor:** Extremely compact **22mm x 9.5mm** size, designed for space-constrained applications.
- **Industrial Mounting:** Pre-drilled **3.4 mm (0.1339")** mounting hole optimized for secure **M3 clearance**.

Power Efficiency

- **Battery Optimized:** Ultra-low typical quiescent current of only **9 µA**, ideal for multi-year battery operation.

Signal Quality

- **Clean Signal Engineering:** Features a **Murata Ferrite Bead** for noise suppression and a **Samsung MLCC Capacitor** for power stability.



Pin Configuration and Functions

Pin Number	Name	Type	Description
1	Vcc	Power	Positive supply input (2.3 V to 5.5 V).
2	Gnd	Ground	Power supply ground.
3	Vo	Output	Linear analog voltage output proportional to temperature.

The sensor features a typical sensitivity of **10mV/°C** with a **500mV offset at 0°C**.

Temperature Calculation & Accuracy

3.1 Simple Linear Method

For most applications between -40°C and 120°C, a simple linear formula can be used to calculate temperature (T_A) from the output voltage (V_o):

$$T_A = \frac{V_o(mV) - 500}{10}$$

Note on High-Temperature Accuracy

The sensor exhibits slight non-linearity at temperatures above **120°C**. If the standard 10mV/°C sensitivity is used up to 150°C, the maximum error caused by this non-linearity will be approximately **2°C** at the 150°C limit.

High Precision Method (Piecewise Linearity)

If higher accuracy is required at elevated temperatures, use the Piecewise Linear Function or the Transfer Table provided in Section 4.

$$V_{OUT} = (T_A - T_{INFL}) \times T_C + V_{OFFS}$$

Where, VOUT = Output Voltage
Temperature Coefficient

TA = Ambient Temperature
VOFFS = Offset Voltage

TINFL = Inflection Temperature

Tc =

(Output Voltage)

Temperature Range (TA)	Voltage Range (VOUT)	TINFL (°C)	TC (mV/°C)	VOFFS (mV)
-40°C to +100°C	< 1500 mV	0	10	500
100°C to 125°C	1500 to 1752.5 mV	100	10.1	1500
125°C to 150°C	> 1752.5 mV	125	10.6	1752.5

Temperature vs. Output (Full Transfer Table)

This table compares the **Actual Piecewise Voltage** against the **Calculated Linear Voltage** (using a fixed 10mV/°C sensitivity) to show the expected error at higher temperatures.

Temp (°C)	Actual Piecewise Vo (mV)	Calculated 10mV/°C Vo (mV)
-40	100.0	100.0
-35	150.0	150.0
-30	200.0	200.0
-25	250.0	250.0
-20	300.0	300.0
-15	350.0	350.0
-10	400.0	400.0
-5	450.0	450.0
0	500.0	500.0
5	550.0	550.0
10	600.0	600.0
15	650.0	650.0
20	700.0	700.0
25	750.0	750.0
30	800.0	800.0
35	850.0	850.0
40	900.0	900.0
45	950.0	950.0
50	1000.0	1000.0

Temp (°C)	Actual Piecewise Vo (mV)	Calculated 10mV/°C Vo (mV)
55	1050.0	1050.0
60	1100.0	1100.0
65	1150.0	1150.0
70	1200.0	1200.0
75	1250.0	1250.0
80	1300.0	1300.0
85	1350.0	1350.0
90	1400.0	1400.0
95	1450.0	1450.0
100	1500.0	1500.0
105	1550.5	1550.0
110	1601.0	1600.0
115	1651.5	1650.0
120	1702.0	1700.0
125	1752.5	1750.0
130	1805.5	1800.0
135	1858.5	1850.0
140	1911.5	1900.0
145	1964.5	1950.0
150	2017.5	2000.0

Error Analysis at High Temperatures

The following table shows the **error in millivolts** when using the simple linear method versus the actual piecewise voltage output:

Temperature (°C)	Error (mV)
-40 to 100	0.0
105	0.5
110	1.0
115	1.5
120	2.0
125	2.5
130	5.5
135	8.5
140	11.5
145	14.5
150	17.5

As shown, the error remains **zero up to 100°C** and increases progressively at higher temperatures, reaching a maximum of **17.5 mV** (approximately **2°C**) at 150°C.

