Product Overview

Ultra-Small Temperature Sensor Comparison Guide

Emerging applications such as augmented reality/virtual reality (AR/VR) headsets, personal electronics, and medical wearable devices such as continuous glucose monitors (CGM) PCBs drive the need for ultra-small temperature sensors. Minimizing the footprint of integrated circuits in these applications improves thermal response by reducing the thermal mass of the device.

TMP110 and TMP112D are TI's first X2SON-packaged temperature sensors. This package improves response time, saves space, and allows closer placement to the heat source due to the smaller form factor compared to a non-chip-scale package. TMP118 is the smallest temperature sensor in a ball grid array (BGA) wafer-level chip-scale package (WCSP), setting a new industry standard for ultra-small size. TMP114, the thinnest sensor in TI's portfolio, is designed for applications requiring minimal height, such as under-component temperature sensing.

These sensors enhance performance and efficiency in space-constrained applications. Figure 1 shows where these devices fit within TI's portfolio, highlighting advancements in size and accuracy. Table 1 lists the key specs to facilitate a quick comparison overview.

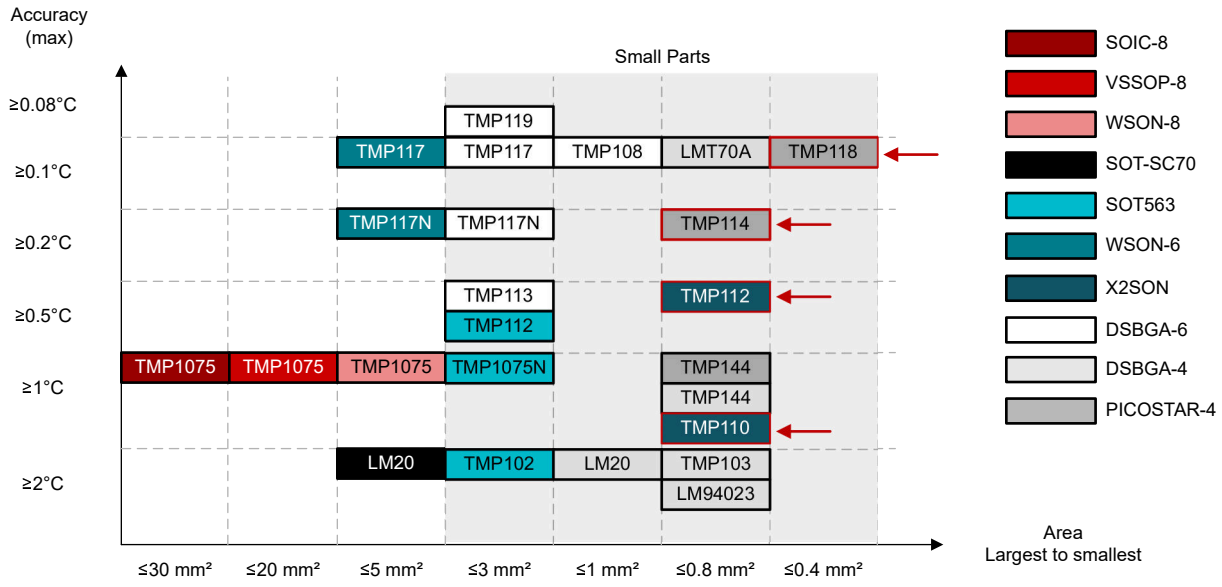

Figure 1. Overview of the Smallest-Sized Temperature Sensors

From Figure 1, there are a few devices to highlight:

- TMP118 is the smallest device with an area of 0.61mm × 0.55mm x 0.23mm.
- TMP114 and TMP144 are the thinnest device with a maximum height of 150µm.
- TMP112, TMP102, and TMP1075N come in the smallest leaded plastic package SOT563 (1.6mm × 1.6mm).
- TMP112D and TMP110 are available in the smallest package X2SON (0.8mm × 0.8mm).

Table 1 shows a comparison of key specifications of a device versus others in TI's portfolio.

