Product Overview

TI Space Qualified Temperature Sensor Product Selection Guide

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TI space grade devices have varying levels of radiation tolerance levels to support low Earth orbit, medium Earth orbit, and geosynchronous orbit missions. Different missions can have various radiation requirements, depending on the distance away from Earth and how long the mission is. This product overview provides space temperature designs that Texas Instruments can offer, insights in the importance of the options available, and guidance in making best decisions in what space devices customers need to incorporate into their system. TI.com offers Space Enhanced Plastic (SEP), Radiation-hardened (SP) QMLP, and Radiation-hardened QMLV qualified temperature sensors. TI's diverse portfolio provides different size options, plastic vs ceramic, and different radiation tolerated options to choose from. Customers need to consider location of the system in space, understand the radiation requirement the system is aiming to pass, the cost willing to spend, size and surface area willing to use, and the risks before choosing a space device.

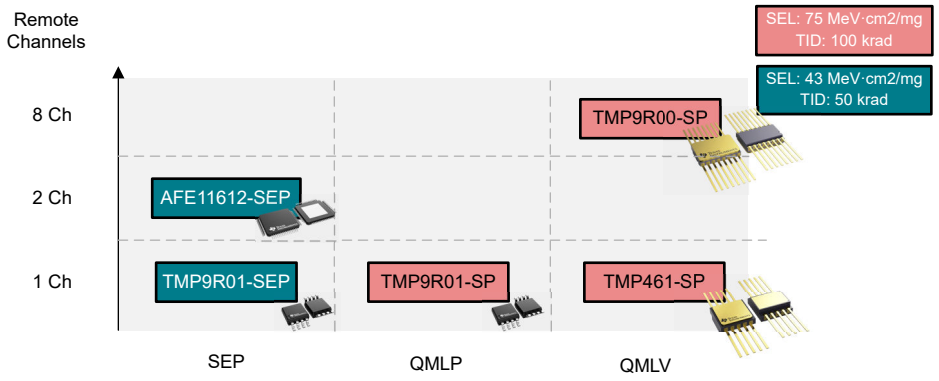

Figure 1. Temperature Space Portfolio

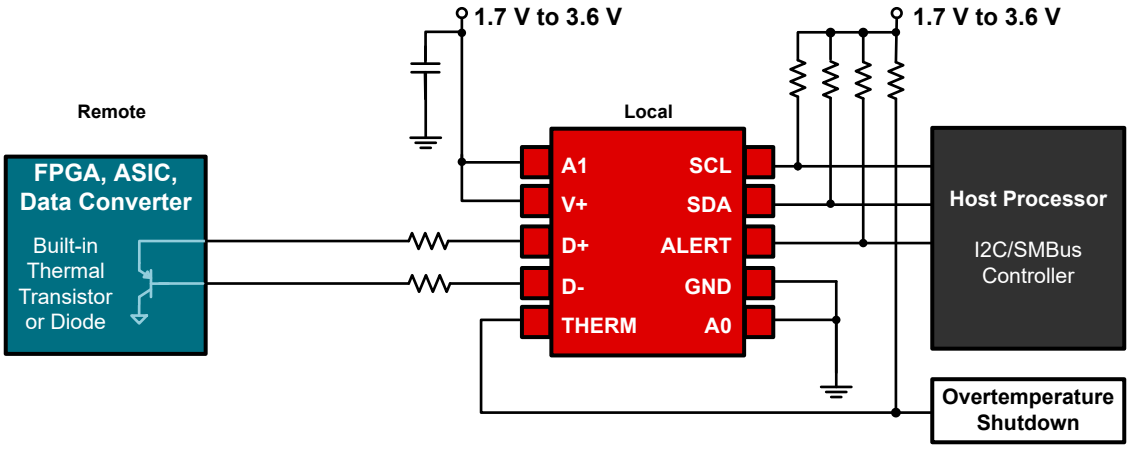

Figure 2. TMP9R01-SEP-SP Application

Space Temperature Sensor Comparison

To assist with making an informed decision, the following table provides a detailed comparison of the temperature designs that TI has. Size has an impact on what can be selected in your design. The following photos show a size comparison of our SP and SEP devices. The operating temperature conditions for all of our space devices range from -55C to 125C.

