

Calibration technology

Advantages of AC resistance thermometry bridges



Smart in sensing

Resistance thermometry bridges

By using internal or external standard resistors (model CER6000), resistance thermometry bridges measure resistance ratios with high accuracy, which are indicative of the temperature, among other things. Due to their high accuracy, these instruments are not only used in the field of temperature measurement, but also in electrical laboratories.

ASL equipment is used for research, primary and secondary calibration verification, process monitoring, sterilisation and validation work by some of the world's most demanding end users in the Aerospace, Pharmaceutical, Oil and Gas, Power and Distribution, Electrical and Electronic industries, and all International Standards Laboratories including the National Physical Laboratory in the UK, BIPM in France, PTB in Germany, NIST in the USA, AIST in Japan and NIM in China.

Our thermometry bridges cover a range of single and multi channel applications and are used extensively by national standards laboratories around the world. We offer also high accuracy precision digital thermometers for scientific and laboratory use.

Moreover ASL provides a full range Platinum Resistance Thermometers (PRT) for use in every application from standards calibration to site temperature measurement. If our "off the shelf" range will not suit your needs we are able to supply custom manufactured thermometers to almost any specification. We also provide a range of Standards Resistors for use when calibrating Platinum Resistance Thermometers.



AC technology



CTR5000

Precision thermometer

Measuring range:
-200 ... +962 °C

Accuracy:
0.01, optional 0.005 K

Sensor type:
Pt100, Pt25

Special feature:
Integrated data logger (optional)
Up to 64 channels

Data sheet:
CT 60.20



CTR6500

AC resistance thermometry bridge

Measuring range:
-200 ... +962 °C

Accuracy:
0.1 ... 1.25 mK depending on resistance ratio

Sensor type:
SPRT, PRT or fixed resistor

Special feature:
Expendable to up to 60 channels (optional)
Internal resistors 25, 100 Ω
AC technology

Data sheet:
CT 60.40



CTR9000

Primary-standard resistance thermometry bridge

Measuring range:
0 ... 260 Ω

Accuracy:
0.1 ppm, 20 ppb optional

Sensor type:
SPRT, PRT or fixed resistor

Special feature:
Expendable to up to 60 channels (optional)
4 selectable standby currents possible (optional)
AC technology

Data sheet:
CT 60.80

DC technology



CTR6000

DC resistance thermometry bridge

Measuring range:
-200 ... +962 °C

Accuracy:
± 3 mK (full range)

Sensor type:
PRT, thermistors or fixed resistors

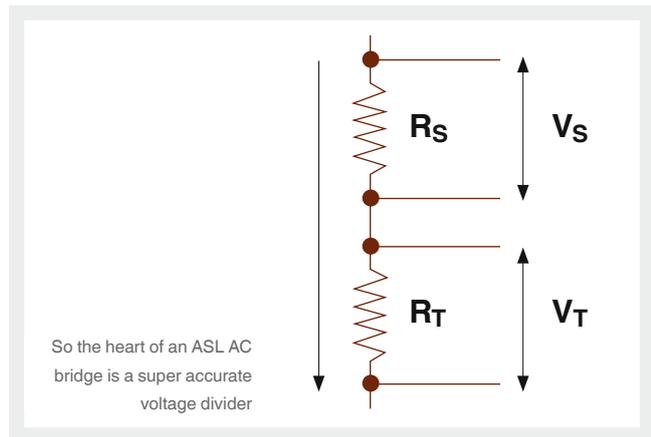
Special feature:
Expendable to up to 60 channels (optional)
Internal resistors 25 Ω, 100 Ω, 10 kΩ, 100 kΩ

