R500
Ruthenium Oxide Temperature Sensor

Cryogenic Control Systems, Inc.

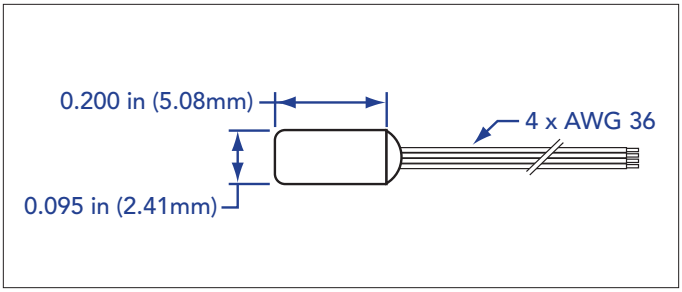
General Description

The R500 Ruthenium Oxide temperature sensor is a Thick-Film resistance temperature sensor that is designed primarily for ultra-low temperature operation. They feature high interchangeability by conforming to a standard calibration curve. Additionally, they are useful in high magnetic fields.

Applications

- **Dilution refrigerators**
- **Helium 3 refrigerators. High sensitivity / low resistance at 200mK**
- **Low temperature super-conducting magnet systems.**

Packaging



Construction: Gold-plated cylindrical OHFC copper canister, Stycast® epoxy filler. There is no internal atmosphere. Epoxy limits the maximum storage temperature to 400K.

Leads: Four, 36 AWG, Phosphor-Bronze, color coded. Formvar® insulation.

Mass: 0.4g.

Installation: Use a 0.101" diameter drill. Place a small amount of Apiezon® N grease in the hole before inserting the sensor. Ensure that the leads are thermally anchored.

Features

- **Temperature range:** <50mK to 40K.
- **High Sensitivity.**
- **Ultra-low Temperature use:** High sensitivity and relatively low resistance below 1K.
- **Interchangeability:** Conforms to a standard curve without special calibrations.
- **Magnetic Field Dependence:** Extremely low. Useful in magnetic fields to 16T with a small but predictable temperature shift.
- **Extremely stable:** Minimum long-term drift
- **Very low susceptibility to ionizing radiation.**

Specifications

Useful Temperature Range: 50mK to 40K.

Standard Curve: Cryo-con R-500.

Temperature Coefficient: Negative

Leads: 36AWG Phosphor-Bronze. Four-lead color-coded cryogenic ribbon cable, 24", Other lengths available by special order.

Lead Resistance: 10Ω/m

Recommended Excitation

Constant-Voltage AC excitation only.
Above 1.5K: 10mV.
1.0K to 200mK: 1.0mV to 100μV
200mK to 100mK: 100μV to 20μV
100mK to5 0mK: 20μV to 10μV

Maximum Storage Temperature: 400K

Maximum excitation current: 3.0mA

Thermal Response Time: 0.5S at 4.2K

Use in Radiation: Recommended for use in ionizing radiation environments.

Magnetic Field Dependence: See graph below.

Maximum Storage Temperature: 400°C.

Connection:

All connections should be 4-wire in order to eliminate errors due to lead resistance.

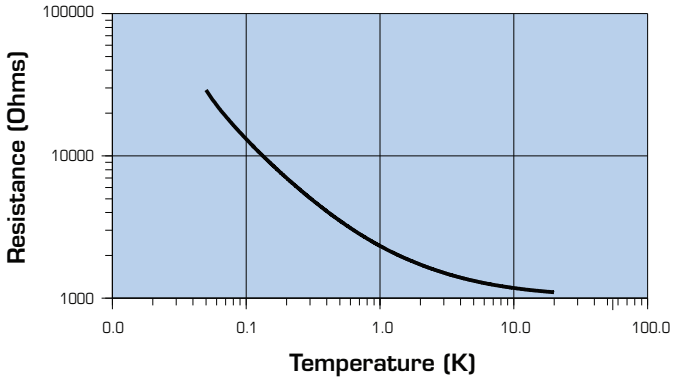
Leads are coated with Butyl and may be separated by dipping them in Isopropyl Alcohol.

Lead insulation is heavy Formvar® which is difficult to strip. Techniques include use of a mechanical stripper or scrapping with a razor blade.

