APPLICATION NOTE

Sensata Technologies

SENSATA HERMETIC THERMAL SWITCHES USED IN SPACE-CRAFT THERMAL CONTROL SYSTEMS

NASA G311P641/02, G311P641/05, G311P641/06, G311P641/07

Background

Thermal control systems are essential to keep all equipment within an acceptable temperature range throughout all mission phases on satellites, space rovers, and manned space exploration vehicles. Space craft equipment design temperatures vary from -270°C up to +125°C. Most systems are significantly less reliable when operated outside their designed operating temperature limits. Propellants, such as hydrazine can freeze. Instruments, antennas, and camera alignment accuracy is dramatically impacted. Flex circuits can become brittle and fracture. Other components can be damaged by extensive thermal cycling. Thermal control subsystems can be comprised of both passive and active elements. These elements work in conjunction to either protect equipment from overheating or extreme cold. Equipment can overheat from external heat fluxes generated by the Sun or planetary infrared and albedo flux, or as a result of improper heat removal from internal sources such electronic equipment. Equipment can also become too cold if in the shadow of a planet or moon, or if the equipment is operating in deep space.

Since the earliest days of the US space program, thermal designers count on the reliability and range of Sensata hermetic thermal switches.

Active thermal control components include resistive heaters, single phase fluid transfer loop with a pump, two phase fluid transfer loops, moveable louvers which open and reject heat, and thermoelectric coolers. These active thermal control components are often coupled with passive elements to provide a complete system. Designers must consider the operating temperature range and survival temperature range. They also must consider temperature stability and uniformity, as well as switch on temperatures.

Solution

Since the earliest days of the US space program, thermal designers have counted on the reliability and range of Sensata KLIXON® hermetically sealed bi-metallic thermal switches. They are the ideal solution for controlling space vehicle active thermal control subsystems. Sensata hermetic thermal switches are qualified products per MIL-PRF-24236, which are further screened to NASA Goddard S-311-P641. This NASA document and detailed specifications establish the general requirements for thermostatic switches intended for use in space environments and sets forth additional screening beyond that required by MIL- PRF-24236.

The Sensata thermal switch product portfolio allows designers to meet specific needs for the thermal mangement systems for almost any mission. The 11041 series (G311P641/05) allows for the widest temperature range and current handling capability. The M2 series (G311P641/02) provides extremely tight temperature control with tolerances as small as 2 to 4°F. Finally, the 3BT (G311P641/07) and 4BT (G311P641/06) thermostats provide the smallest and lightest hermetically sealed thermal switches available in the marketplace. All Sensata hermetically sealed bi-metallic thermostats feature destined for use on space vehicles are subjected to additional screening steps. During assembly, components undergo millipore cleaning and inspection. Pre-cap inspection is performed before each thermostat is backfilled with dry nitrogen and sealed. Each thermostat is Helium leak tested on a mass-spectrometer to ensure a maximum leak rate of 1 x 10^-8 cc Helium/second. After verifying set point calibration, creep, DWV, and insulation resistance, each thermostat undergoes mechanical run-in, vibration screening, and PIND testing. Following successful completion of all screening tests, initial performance characteristics are verified. Each thermostat ships with an end item data packet that includes a copy of the characteristic sheet, including actual calibration set points, screening data, and a certificate of conformance.

RECOMMENDED PRODUCTS

Product	Features	Function	Brand
11041 (G311P641/05)	• Temp Range: -55°F to +550°F (-48.3°C to +287.8°C) • Temp Tolerance: as low as to +/-3°F (+/-1.7°C) • Differential: as low as 12°F (6.7°C) • Contact Rating: 100,000 cycles at 5A, 30VDC	Temperature Control	Sensata Technologies

M2
(G311P641/02)
	• Temp Range: -40°F to +235°F (-40.0°C to +112.8°C)
	• Temp Tolerance : as low as +/-3°F (+/-1.7°C)
	• Differential : up to 2°F to 4°F (1.1°C to 2.2°C) with respect to the close temperature
	• Contact Rating:
	  • 250,000 cycles at 2A resistive, 30VDC/120VAC
	  • 50,000 cycles at 3A resistive, 31VDC
		Temperature Control	Sensata Technologies

4BT (G311P641/06)	• Temp Range: -30°F to +365°F (-34.4°C to +185°C) • Temp Tolerance : +/-8°F (+/-4.4°C) • Differential : 30°F (16.7°C) • Contact Rating: 10,000 cycles at 1A, 30VDC/115VAC, 10,000 cycles at 10mA, 30mVDC/30mVAC	Temperature Control	Sensata Technologies
3BT (G311P641/07	• Temp Range: -30°F to +365°F (-34.4°C to +185°C) • Temp Tolerance : +/-8°F (+/-4.4°C) • Differential : 30°F (16.7°C) • Contact Rating: 10,000 cycles at 1A, 30VDC/115VAC, 10,000 cycles at 10mA, 30mVDC/30mVAC	Temperature Control	Sensata Technologies

Notes:

1. All contact ratings are shown are based on Sensata standard differential between the open and close temperatures
2. For PIND testing at temperatures below 0°F, consult factory.

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