Data sheet:
CT 60.30

Heart of the AC bridge concept

The ratio transformer

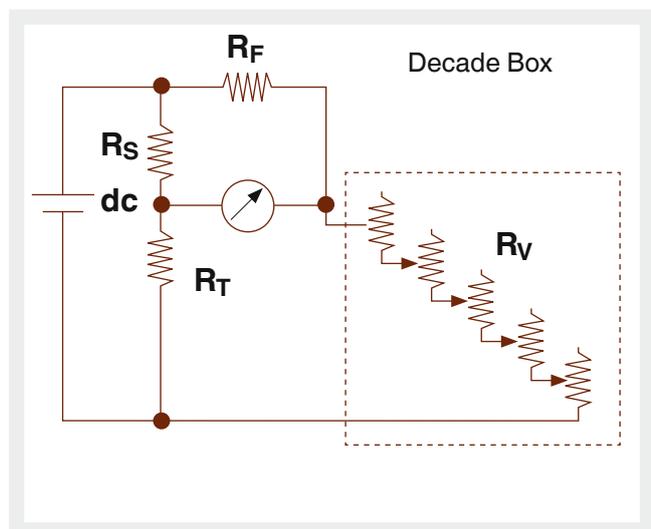
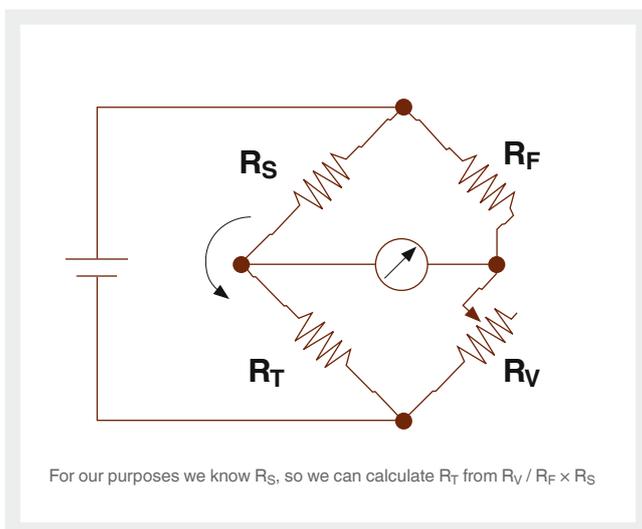
The ratio transformer is sometimes referred to as an IVD, an Inductive Voltage Divider. As suggested by its name the “simple” task of the ratio transformer is to divide the voltage across the resistance thermometer R_T and a reference resistor R_S , which carry a common current, and therefore measure the ratio V_T / V_S , which is the same as the ratio R_T / R_S .



Direct Current (DC)

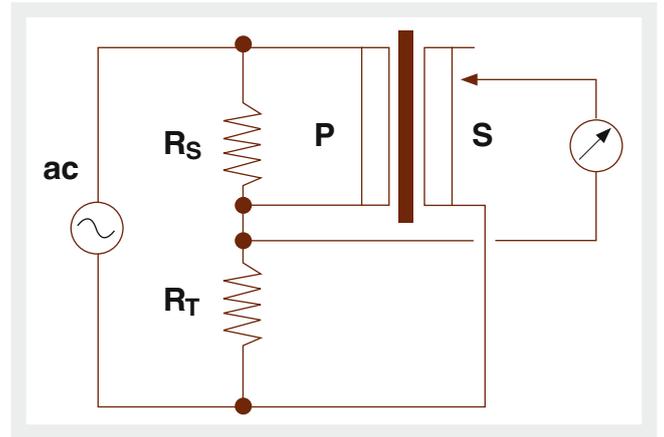
A traditional method for measuring resistance accurately in this way is the Wheatstone bridge, this is made of two resistance elements, one of which is fixed R_F and one is variable R_V . As with an AC bridge, the other half of the bridge is the resistance thermometer R_T and the standard resistor R_S . In the Wheatstone bridge, adjustment of the variable resistor R_V allows the voltage across the galvanometer to be adjusted to zero. In this condition, when the bridge is said to be balanced, the ratio R_V / R_F is the same as R_T / R_S .

However, to help us understand the equivalent AC bridge principles, it might be easier to picture the Wheatstone bridge using a decade resistor box to obtain a balance as shown below.



Alternating Current (AC)