Layout & Mechanical Guidelines

1

Thermal Interface

Apply a thin layer of thermal grease to the aluminum back for maximum heat transfer.

2

Design Note

The module includes **sufficient extra free area** specifically intended to act as a heat-spreader, ensuring the sensing element reaches equilibrium with the target surface as quickly as possible.

3

Dimensions

22.00 mm x 9.5 mm.

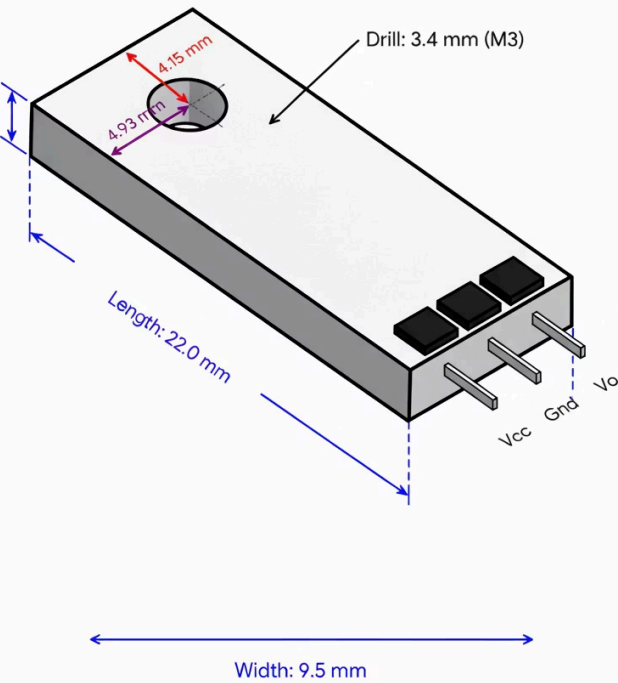
4

Mounting

Pre-drilled **3.4 mm** (0.1339") hole for standard M3 clearance.

 **NOTE:** For applications requiring operation at high temperature, it is recommended to remove the plastic header connector and directly solder **silicone-insulated wires** to the pads, as silicone wire can withstand much higher temperatures without degradation.

ALU-QUICK 111 Mechanical Layout
(Dimensions & Pin Connections)



Quality & Manufacturing

Designed and Manufactured in India

Verified Authentic Components Guarantee

Every **SwiftSense T235** module is built with genuine components from trusted manufacturers:(choose to work at 150 °C)

- **Texas Instruments** analog sensor TMP235 A2
- **Murata** ferrite bead
- **Samsung** MLCC capacitor



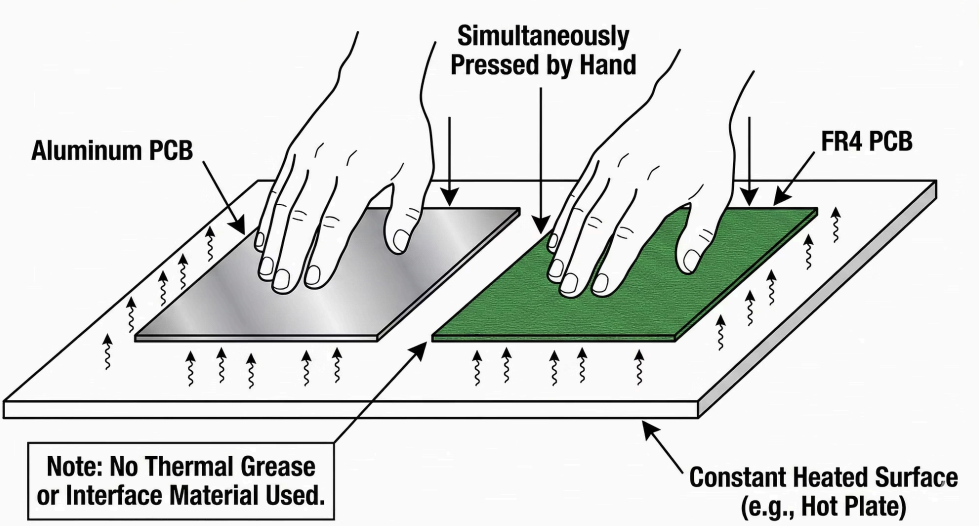
Performance Benchmark: The Aluminum Advantage