Table 1. Key Specifications Comparison For Digital Temperature Sensors

Device	Interface	MAX Accuracy	Package	Area (mm × mm)	MAX Height (µm)	Power Supply Range	Shutdown Iq (typical)	Q100 Available
TMP118	I2C	0.1°C	PICOSTAR-4	0.610 × 0.550 = 0.336	230	1.4V to 5.5V	0.10µA	No
TMP114	I2C	0.2	PICOSTAR-4	0.760 × 0.760 = 0.578	150	1.08V to 1.98V	0.16µA	No
TMP103	I2C	2°C	DSBGA-4	0.760 × 0.760 = 0.578	625	1.4V to 3.6V	0.50µA	No
TMP112D	I2C	0.5°C	X2SON-5	0.800 × 0.800 = 0.640	400	1.4V to 3.6V	0.15µA	Yes
TMP110	I2C	1°C	X2SON-5	0.800 × 0.800 = 0.640	400	1.14V to 5.5V	0.15µA	Yes
TMP144	UART	1°C	PICOSTAR-4	0.760 × 0.960 = 0.7296	150	1.4V to 3.6V	0.50µA	No
TMP108	I2C	0.75°C	DSBGA-6	1.186 × 0.786 = 0.932	625	1.4V to 3.6V	0.30µA	No
TMP113	I2C	0.5°C	DSBGA-6	1.490 x 0.950 = 1.4155	525	1.4V to 5.5V	0.07µA	No
TMP119	I2C	0.08°C	DSBGA-6	1.488 × 0.950 = 1.414	525	1.7V to 5.5V	0.15µA	No
TMP117	I2C	0.1°C	DSBGA-6	1.488 × 0.950 = 1.414	531	1.8V to 5.5V	0.50µA	No
TMP112	I2C	0.5°C	SOT563	1.600 × 1.600 = 2.56	600	1.4V to 3.6V	0.15µA	Yes

Commonly Used Packages

Figure 2 shows a visual representation of how different package sizes compare in a PCB layout.

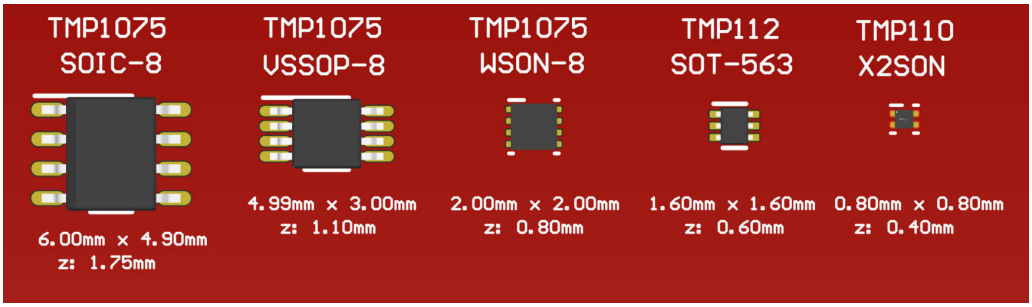

Figure 2. Device Size Comparison: Commonly-Used Packages

As seen in the figure above, the X2SON package is considerably smaller than the common packaged temperature sensors. As reference, Figure 3 shows the X2SON package compared to chip-scale devices on a PCB layout along with the smallest leaded package SOT-563.

Figure 3. Device Size Comparison: Chip-Scale Devices (Topside View)

Figure 4 shows an angled view of the chip-scale devices size comparison highlighting the package name, the device used for the comparison, and the maximum height of it.

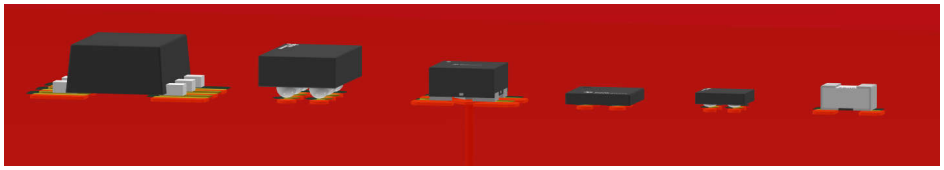

Figure 4. Device Height Comparison: Chip-Scale Devices (Angled View)

Multisourcing SOT-563 and X2SON-5 Packages

As TMP112 and TMP110 are fully software-compatible, it is important to note that, while they are not pin-to-pin compatible due to the differences between footprints, the end user may still layout the device in such a way that SCL and SDA are stacked on top of each other in cases where multisourcing is required. This layering solution helps reduce the total footprint of an SCL/SDA trace stackup method.

