



# 6640T AMS THERMOMETRY BRIDGE

## ADVANCED MEASUREMENT SERIES OF TEMPERATURE BRIDGES

World's Most Advanced and Best Performing Temperature Bridges



- Best Accuracy:  $\pm 0.015$  ppm with 1 mA of Current
- Linearity:  $< \pm 0.01$  ppm of Full Scale
- Patented Toroid Design Specifically for Temperature Measurement Applications
- Measurement Rates Fast as 2 Seconds
- Built-in Windows 10 Computer and Touch Screen Display Providing Complete Measurement Results and Graphs
- System Control via USB, Network, or IEEE
- Widest Available Resistance Range up to 100 k $\Omega$
- Full Pre-Heat and Individual Channel and Current Control with Model 3210
- Modular Design, Expandable Capabilities
- Complete Investment Protection
- Full 10.5 Digits (0.1 ppb) Display Resolution
- Change All Key Parameters "On-the-Fly" While the Measurement is Running
- Wide Range of Ratios: 0.1:1 ~ 13.4:1
- Available USB Ports for Data Collection and/or Ancillary Items Such as Hard Drives, Mouse, Keyboard, etc
- BridgeWorks™ Data Acquisition Software
- Unique Calibration Support Strategy
- Complete Measurement Systems Available!

GUILDLINE'S NEW 6640T SERIES OF TEMPERATURE BRIDGES are redesigned to provide better uncertainties, faster measurement rates and more operational capability.

The large touch screen with rich color graphics is the most visible feature on the 6640T Series. The 6640T Series is much more than the addition of a touch screen interface centered on the same old technology used for the last 25 years. This latest Temperature Bridge incorporates the most advanced design and best operational features, some of which are patent protected.

**THE 6640T SERIES PROVIDES THE BEST IN INNOVATIONS, ADVANCED TECHNOLOGY, AND MOST IMPORTANTLY - THE BEST IN MEASUREMENT PERFORMANCE OF ANY TEMPERATURE BRIDGE MANUFACTURED TODAY!**

The 6640T is based on more than 50 Years of Guildline's experience designing and manufacturing DCC Bridge. It incorporates customer feedback from over two hundred Guildline 6622A Bridges in use at NMLs, militaries, and calibration laboratories throughout the world.

The 6640T incorporates a new patented toroid design, low current measurement improvements, nano-volt meter used as the null detector, very fast processor, and powerful new firmware. The new Windows 10 touch screen interface makes the 6640T easy to use while providing complete functionality for measurements.

These new techniques provide a materially quieter measurement, faster measurement cycles, improved repeatability and the world's most advanced operator interface found on any Temperature Bridge.

While still maintaining the same form and fit of the widely -fielded Guildline 6622T and older 6675A Bridges, customers will be able to simply replace their current bridge without having to buy a new rack or any other equipment to interface with existing Guildline Instruments and Standards.

# 6640T AMS Series of Temperature Bridges

## 6640T Series – The Best in Engineering Design and Innovation

For quality in measurements, you must have quality design and quality manufacturing. If you examine the internal layout of the new 6640T Bridge you will find this quality throughout. Special attention has been paid to: isolation and use of shielding to reduce noise, the latest in modern components to reduce affects due to temperature and power dissipation, increased resolution and stability in excitation current, increased reliability, and faster measurement cycles. **The 6640T Temperature Bridge also has two processors, one dedicated to running the measurement circuitry, and one dedicated to the user interface.** Add to this the new patented designs and a carefully thought out internal layout, and you will find a Temperature Bridge Series that meets customer requirements today, as well as years into the future.

While there are many design and measurement improvements, we did not forget what has made Guildline the leader in Laboratory Standards - the ability to buy what you require today and ensure your investment is protected if future requirements change.

Like the worlds most widely implemented DCC Bridge, the Guildline 6622A Series, the 6640T Series modular design allows a customer to buy what is required today with existing budgets, and when workload requirements change, simply expand your bridge to meet these requirements without any loss of your original investment! Modular design provides a single solution reducing life cycle costs not only for equipment support, but also for software development and operator training.