This technical note quantifies the thermal response speed and steady-state accuracy of Ramanu Systems SwiftSense T235 sensor modules mounted on aluminum (MCPCB) versus standard FR4 PCB substrates. The benchmark simulates real-world dry mounting conditions without thermal interface materials, providing critical data for engineers evaluating sensor mounting strategies in thermal-critical applications.

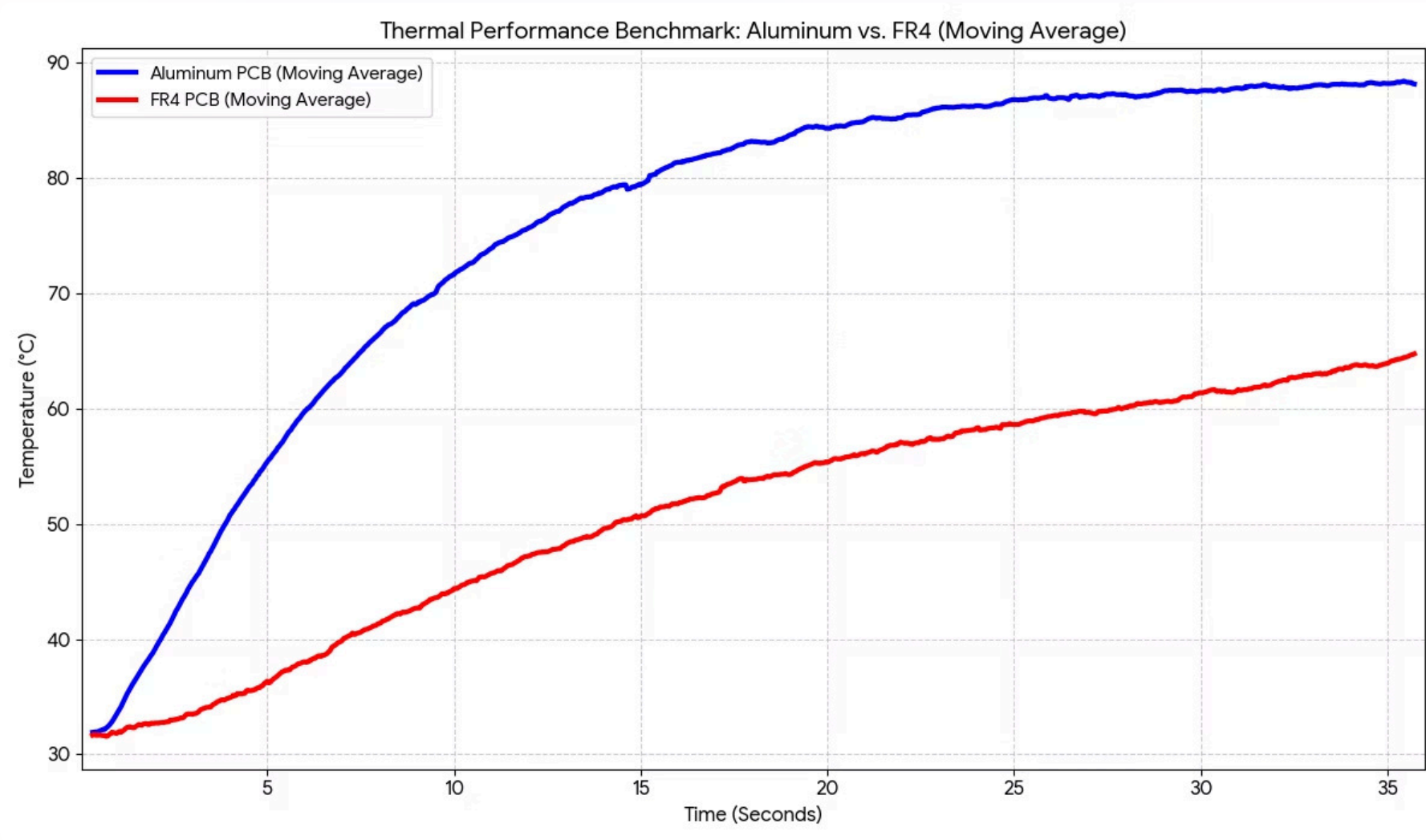
Experimental Setup

Test Configuration

To replicate field deployment scenarios where thermal grease may be unavailable, both aluminum and FR4 PCB sensors were simultaneously pressed onto a constant temperature hot plate surface 90°C with equal hand pressure. Data acquired at sampling rate of 40ms intervals, capturing the complete thermal transition profile from ambient to steady-state conditions.



Step-Response Benchmarking Procedure



Transient Thermal Step-Response: Aluminum vs. FR4

The Thermal Gap: Understanding Substrate Performance



Aluminum: High-Efficiency Heat Spreader

The aluminum substrate overcomes contact resistance rapidly, functioning as an integrated thermal conductor. It reaches 63% of target temperature in just 7.4 seconds and stabilizes at 88.22°C—within 2°C of the 90°C source temperature, demonstrating exceptional measurement fidelity.



FR4: Thermal Insulation Barrier

FR4 fiberglass acts as an insulator rather than a conductor. The slow, linear temperature rise flatlines at 64.05°C because ambient heat loss exceeds board-conducted thermal energy. This 24°C deficit represents a critical measurement error in time-sensitive applications.

