Primary-standard resistance thermometry bridge Model CTR9000

Applications

- High-performance AC resistance thermometry bridge for very accurate temperature measurements
- Primary thermometer calibration for national and accredited laboratories, commercial temperature measurement and calibration applications

Special features

- Accuracy: < ±20 ppb (±5 µK [1]), optional < ±0.1 ppm (±25 µK [1])
- Resolution: 1 ppb (0.25 µK [1]), optional 0.1 ppm (25 µK [1])
- Fast measurement time (2 seconds balance)
- Differential and absolute measurement
- Warm-up time < 30 seconds

1) 25 Ω SPRT referred to a 25 Ω reference resistor

Model CTR9000 primary-standard resistance thermometry bridge, version 20 ppb accuracy

Description

In metrology, the most important consideration is the quality of the fundamental measurement. The bridge technology from ASL represents the peak of performance in resistance thermometer measurement. It exploits the inherent advantages of AC bridge technology to maintain repeatable measurements of highest precision under practical operating conditions.

The model CTR9000 primary-standard resistance thermometry bridge is designed specifically for resistance thermometry to provide the best possible accuracy.

The 25/30 [2] Hz or 75/90 [2] Hz operating frequency provides fast, continuous measurement with high immunity to thermal EMF errors and supply frequency noise sources.
Practical measurements involve cables, connectors and imperfect operating environments. The CTR9000 achieves its full specification under a wide range of real operating conditions.
AC bridge technology will always outperform measurements made using DC technology with slow current reversal.
These benefits are inherent to the fundamentals of electrical measurement and not just the implementation.

2) 60 Hz supply frequency

Data sheets showing similar products:
AC resistance thermometry bridge; model CTR6500; see data sheet CT 60.40
Reference thermometer; model CTP5000; see data sheet CT 61.20
Standard reference resistor; model CER6000; see data sheet CT 70.30

Specifications	Model CTR9000
Input channels	2 on the main device (one platinum resistance thermometer (PRT) or standard platinum resistance thermometer (SPRT) or resistor + one reference resistor) 60; over multiplexer CTS9000
Input connections	4 x BNC + shield (front panel)
Data entry format	ITS 90 and CVD for calibrated probes; or EN 60751 for uncalibrated probes
Accuracy	0.1 ppm ratio error over full range or 20 ppb ratio error over full range, dependent on configuration
Measuring ranges	
Sense current	1 mA, 2 mA, 5 mA
Sense current mulitpliers	0.1, 10 and √2
Sense current accuracy	Accuracy option 0.1 ppm: ±1 % Accuracy option 20 ppb: ±0.1 %
Carrier frequency	50 Hz supply frequency: low 25 Hz, high 75 Hz 60 Hz supply frequency: low 30 Hz, high 90 Hz Phase locked to the local supply frequency
Bandwidth	Accuracy option 0.1 ppm: 0.5 Hz, 0.1 Hz, 0.02 Hz Accuracy option 20 ppb: 0.5 Hz, 0.2 Hz, 0.1 Hz, multiplier x 0.1, x 0.01
Measuring range	0 ... 260 Ω
Rated accuracy range	0 ... 130 Ω
R_S range	1 ... 200 Ω
Display	
Range	Accuracy option 0.1 ppm: 1.299 999 9 ratio of two resistors Accuracy option 20 ppb: 1.299 999 999 ratio of two resistors
Resolution	The digital resolution is typically 0.01 ppm with a Pt100 at 1 mA.
Voltage supply	
Power supply	AC 240 V, AC 220 V AC 120 V, AC 100 V User selectable on rear panel
Supply frequency	50 or 60 Hz
Power consumption	max. 250 VA
Permissible ambient conditions	
Operating temperature	15 ... 25 °C
Communication	
Interface CTR9000	IEEE-488.2
Interface via driver module CTS9000 (optional)	RS-232 or IEEE-488.2
Case	
Dimensions	Approx. 545 x 382 x 500 mm (W x H x D)
Weight	46 kg