Customers should be wary of other manufacturer's claims of providing modular and upgradeable solutions in Temperature Bridges. When you decide to improve the measurement uncertainty on a 6640T Series Bridge, this is accomplished by upgrading your existing 6640T Bridge. With competitors' models, a customer has to purchase a brand-new bridge. A Modular design, when implemented properly, provides the perfect solution for current and future needs, whether you need secondary uncertainties or as a Primary Laboratory Standard.

The choice of 6640T Model is yours and designed to meet your workload, not ours! Best of all, your current software programming will work, and the menus will be the same, thus dramatically reducing learning curves and training requirements. Ongoing operating costs are also dramatically reduced because a **SINGLE 6640T TEMPERATURE BRIDGE** offers reduced support costs when the time comes for calibration.

And the 6640T Series will continue to work with your current Guildline Bridge accessories. If you own a 3210 Thermometry Adaptor or 6664 Scanner, 5032 Air Bath, or 5600 Fluid / Oil Bath they will continue to work with a 6640T Bridge. You simply remove the older Guildline Automated Bridge and replace with a new 6640T Bridge and all you need to do is reconnect the terminal wires.



## Available 664oT AMS Series Models

**6640T-Base Model** - The entry level 664oT Base Temperature Bridge provides uncertainties down to 0.05 ppm at 1 mA and with a complete measurement range to 100 k $\Omega$ . The Base Model has the same advanced measurement functions as the XP Model. The Base model is fully upgradeable to the XP Model to meet future requirements.

**6640T-XP Model** - The eXtended Performance (XP) Temperature Bridge provides uncertainties down to 0.015 ppm at 1 mA and with a complete measurement range to 100 k $\Omega$ ! Instrument control and internal are the same as Base Model, and your software procedures will still work – the same instrument operation and calibration support but with the improved uncertainties you need!



## 664oT Series Operator Interface

**NEW 10-inch capacitive multi-touch screen with full color graphical user interface.** The most visible feature on the new 664oT Series is the NEW 10 Inch embedded touch display and embedded Windows 10 Computer. This display not only has low noise characteristics but is designed to provide maximum protection from Electromagnetic Interface (EMI) and noise for the internal measurement circuitry, and for the Bridge terminals. The embedded Windows 10 Computer provides a true graphical interface based on LabVIEW software which runs right on the 664oT.

When you buy any 664oT Series Bridge it's as if you know them all. Menu operation, measurement setup, and software are identical among all models. The easy-to-use embedded display and dedicated user-interface processor runs under the Windows 10 Operating System. The **menu system is common to all models** eliminating in-depth operator learning requirements. **USB is standard on all models** with the universally recognized **Standard Code Programmable Interface (SCPI)** based commands incorporated as the programming language of choice. A **IEEE 488.2** interface is provided. You can have a rack or bench mount model and even have your choice of **front or rear terminals**. Your requirements, your needs - one family of Temperature Bridges!



All 664oT Bridges provide a full 10.5 digits of resolution and the ability to **graphical see** the data (trending). You can have the data presented in a **summary or detailed format** right on the Bridge Screen or available via PC based BridgeWorks Software. The 664oT Temperature Bridge provides the **Measurement and Uncertainty Analysis** you need as a Metrologist or to meet the requirements of ISO 17025 Accreditation!