Performance Results

7.4s

Aluminum Response Time

Time to 63% of target temperature

14.6s

FR4 Response Time

Nearly 2× slower thermal transition

88.2°C

Aluminum Accuracy

Within 2°C of 90°C source

64.1°C

FR4 Accuracy

24°C thermal measurement gap

Performance Metric	Ramanu Aluminum PCB	Standard FR4 (No Vias)
Response Speed (τ)	7.40 seconds	14.56 seconds
Stabilized Temperature	88.22°C	64.05°C
Curve Characteristic	Logarithmic (Fast Transition)	Linear (Heavily Lagged)

Engineering Conclusion: Why Aluminum Substrates Are Critical

For industrial thermal monitoring applications, substrate selection directly impacts system safety and response capability. The choice between aluminum MCPCB and standard FR4 is not merely a cost consideration—it fundamentally determines whether your thermal monitoring system can detect critical temperature events before component failure occurs.



Critical Speed Advantage

Detects temperature spikes 2× faster than FR4, providing crucial early warning in transient thermal events common in motor drives and battery management systems.



Measurement Integrity

Delivers readings 24°C closer to true source temperature in dry-mounting scenarios, ensuring accurate thermal characterization without thermal interface materials.



Safety Assurance

Ideal for motor controllers, battery packs, and power electronics where a 7-second detection delay versus 15 seconds could mean the difference between controlled shutdown and catastrophic thermal runaway.