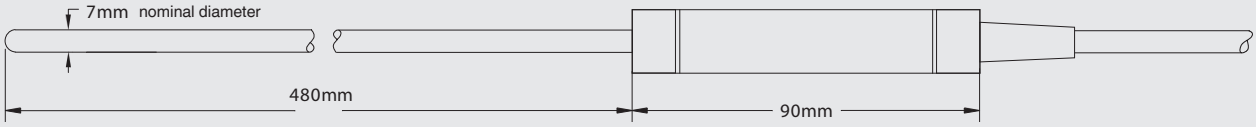
CE conformity, certificates

CE conformity	
EMC directive	2004/108/EC, EN 61326 emission (group 1, class B) and interference immunity (portable test and measuring equipment)

Approvals and certificates, see website

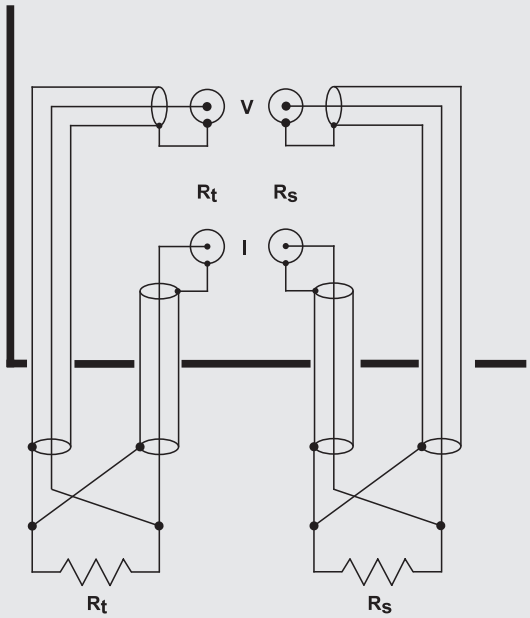
Recommended temperature probes

Resistance thermometer



Model	Dimensions	Temperature range
CTP5000-T25	Pt25, d = 7 mm, l = 480 mm	-189 ... +660 °C

Input connections



R_S input:
Two co-axial connectors that supply the current drive and voltage sense to an external standard resistor.

R_t input:
Two co-axial connectors that supply the current drive and voltage sense to the resistor or PRT being measured.

Features of the primary-standard resistance thermometry bridge

Temperature measurement specification
The performance of the CTR9000 as a temperature measuring instrument depends on the resistance SPRTs used, and varies over the range. In addition to the maximum errors quoted in the PRT calibration certificate and reference resistor certificate, the CTR9000 errors must be added to give the combined accuracy figure.

Resolution
- **Accuracy option 0.1 ppm:** The digital resolution is typically 0.025 mK with a 25 Ω SPRT at 2 mA.
- **Accuracy option 20 ppb:** The digital resolution is typically 0.25 µK with a 25 Ω SPRT at 2 mA.

The analogue output can be used for higher sensitivity measurements with a noise level of typically 10 µK RMS using a Pt100 at 1 mA.

Analogue output
- **Socket 1:** DC +10 V max
  Three consecutive digits of the indicated ratio are converted to an analogue form and scaled 0 ... 9.99 V for 000 ... 999. The required decades can be 567, 456 or 345 as selected from the front panel.

- **Socket 2:** DC -10 ... +10 V max
  Bandwidth: 1 Hz
  The output from the in-phase detector indicating the out-of-balance.
  Maximum load: 10 K, 10 nf - 100 m coax cable
  Note: The sensitivity is determined by the **Gain** select switches and **Gain** control.

Bridge self check

Instrument zero check
- **Manual balance mode**
  - Ensure the balance mode is set for manual balance, **Auto LED** off.
  - Set the manual balance rotary switches to read **1.000 000 00**.
  - The instrument should balance to a ratio **0.000 000 000** ±10 LSD.