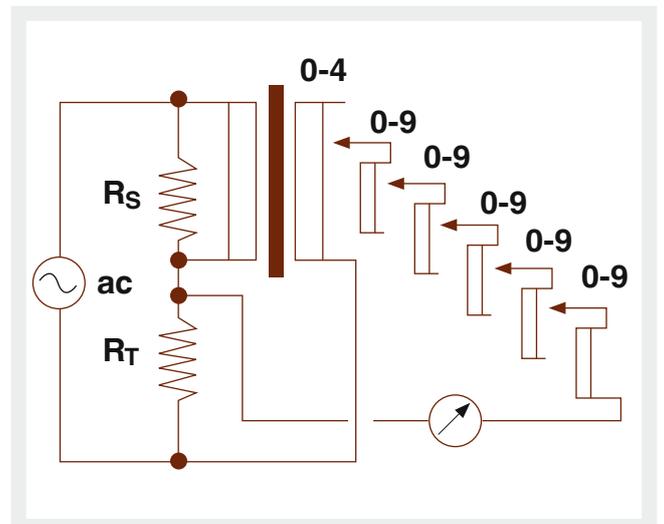
A simplified diagram of an AC bridge is shown below, the voltage across the standard R_S is measured by the fixed primary winding (P) of the ratio transformer. The secondary winding (S), or the variable, can be adjusted so the voltage division is equal to that of R_T to R_S .



The secondary winding (S) is far from a simple secondary and can be shown to take the form of cascaded “decades”, which can be considered similar in principle to that of the decade resistor box.

In effect, one tapping of the “unity ratio” decade has ten tapings which represent “0.1” ratio each. So the AC voltage across the one unity tapping is also across all ten “0.1” ratio tapings, hence a division of 10 is available on this AC voltage. Each “0.1” ratio tapping has ten tapings representing “0.01” etc.

In this way the ratio of the thermometer R_T and the standard resistor R_S may be read directly. A representation of this arrangement is shown beside.



Disadvantages of the DC measurement technique

- Voltmeter offset and linearity errors
- Noise on the sense current and voltmeter
- Sequential measurement temperature change
- Thermal EMFs
- Slower speed of response to achieve the correct measurement

These all lead directly to the measurement uncertainty.

Advantages of the ratio transformer

High accuracy

Accuracy is inherent in the design of ASL bridges, ASL use AC measurement techniques in its bridges because the AC ratio technique is the best ratio standard able to provide higher precision.

Long-term stability

The Ratio transformer (Inductive Voltage Divider) does not drift with time and has proven to have long term stability providing consistent measurement results.

Elimination of DC circuit drifts

By using AC the amplifier drifts associated with DC instruments are not a problem, therefore providing good stability and fast measurements.

Low temperature coefficient

The ratio transformer is insensitive to ambient temperature changes and therefore requires little or no warm-up time providing less waiting time and no need for ambient temperature control.

4-wire measurement

To provide the highest possible accuracy and eliminates the effects of lead resistance within the measurement, even with the addition of Multiplexers and long cables.

Active input circuitry

Input “guarding” techniques increase the input impedance of the ratio transformer so as not affect the current and maintain the measurement accuracy from leakage currents. This allows the ASL AC bridges to be used in a wide range of applications without affecting the performance.

Elimination of thermal and electrochemical EMFs

These effects are cancelled by using AC current, in an attempt to cancel these errors, DC instruments reverse their measuring current but at the expense of measurement time and level of accuracy.

DC instruments have to reverse their measurement current periodically in an attempt to match the AC bridge performance and in doing so extend the measurement time. In effect, DC measurements are sequential, whereas AC bridge measurement is concurrent, or overlapping, so there are no errors caused by conditions changing while the actual measurement is taking place. In addition these current reversals in DC instruments generate heating and cooling due to the Peltier effect at all the connections in the measurement circuit. This heating and cooling effect then caused thermal EMFs to be created and will be added to the thermometer voltage, even when reversed the measure resistance will be higher than the true ohmic value. By contrast the low frequency AC measurement technique will not allow time for significant heating and cooling to take place, so the true ohmic value of the thermometer is measured.

Low frequency carrier

The use of 25 ... 75 Hz (30 ... 90 Hz) almost completely eliminates the “1/F noise” generated within DC instruments, this provides a measurement that is more precise, has lower noise, a high resolution and in a fast time.

The “1/F noise” or “flicker noise” is basically the tendency of the offset voltage of many meters and amplifiers to vary erratically in a way which is inversely proportional to frequency. With the CTR9000 (ASL F900 / F18) a matching transformer is part of the design that optimally matches the Thermometer resistance that also reduces the effects of noise at this level of measurement.

This measurement frequency also provides an inherent rejection of line / supply frequency interference and harmonics, while reducing reactive effects with a quadrature servo enabling the correct resistance values being obtained in the measurement.