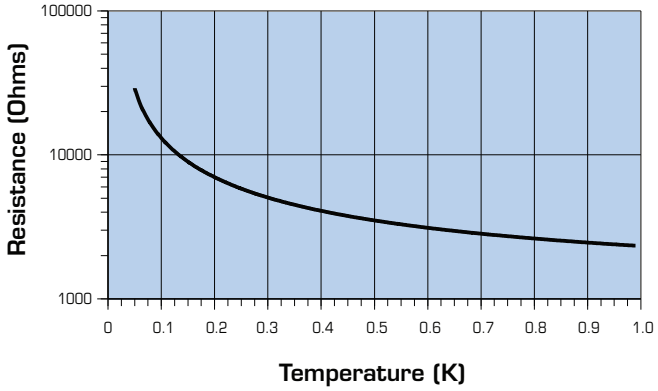
Cable Color Code	
V+	Clear
V-	Green
I+	Black
I-	Red

Typical Performance Charts

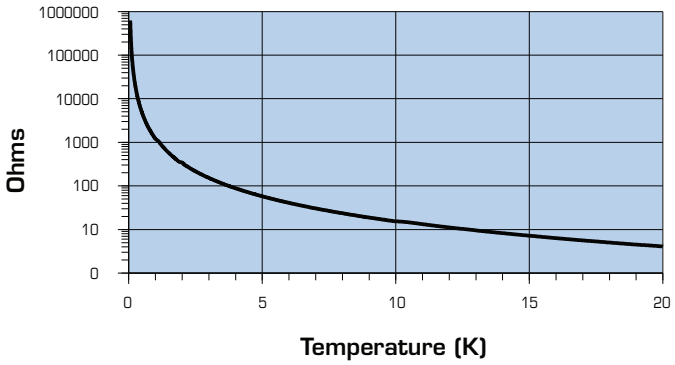
Temperature Response



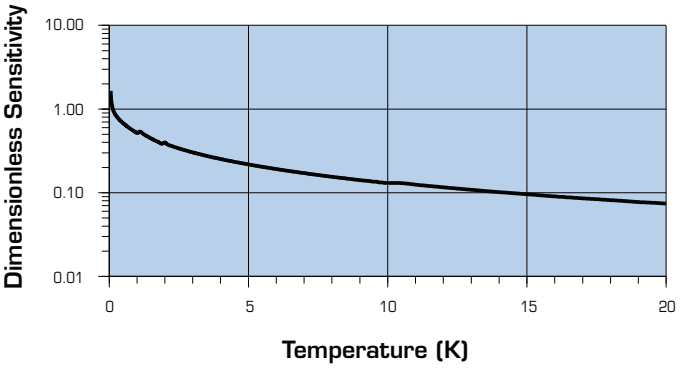
Temperature Response Below 40.0K



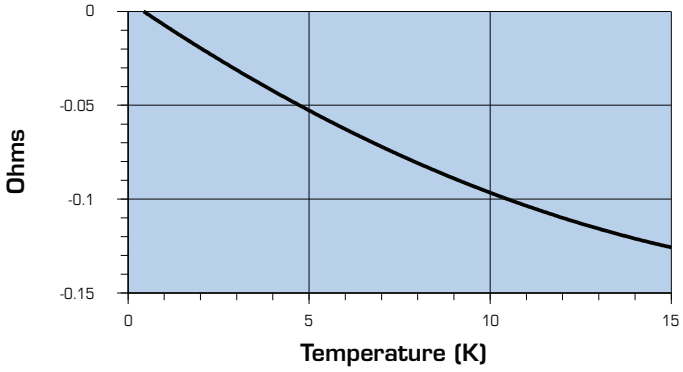
Sensitivity (Ohms/K)



Dimensionless Sensitivity (T/R0)(dR/dT)



Temperature Dependence in Magnetic Fields
T = 50mK to 4.2K



Typical Temperature Response

T(K)	R(Ω)	S(Ω/K)
20	1100	4.08
5.00	1325	58
1.00	2327	1203
0.500	3503	4760
0.200	6996	30943
0.100	13115	145658
0.050	29072	628083

Accuracy / Calibration

	50mK	1.5K	4.2K	20.0K
Group A	±10mK	±60mK	±100mK	±1.00mK
Uncalibrated	±10mK	±100mK	±200mK	±1.00mK

Ordering Information

Ruthenium-Oxide Temperature Sensor in Canister Package	
R500-A	Tolerance band A.
R500	Uncalibrated.

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