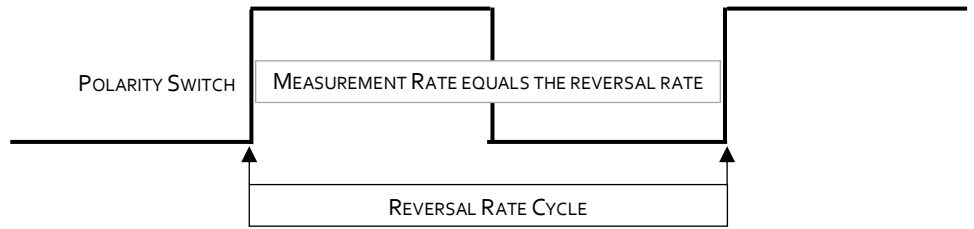
Every effort has been taken in the 664oT Series design to reduce noise and error. **Thermal EMF effects are eliminated** by automatic current reversal. The **unique architecture** of the bridge and its **control algorithms** further remove gain and offset errors in the **nano-volt balance detector** and the **new precision toroid**. The end results are shown by **long term accuracy and linearity** without the need for routine, frequent verification tests or calibrations.

The 664oT bridges can be used in either a **fixed or automatic** mode of operation. In fixed mode, the **measurement rate** is programmable, updating measurements from every 2 seconds to 14 minutes. A unique automated measurement mode provides automatic reversal rates, optimizing the measurement rate to the required uncertainty.

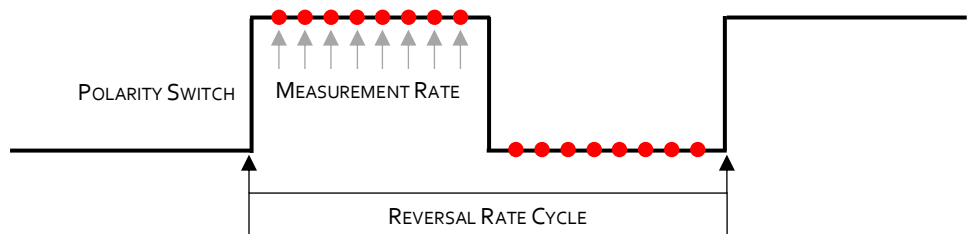
# 6640T AMS Series of Temperature Bridges

Although AC Bridges claim to provide a faster measurement, they have to be heavily filtered to meet a 0.02 ppm uncertainty, typically resulting in a latency of over 10 minutes. DCC Temperature Bridges from other manufacturers rely on extensive filtering to meet stated uncertainties.

Old DCC Bridge technology, used by competitors, requires that a measurement be based on the polarity reversal. This can be represented by the figure shown to the right. While having statements such as reversal rates as low as 2 seconds, in truth – to meet published specifications, the reversal rates are typically 20 seconds or more. This equates to a reading every 20 seconds.



Guildline's new 6640T Temperature Bridge decouples the polarity reversal rate from the measurement rate allowing measurements to be made much faster than competitive DCC bridges. As shown in the below figure, you can independently specify a measurement rate and a reversal rate. With the 6640T's dedicated measurement processor, many measurements can be made while on a single polarity. This allows a vastly increased number of measurements to be made on a single reversal rate cycle. Add to this our many other patented design features and you will find that the Guildline's 6640T Temperature Bridge is truly the latest in innovations and technology. Guildline's new 6640T Temperature Bridge provides best performance across the entire SPRT operating range; and provides ratios up to 1:13.4. Competitive bridges with similar uncertainties only provide ratios up to 1:4 which limits their use.



As stated in the previous design and engineering section, one of the many design upgrades found on the 6640T Temperature Bridge is the incorporation of two processors. The measurement processor is the latest, very high speed, chip designed for real-time operation. This real-time processor is dedicated to only running the measurement circuitry and measurement cycle. A second Intel processor, running Windows 10, is dedicated only to the user interface.

## 6640T BridgeWorks Temperature Software

Guildline also offer complete new solutions for software. Guildline's proven **BridgeWorks** Temperature software provides for setup, control, automatic measurements, and reporting. BridgeWorks is provided free with any of the Bridges in the 6640T Series. Note that the BridgeWorks software is very similar to the software that operates on the 6640T's embedded Windows 10 Computer, thus customers do not have to learn two different user interfaces.