Table 1. SP and SEP Device Spec Comparisons

Device	Military Spec	Qualification Level	TID Char. (krad)	TID RLAT (krad)	SEL (MeV·cm2/mg)	Number of Channels	Local Maximum Accuracy	Remote Maximum Accuracy	Supply Voltage	Shutdown Iq (typical)	Package	Size (mm)	Interface	Bit Temperature Capable Range
TMP9R00-SP	5962-20214	QMLV-RHA	100	100	75	1 Local 8 Remote	1.5C	2C	1.7 to 2V	300µA	CFP (16)	10.16mm X 7.10mm X 2.13mm	I2C, SMBus, 2-Wire	-256 to 255.9375 C
TMP461-SP	5962-17218	QMLV-RHA	100	100	76	1 Local 1 Remote	2C	1.5C	1.7 to 3.6V	350µA	CFP (10)	7.02mm X 6.86mm X 2.62mm	I2C, SMBus, 2-Wire	-64 to 191C
TMP9R01-SEP	V62/24615	Rad Tolerant	50	30	43	1 Local 1 Remote	2C	1.5C	1.7 to 3.6V	350µA	VSSOP (10)	3mm X 3mm X 0.4mm	I2C, SMBus, 2-Wire	-64 to 191C
TMP9R01-SP	5962-17218	QMLP-RHA	100	100	75	1 Local 1 Remote	2C	1.5C	1.7 to 3.6V	350µA	VSSOP (10)	3mm X 3mm X 0.4mm	I2C, SMBus, 2-Wire	-64 to 191C
AFE11612-SEP	V62/22614	Rad Tolerant	50	20	43	1 Local 2 Remote	4.5C	6C	2.7 to 5.5V	1.6mA	HTQFP (64)	10mm X 10mm X 1.2mm	I2C, SPI	-256 to 255.875C