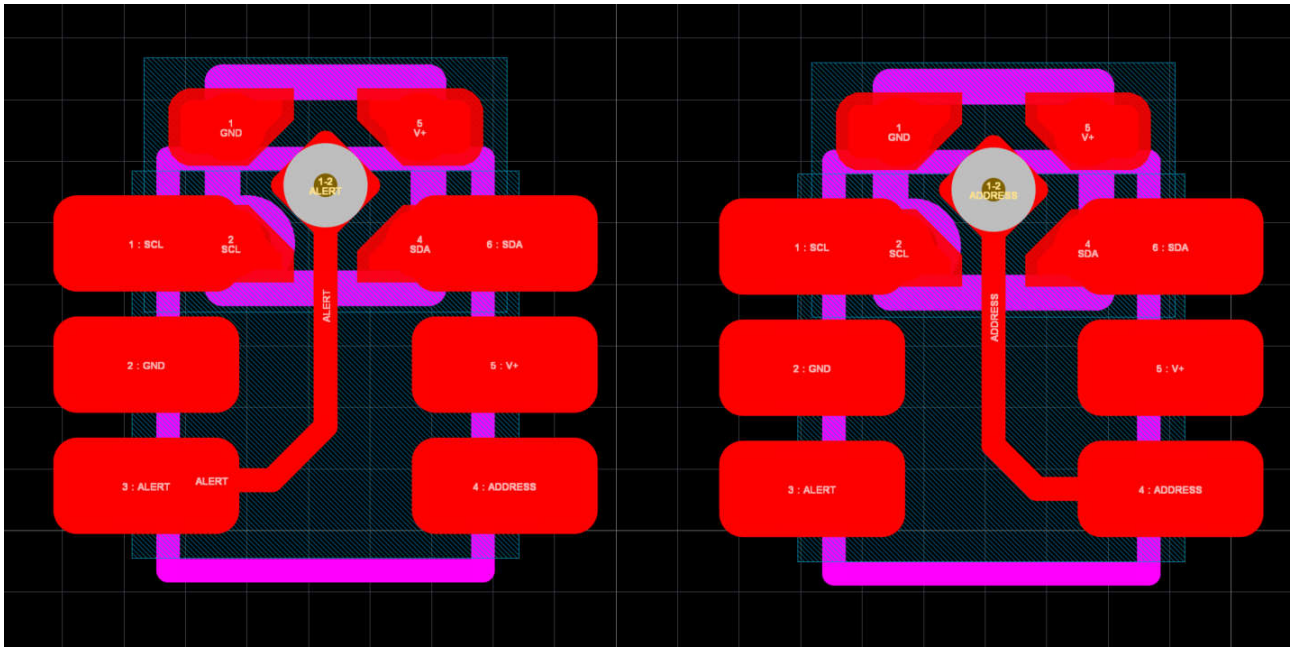

Figure 5. SOT-563 and X2SON-5 Alert and Address Multisourcing Layout

Comprehensive Overview

Table 2 shows a comprehensive overview of TI's portfolio of local temperature sensors in terms of package and performance over multiple interfaces. Table 3 serves as a reference for picking the right device, according to the end application needs.

Table 2. Featured Devices

Interface	Smallest Leaded Device	Smallest Surface Mount Device	Smallest Chip Scale Device	Thinnest Chip Scale Device	Highest Accuracy
Digital	TMP102 TMP112 TMP1075N	TMP110 TMP112D	TMP118	TMP114 TMP144	TMP119
Analog	TMP20	LM57 LM26LV	LMT70 LM94023	LMT70 LM94023	LMT70

Learn More

- Learn about the recommended layout practices and considerations when designing with X2SON packages.
- Learn more about monitoring ambient and PCB temperature with the Guide to monitoring ambient and PCB temperature using surface-mount devices.
- Refer to the LM75B and TMP1075 Industry-Standard Devices: Design Guidelines and Spec Comparison application note for more information on compatibility.
- To learn about decoding binary codes for temperature sensors, refer to How to Read and Interpret Digital Temperature Sensor Output Data.
- Learn about the effect of thermal mass in thermal response by looking at Analyzing Thermal Response in High-Accuracy Temperature Sensors.

Choosing the Right Device

Table 3. TI X2SON Temperature Sensors

Generic Part Number	Orderable Part Number	Center Pad	Address (7-bit format)
TMP110	TMP110D0IDPWR	ALERT	0x48
	TMP110D1IDPWR		0x49
	TMP110D2IDPWR		0x4A
	TMP110D3IDPWR		0x4B
	TMP110DIDPWR	ADDRESS	0x40, 0x41, 0x42, 0x43
TMP112D	TMP112D0IDPWR	ALERT	0x48
	TMP112D1IDPWR		0x49
	TMP112D2IDPWR		0x4A
	TMP112D3IDPWR		0x4B
	TMP112DIDPWR	ADDRESS	0x40, 0x41, 0x42, 0x43

For additional assistance, ask questions to TI engineers on the TI E2E Sensors Support Forum.

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