BridgeWorks software is extremely powerful, yet **straight forward and user friendly**. The software comes with all of the useful and convenient features commonly found in **Windows based** commercial software programs. **On-line context help** is available to provide added assistance in understanding the functions of the software. BridgeWorks was **developed in LabVIEW®** offering direct compatibility to all National Instruments GPIB interfaces. These interfaces come in a wide variety of connection options to your PC such as **USB, FireWire, Ethernet, PCI, PCMCIA, RS232/485**, and more.



Guildline can even provide a complete **6645T Temperature Measurement System** by adding 6634A Temperature Stabilized Resistance Standards, 3210 Thermometry Adaptors/Scanners, and Software. This System is integrated, verified and tested in a rack a little more than 24" high (i.e. less than 60 cm or 15U). **Complete turnkey solutions!**

When the 6640T Bridge is used with a Guildline Model 3210 **Low Thermal Thermometry Adaptor / Matrix Scanner**, the software can turn the Bridge into a **multiple-channel** calibration and measurement system. Timed, sequenced single or multiple tests can be

initiated while the Bridge is unattended. All user **definable test variables**, such as excitation current, pre-heat current, measurement speed, reversal rate etc can be **programmed on a per test basis**, giving the **users full control and flexibility** in conducting well designed measurements, and for calibrating temperature probes.

**BridgeWorks Software** provides comprehensive graphics display, mathematical functions and trend analysis. Data can be **easily exported** to MS-Excel®, Crystal Reports® and in HTML format. All reports generated conform to traceability



requirements of ISO-17025. Uniquely, all analysis can be performed on the Windows 10 computer embedded inside the 6640T Temperature Bridge. Optional utilities include control of connected Guildline 3210 Thermometry Adaptors / Scanners, 5030 Air Baths and 5600 Fluid/Oil Baths.

## 6640T Series Specifications

DCC bridges have inherently **better noise immunity** to external electromagnetic and mechanical noise when compared to AC bridges. Measurements are conducted in **true four-terminal mode**, so long test leads can be used. Since excitation current is DC, reactance introduced by the probe and probe leads does not affect measurement accuracy. **Thermal EMF is eliminated** by periodic polarity reversal that is **programmable by the user**. The built-in, extremely stable current supply permits selection of output currents between 20  $\mu$ A and 150 mA to satisfy a wide range of sensitivity requirements. Root square values can be conveniently chosen from the instrument front panel or via software. **Temperature conversion and display** is done on the front panel, or on a PC using the BridgeWorks software.

One of the **key features** of Guildline's 6640T DCC Temperature Bridge is how the unit is calibrated. The 6640T is specifically **tested** at the **lower currents** (1 mA) found in thermometry and the calibration coefficients are stored separately for each decade of resistance and for each ratio. In contrast competitive DCC temperature bridges are calibrated and specified for 10 mA to 150 mA of operation, rather than the 1 mA required for temperature measurements. As a result, competitors misleadingly provide specifications based on 10 mA and higher currents, thus may not meet their published specifications when used for real thermometry applications.

The 6640T Series specifications are for **3 Years** based on a  $23^{\circ}\text{C} \pm 3^{\circ}\text{C}$  laboratory temperature. The 6640T performance is not limited to  $+0.5^{\circ}\text{C}$  or  $-0.5^{\circ}\text{C}$  ( $1^{\circ}\text{C}$  change), has minimal filtering (controllable), and has been verified for repeatability! Because the 6640T does not have embedded resistance standards, the stability is primarily based on the current comparator, so a Guildline Bridge only needs to be calibrated once every three years. **Guildline's specifications are based on 1 mA of current** typically used for temperature measurements in contrast to competitive DCC bridge manufacturers whose specifications are based on 10 mA to 150 mA, and may not be achieved under real 1 mA thermometry conditions. Want to see how a New Temperature Bridge really performs? Ask for a demo.