- **Automatic balance mode**
  - Set the mode switch for automatic balance, **Auto LED** on.
  - The instrument should automatically balance to a ratio **0.000 000 000** ±10 LSD.

Instrument unity check
- **Manual balance mode**
  - Ensure the balance mode is set for manual balance, **Auto LED** off.
  - Set the manual balance rotary switches to read **1.000 000 00**.
  - The instrument should automatically balance to a ratio **1.000 000 000** ±20 LSD.

- **Automatic balance mode**
  - Set the mode switch for automatic balance, **Auto LED** on.
  - The instrument should automatically balance to a ratio **1.000 000 000** ±20 LSD.

The internal automatic balance procedure
When the automatic balance is selected, the internal microprocessor measures the out-of-balance and sets the ratio in order to achieve a null. This is carried out every decade; the gain of the main amplifier is being increased by a factor of ten for each decade until it reaches the gain selected by the front panel.

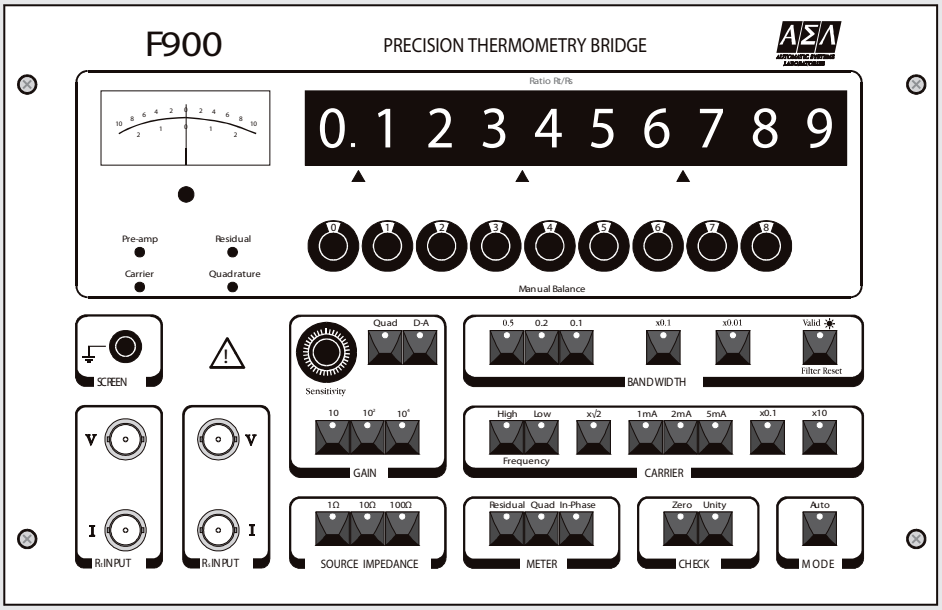
If at any time the out-of-balance is too great, the gain is progressively decreased until the out-of-balance is corrected, and the gain can be progressively increased again to the selected value.

When the out-of-balance is measured, the optimum automatic balancing requires the correct gain. This is set nominally by the front panel switches, but a fine adjustment is provided by the ten turn potentiometer. This should be set to approximately 5.0 (0.1 ppm) or 3.2 (20 ppb) for correct automatic operation.
The fine adjustment can be used to facilitate very sensitive out-of-balance measurements in the manual mode.

Quadrature
At a frequency of 75/90 Hz the reactive component of most PRTs and standard resistors is insignificant and is rejected by the quad servo and phase sensitive synchronous detector.

With higher values of R_t or R_s and long cables, the quadrature component increases and may produce an in-phase error if the maximum quad servo range is exceeded. Quadrature can be minimised by using low resistance, low loss, low capacitance coaxial cables of equal length on R_t and R_s inputs.