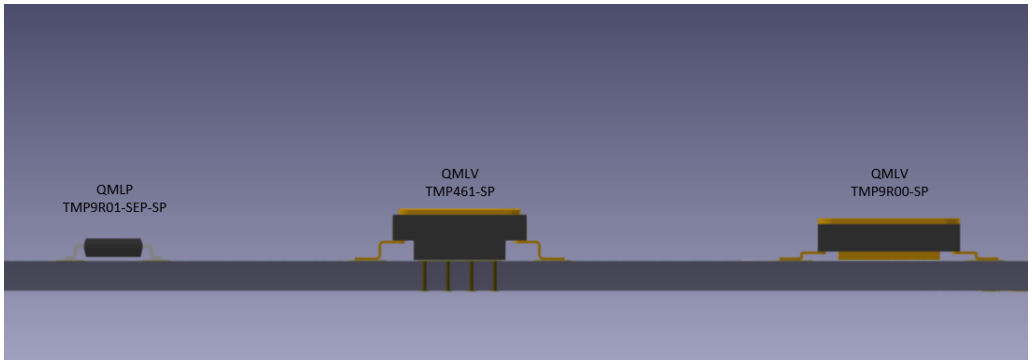

Figure 3. Height Comparison

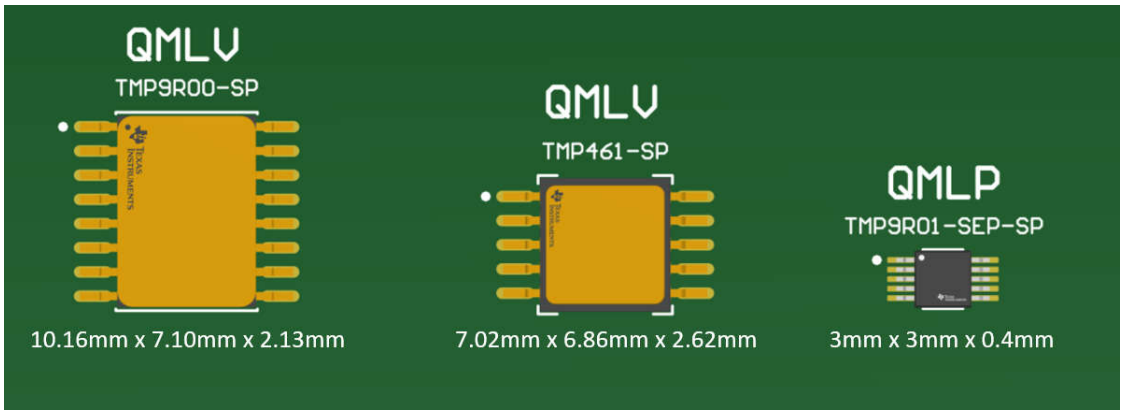

Figure 4. Size Comparison

Orderable Part Number (OPN) Selection

Often there is confusion with SMD and military part numbers and the associated manufacturer part numbers. Understanding the naming conventions can enhance overall efficiency and reduce errors of receiving the incorrect items. One key requirement that our space customers request for is to meet Military Standard DLA requirements MIL-PRF-38535, and MIL-STD-883. Our Space IC OPN follow and matches these Military Standards. Defense Logics Agency (DLA) is an agency within the Department of Defense (DoD) that monitors all electronics that are created primarily for military applications. A Standard Microcircuit Drawing (SMD) and the Military Part Number is created for all TI QML-qualified space products. The following table provides a general understanding of Space OPN naming conventions. For more information about naming conventions please refer to *DLA Standard Microcircuit Drawings (SMD) and JAN Part Numbers Primer*, application note.

Table 2. OPN Description

Term	Description	Example
Engineering Model (EM)	Orderable ending with /EM or MPR under same GPN. Tested at 25C only and does not receive full space processing (such as burn in).*TI Engineering Evaluation Units vs. MIL-PRF-38535 QML Class V Processing (Rev. A)*	TMP461HKU/**EM** TMP9R00HKT/**EM**
Flight Part - QMLV	Space grade qualification. DLA spec (MIL-PRF-38535)/flow all space parts must use. Specific to hermetic parts (ceramic package), and includes extra testing like Wafer Lot Acceptance (including life test and SEM by wafer lot), tightened precap visual inspection, x-ray, and PIND. Flow in key links	5962-1721801VXC
Flight Part - QMLV-RHA	Radiation Hardness Assured. Radiation capability (TID) of a part is designed for by testing on each wafer or wafer lot. Full price orderables that are fully space qualified. Start with a 5962Yxxxxxx. “Y” represents level of radiation hardness. R = 100krad; L = 50krad; F= 300krad	5962**R**1721801VXC **5962**R2021401VXC

Location of the System

The further away the system is from the earth surface, the higher the probability your system can be exposed to radiation. Three defined areas include Low Earth Orbit (LEO), Medium Earth Orbit (MEO), and Geostationary Orbit (GEO). Where LEO has a 100-2,000 km altitude, MEO has a 5,000-10,000 km altitude, and GEO has a 35,800 km altitude. Please refer to the *Radiation Handbook for Electronics* (page 4) for more information about the space radiation environment. If the system is in the LEO orbit, SEP products tends to be favored. If the system is in the GEO/MEO orbit, SP products tends to be favored.

Radiation Requirements and Risks

There are two levels to which TI temperature sensor space products are characterized under: Space EP (SEP) for LEO applications, and Space grade (SP) for GEO/MEO applications. All TI sensor space classifications and the requirements are listed in TI's Space product page. Key differences between the space selection is packaging, bondwire, radiation levels, and Outgassing tests. The two main tests are preformed for space qualification are Single Event Effects (SEE) and Total Ionizing Dose Effects (TID). SEE tests the effect on the device due to a single particle of a radiation strike. TID tests long-term exposure of radiation effects on the device. GEO/MEO space missions look for an SEE level of greater than 60MeV. LEO missions generally only need less than 43MeV. TID is the amount of accrued charged particle radiation over time during a mission. Most LEO missions require 30krad or less, while deep space missions can require up to 300krad. For RHA devices, TID is tested on a sample of units from every assembly lot. The combination of SEE and TID results can provide the information to predict how the device can preform in space. TI follows MIL-STD-883 Test Method 1019 for radiation tests. See TI's Part Rating page.

Table 3. SEP and SP

Products	Description
Radiation Tolerant (-SEP)	Plastic, small size, cost effective design that provides the following: • Radiation SEE and TID Reports • One Wafer Fabrication Site • One Assembly and Test Site • Gold Bond Wire, NiPdAu Lead Finish • Wafer Lot Traceability • Extended Product Life Cycle • Extended Product Change Notification • Vendor Item Drawing (VID) Example: V62/21610 • Military Temp Range (-55°C to 125°C) • Outgassing can occur due to the plastic packaging. Outgassing data is provided. Meets NASA's ASTM E595 Outgassing Spec
Radiation Hardness Assured (-SP)	An advancement to SEP products as they make sure of larger radiation performance. Follows MIL-PRF-38535 **QMLP:** Sealed in plastic packaging. Outgassing can occur. Outgassing data is provided. **QMLV:** Ceramic packaging are hermetically sealed and have no outgassing. Large thermal mass and surface area space.

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