# 6640T AMS Series of Temperature Bridges

GENERAL SPECIFICATIONS			
Linearity		< ± 0.01 ppm (1:1 to 13.4:1)	
Display resolution (ppm)		Selectable (Programmable) from 0.0001 ppm to 10 ppm	
Temperature Coefficient		0.01 ppm/°C of reading (Outside 23 °C ± 3 °C)	
Automatic current reversal rate (in seconds)		4 to 1637 programmable, increment of 1 second	
Fastest Measurement Sample Rate		2 seconds	
Communication		USB, Network, IEEE 488.2 (Optional), SCPI Based Instructions	
Test current (for measurements to 100 kΩ)	Usable range (±30V) compliance (A)	10 µA ~ 150 mA (extension to 10,000A available for resistance measurements)	
	Resolution (µA)	1 µA	
	Accuracy [error(ppm) + offset(A)]	±100 ppm ± 10 µA	
Bridge Operating Temperature to Full Specifications		23 °C ± 3 °C	73 °F ± 5 °F
Bridge Maximum Operating Range (<50% RH)		+18 °C to +25 °C	+65 °F to +82 °F
Bridge Temperature Storage Range		-20 °C to +60 °C	-4 °F to +140 °F
Power Requirements		VAC: 100 V, 120 V, 220 V and 240 V ± 10 % / 50 or 60 Hz ± 5 %, 200 VA	
Dimensions (Width x Height x Depth)			Weight
440 mm x 200 mm x 465 mm	17.3" x 7.8" x 18.3"		27 kg 59.5 lbs

**Note:** The 6640T-Base and 6640T-XP models are limited to a maximum of 100 kΩ. Because of the unique variable ratios available on all models, it is possible to measure UUT's with a variety of Rs Standards. For example, a 25 Ω UUT could be measured with a 100 Ω, 25 Ω, 10 Ω or 1 Ω Resistance Standard (Rs). To determine the measurement uncertainty due to the bridge, simply look at the Rs you are using, and then go to the appropriate UUT Sub range.

6640T Base				RESISTANCE STANDARD	6640T-XP			
INTERCHANGE <sup>1</sup>	3 Year Ratio (± ppm)				3 Year Ratio (± ppm)	INTERCHANGE <sup>1</sup>		
1 : 1	0.1 : 1	1 : 1	10 : 1	1 Ω	0.1 : 1	1 : 1	10 : 1	1 : 1
± 0.03	± 0.2	± 0.05	± 0.05	10 Ω	± 0.1	± 0.02	± 0.02	± 0.015
± 0.03	± 0.2	± 0.05	± 0.05	25 Ω	± 0.1	± 0.02	± 0.02	± 0.015
± 0.03	± 0.2	± 0.05	± 0.05	100 Ω	± 0.1	± 0.02	± 0.02	± 0.015
± 0.03	± 0.2	± 0.05	± 0.1	1 k Ω	± 0.1	± 0.02	± 0.05	± 0.015
± 0.05	± 0.2	± 0.1	± 0.2	10 k Ω	± 0.1	± 0.05	± 0.1	± 0.03

1 - Interchange specification (i.e. sometimes referred to as a self-calibration) with minimal filtering.  
 2 - Specifications are based on 1 mA maximum current in Rs and temperature of 23 °C ± 3 °C.

## Making the 664oT Series Even Better

Guidline provides a variety of standards to **support the 664oT Series** of Bridges. For the **ultimate in ease of use and wide** temperature operating environment, look at our 6634A Temperature Controlled Resistance Standards. These resistance standards are a rack or bench mount unit with up to 10-resistance values specified by a customer. The values are in a **shielded, self contained 30°C** temperature environment and usable in a laboratory environment of **23°C ± 5°C**. For the **best in air resistances** see our 9334A Series of Air Resistance Standards.