With important criteria to the right product

| Model | Technology | | Accuracy | Reference resistors | | Sensor current | | Number of channels |
|---------|------------|----|------------|---------------------|----------|----------------|------|--------------------|
| | AC | DC | Full range | Internal | External | Standard | User | Maximun |
| CTR5000 | ● | ○ | 0,005 K | ● | ○ | ● | ○ | 64 |
| CTR6000 | ○ | ● | 3 ppm | ● | ● | ● | ● | 60 |
| CTR6500 | ● | ○ | 1 ppm | ● | ● | ● | ● | 60 |
| CTR9000 | ● | ○ | 20 ppb | ○ | ● | ● | ● | 60 |

Legend ● possible ○ not possible

Industries

Our temperature measuring bridges are mainly used to measure and calibrate temperature sensors. Our products make your measurements and calibrations very easy. This is ensured through intuitive operation and very precise measurement technology.

Automotive industry

Calibration of high-precision automotive sensors and transmitters.

Heating, ventilation, air-conditioning

Accurate measurements for applications such as air-conditioning, water heating and cooling systems.

Manufacturing of temperature sensors

Measurement of process-critical parameters during manufacture.

Pharmaceutical industry

Precise calibration of measuring systems from production in the manufacture of medical instruments, surgical equipment and of innovative medical solutions.

Oil & gas

Precise calibration for instruments in harsh, dirty environments.

Calibration service

Efficient and precise calibration conforming to local and national standards.

WIKA and ASL

ASL (Automatic Systems Laboratories) is a worldwide leader in the manufacture of temperature products in the area covering high-precision temperature hand-helds through to the highest level of temperature measuring bridges.

Since 2013, ASL has been part of the WIKA Group in the calibration technology division. Since then, ASL has improved even further. Modern and efficient warehousing ensures short and exact delivery times.

The services and product range will be expanded even further.

Accessories

CTP5000-T25



High Precision Standard Platinum Resistance Thermometer (SPRT)

Measuring range:
-189 ... +660 °C

Sensor type:
Pt25

Dimensions:
d = 7 mm, l = 480 mm

Special feature:
Free cable ends,
DIN or SMART connector

Data sheet:
CT 61.20

CER6000-RW



Standard reference resistor

Resistance value:
1, 10, 25, 100, 300, 400, 500, 1,000 and
10,000 Ω

Long-term stability:
2 ppm per year
(HS version 0.5 ppm per year)

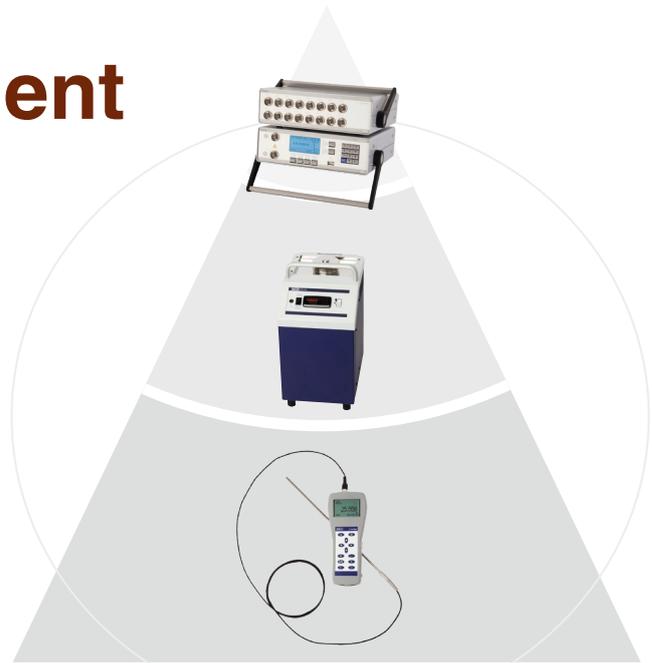
Special feature:
Low temperature coefficient
Rugged stainless steel construction

Data sheet:
CT 70.30

Highest precision for each requirement

In addition to the umbrella brand WIKA, you will also find the brand ASL for the measurement parameter temperature. With these established brands within the calibration market we deliver the ideal solution for each measurement task.

The products of ASL can be combined perfectly with the WIKA product programme, even allowing a presentation to the most exigent customers, as a full-range supplier.



Range of services
Measuring range: -200 ... +1,300 °C
Control range: -55 ... +1,100 °C



Smart in sensing

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