Cryogenic Control Systems, Inc.

# R400

## Ruthenium Oxide Temperature Sensor

### General Description

The R400 Ruthenium Oxide temperature sensor is a Thick-Film resistance temperature sensor that is designed primarily for low temperature operation. They feature high interchangeability by conforming to a standard calibration curve. Additionally, they are useful in high magnetic fields.

### Applications

- **Low temperature super-conducting magnet systems.**
- **Liquid Helium Systems.**

### Features

- **Temperature range**: 2.0K to 273K.
- **High Sensitivity** in the 2.0K to 40K range. Monotonic to 273K.
- **Low Temperature use:** High sensitivity and relatively low resistance below 20K.
- **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:** 2.0K to 273K.

**Standard Curve:** Cryo-con R400.

**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 or

**Recommended Excitation**
Constant-Voltage AC excitation of 1.0V or less for full range.
Constant-Current DC excitation of 10μA for operation above 3.0K.

**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.

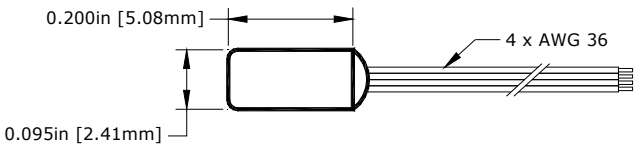
**Magnetic Field Dependence:** See graph below.

**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 scraping with a razor blade.

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




**R400**
**Canister Package**

**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.

### Tolerance Bands

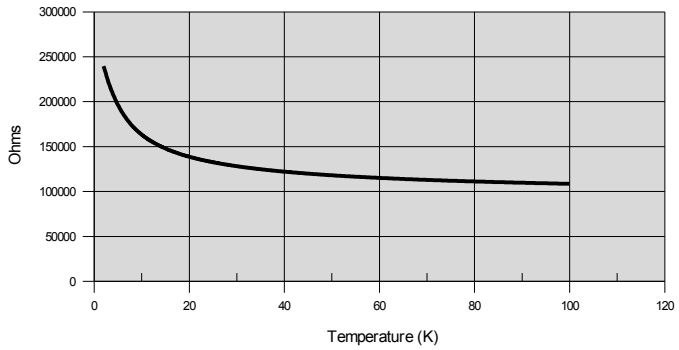
| | 4.2K | 77K | 273K |
|---|---|---|---|
| **Group A** | ±100mK | ±750mK | ±20K |
| **Uncalibrated** | ±300mK | N/A | N/A |

### Ordering Information

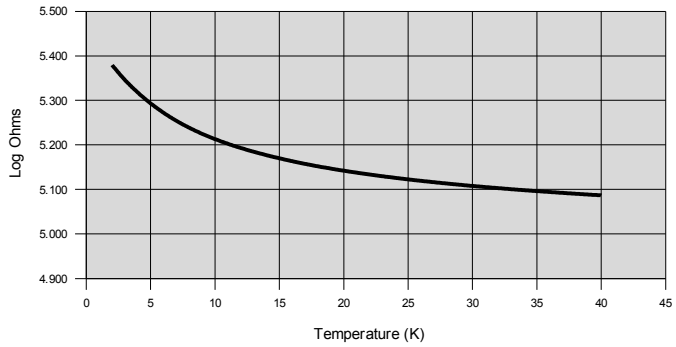
| Ruthenium-Oxide Temperature Sensor in Canister Package | |
|---|---|
| R400-A | Tolerance band A. |
| R400 | Uncalibrated. |

## Typical Performance Characteristics

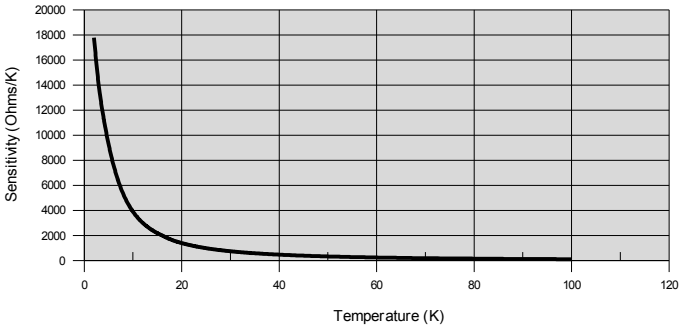
**Temperature Response**



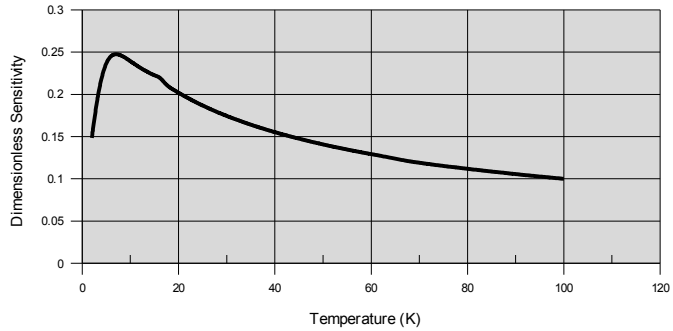

**Temperature Response Below 40.0K**




**Sensitivity (Ohms/K)**




**Dimensionless Sensitivity (T/R)(dR/dT)**




**Temperature Dependence in Magnetic Fields**

| | | Magnetic Field (Tesla) | | |
|---|---|---|---|---|
| | | **2** | **7** | **10** |
| **Temperature** | **2.2** | 0 | 250mK | 350mK |
| | **4.2** | 0 | 80mK | -- |
| | **75** | 0 | 90mK | -- |

**Typical Temperature Response**

| T(K) | R(Ω) | S(Ω/K) |
|---|---|---|
| 273 | 101K | 18 |
| 100 | 109K | 91 |
| 77.35 | 112K | 162 |
| 20 | 139K | 1,400 |
| 4.2 | 205K | 11,060 |
| 2.0 | 239K | 17,390 |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