ALU-QUIC 111 Temperature Sensor Module: Specifications Overview

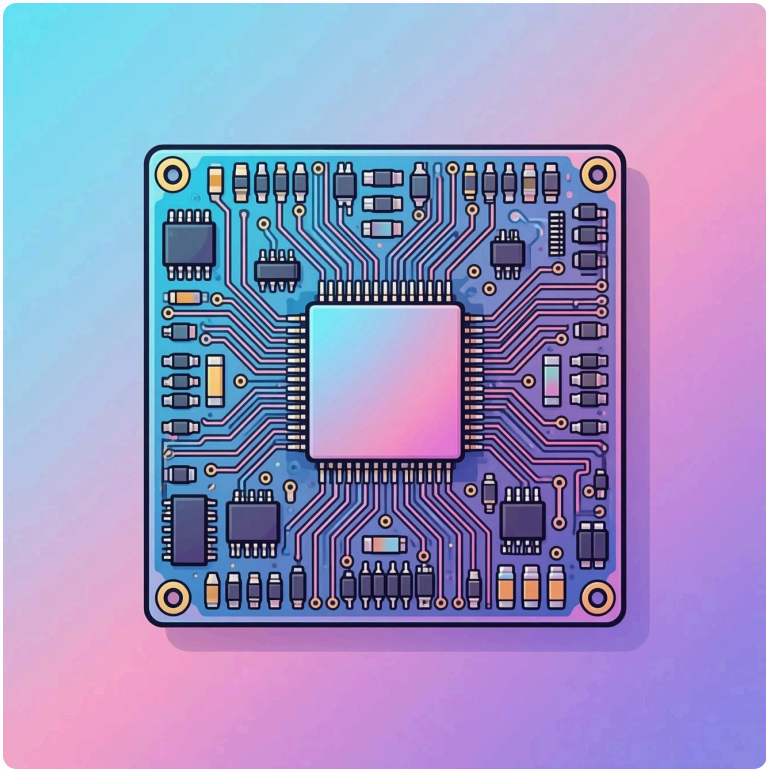
The sensor module delivers precise temperature measurements across extreme industrial environments. Understanding the operational envelope ensures optimal performance and longevity in demanding applications.

		
<div>Measurement Range</div> <div>-40°C to +150°C</div> <div>Full sensing capability of the TMP235 across the complete industrial temperature spectrum.All component choosen to work at +150°C</div>	<div>Max Continuous Temp</div> <div>130°C</div> <div>Recommended for 24/7 operation to ensure maximum PCB lifespan in continuous monitoring applications.</div>	<div>Peak Exposure Temp</div> <div>150°C</div> <div>Supports intermittent and short-term measurements above 130°C for process monitoring and peak detection.</div>

Critical Specifications

These three parameters define the thermal operating envelope for reliable sensor deployment. The measurement range represents the sensor's full capability, while the maximum continuous temperature establishes the boundary for extended operation without accelerated aging.

Peak exposure ratings enable flexible application design, accommodating transient thermal events and intermittent high-temperature measurements without compromising overall system reliability.



Optimizing Sensor Longevity

Engineered Precision

The **SwiftSense T235** delivers precise measurements up to **150°C** across all industrial sensing applications.

Recommended MOT

Maximum continuous operating temperature of **130°C** for 24/7 industrial deployment ensures optimal substrate longevity.

Operating Guidelines for Extended Service Life

To maximize the service life of the Aluminum PCB substrate, we recommend a maximum continuous operating temperature (MOT) of **130°C** for 24/7 industrial applications. This guideline balances performance with long-term reliability in demanding production environments.

 **Intermittent High-Temperature Operation:** The module is fully capable of operating above 130°C for intermittent sensing or process monitoring applications. However, prolonged continuous exposure to temperatures near 150°C may gradually accelerate the aging of the PCB dielectric layer.

Standard Applications

- Continuous monitoring at $\leq 130^{\circ}\text{C}$
- 24/7 production environment sensing
- General industrial temperature control
- Standard PCB substrate configuration

High-Temperature Applications

- Intermittent measurements up to 150°C
- Process monitoring with thermal cycling
- Peak detection in transient environments
- High-Tg substrate options available

For mission-critical tasks requiring permanent 150°C immersion, please contact our engineering team for High-Tg substrate options. These specialized configurations provide enhanced thermal stability for extreme continuous-duty applications.

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