Operation



Instrument function keys

Parameter	Parameter selection
SOURCE IMPEDANCE	
1, 10, 100	Select to match the bridge pre-amp input impedance to the source impedance for optimum noise performance. The source impedance depends on the standard resistor, SPRT resistance and lead resistance. Default setting is **100**.
FREQUENCY	
Low, High	Set as required. Make measurements at both frequencies if AC effects are to be evaluated. The normal setting is **High**.
GAIN (switched)	
x1, x10, $x10^2$ $x10^3$, $x10^4$	Set gain to achieve required resolution in manual or automatic modes. **10^4** gives resolution of 0.1 ppm **10^3** gives resolution of 1 ppm etc. The normal setting is **10^4** (accuracy 0.1 ppm) and **10^5** (accuracy 20 ppb).
Sensitivity	For normal manual or automatic modes set to x5.0 (0.1 ppm), x3.2 (20 ppb). Make fine adjustments to optimise balancing in **Auto** mode.
REFERENCE AMP / QUAD GAIN	
x1, $x10^2$, $x10^4$	Set to a minimum which does not result in saturation of the quad servo. Check that the reference amplifier is not saturated. Normal setting **x10**.
CARRIER	
Current	Select maximum carrier current that does not exceed the ratio transformer saturation limits or cause excessive self-heating of the PRT. Refer to the PRT manufacturer's instructions. Check self-heating with x√2 facility. Default setting is **1 mA**.
CHECK	
Zero, Unity	The bridge operation can be verified by performing a zero and unity check. Suitable resistors should be connected to R_t and R_S with appropriate bridge settings. Default setting is normal operation.
METER	
In-Phase, Quad, Residual	Use front panel meter to measure the amount of in-phase, quadrature and residual signals coming through the detector. Default setting is **In-Phase**. (Both LEDs off.)
BANDWIDTH (Hz)	
0.5, 0.1, 0.02 (option 0.1 ppm) 0.5, 0.1, 0.2 x0.1/x0.01 (option 20 ppb)	Set to the maximum bandwidth to achieve the required resolution in automatic balance mode. This does not affect manual operation.

Scope of delivery

- Model CTR9000 resistance thermometry bridge incl. power cord and operating instructions, version 20 ppb incl.
  - BNC to BNC cable (3 m) - connection bridge to adapter box FA3
  - BNC to open end (3 m) - connection bridge to reference resistors
  - PRT adapter box (4 terminals to BNC)
  - 2 x 25 Ω, test resistor, 0.1 %, 0.6 ppm/°C
- Model CTR9000 resistance thermometry bridge incl. power cord and operating instructions, version 0.1 ppm incl.
  - BNC to BNC cable (3 m) - connection bridge to adapter box FA3
  - BNC to open end (3 m) - connection bridge to reference resistors
  - PRT adapter box (4 terminals to BNC)
  - 2 x 100 Ω, test resistor, 0.1 %, 0.6 ppm/°C
- Choice of model CTS9000 multiplexer
- Choice of model CTP5000 temperature probes
- Choice of model CER6000 standard reference resistor

Option

- Model CTS9000 10-channel automatic/remote scanner with standby current for un-selected PRTs.

Accessories

- BNC to BNC cable (3 m) - connection bridge to adapter box FA3
- BNC to open end (3 m) - connection bridge to reference resistors
- PRT adapter box (4 terminals to BNC)
- BNC to 2 x 4 mm banana terminals (2 per pack)
- BNC to 2 x 4 mm banana plugs (2 per pack)
- Adapter BNC to 5-pin DIN plug (1 m)
- Connection cable bridge to multiplexer CTS9000 (2 cable)
- 25 Ω, test resistor, 0.1 %, 0.6 ppm/°C
- 100 Ω, test resistor, 0.1 %, 0.6 ppm/°C
- Set of accessories for resistance thermometry bridges (FA1, FA2, FA3 and 2 x test resistor 100 Ω)
- Mounting kit for multiplexer CTS9000 in 19" rack
- Mounting kit for driver module in 19" rack

Ordering information

Model / Accuracy / Frequency / Number of multiplexers CTS9000 / Standby current / Definition standby current / Interface driver modul / Housing / Additional order information

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