Guidline is proud to announce the release of our **NEW AC/DC Oil Based Resistance Standards**, the 7330 Series. These resistors were made specifically to take advantage of the new Guidline **5600 Oil/Fluid Series Baths** also recently introduced. They are **extremely useful** as references for DC and AC **Temperature Bridges** and for the calibration of resistance ranges of multi-function calibrators and high accuracy DVMs, as well as being used in more classical standards and calibration resistance measurements. With a standard range from 0.1Ω to 100 kΩ, or also available in custom values, these resistance standards are designed to work for years to come.

For **multi-channel operation** look at our 3210 Thermometry Adaptors with scanning and switching capability. Each model has a built-in switch to automatically measure multiple connected devices, while using individual programmable pre-heat/keep-warm currents in between measurements. USB connections are provided, and the 3210 Thermometry Adaptor can be controlled by Guidline's PC based BridgeWorks software. The 3210 Thermometry adaptor automates the calibration of up to eight PRT's or SPRT's with user programmable channel currents! If required, additional 3210 Thermometry Adaptors can be purchased to provide up to 32 PRT/SPRT connections.

For the best Unit Under Test (UUT) environmental control Guidline produces the **5030 Series of Precision Air Baths** (shown to the right with optional window). This series of programmable Air Baths not only maintains an **ultra stable 0.015°C** environment but also provides **EMI and EMF Shielding** within the high quality dual wall Stainless Steel Chamber. Dual Heaters/Coolers/Fans provide for operational redundancy and the unit is **fully IEEE 488 programmable**. **Control Resolution is a 0.001°C**. This bath incorporates an extensive **Metrology based menu operation**. A second temperature sensor is provided so that the actual interior bath temperature can be read directly on the front panel. With baths from other companies a customer has to purchase an additional digital thermometer to know the real interior bath temperature requiring extra spending and integration software.

The 5030 Series can be programmed directly from Bridgeworks Software. With the large chamber capacity, and when used with the 3210 and/or 6664C Scanners, **multiple temperature probes** can be calibrated at one time. An operator simply has to review data when the multiple tests have finished.



# 6640T AMS Series of Temperature Bridges

And Guildline is back providing precision Fluid/Oil Baths. Guildline's new 5600 Series of Programmable Fluid Baths is based on a new design that includes the best features from our older baths and modern control electronics. A 5600 Fluid bath uses a highly reliable and extremely stable analogue control and adds fine control via an additional proportional-integral-derivative (PID) digital overlay. A windows tablet allows storing and accessing 17025 required Metrology Based data on temperature, resistor configurations, and bath operation. A true Metrologist tool! The 5600 Series of Baths can be used with oil, water, or salt water for oceanography applications. The 5600 provides uniform constant fluid temperature over a wide range from -5°C to 55°C with best stability < 0.0015°C. Four sizes of EMI shielded Fiberglass Tanks are available: 50 liters, 75 liters, 100 and 300 liters.



Guildline also provides **full system solutions and full system integration**. Need a base



system with one thermometry adaptor / scanner and a resistance standard in a rack? Not a problem. Need a **6640T-XP with 32 channels**, and Resistance Standards? We can do it! In fact, Guildline has produced over one hundred 6625 Measurement Systems complete with Bridge, Multi-Channel Scanners, and Resistance Standards all in a single rack. The **6645T Temperature Measurement Systems** are supplied with all hardware and software installed, tested and verified. Need the **ultimate temperature measurement** in a single rack solution? Combine any one of the 6640T Series Temperature Bridges with a 6634A Temperature Stabilized Resistance Standard, and 3210 Thermometry Adaptors / Scanners with individually programmable pre-heat per channels. Just ask what **Guildline can make for you**.

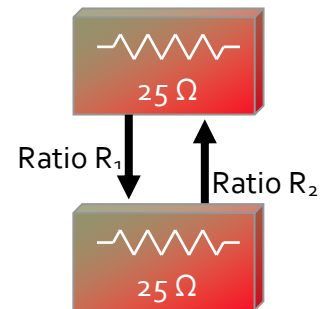
## Verification of Performance

Bridges are not self-calibrating. All Bridges must have an initial calibration done at time of manufacture, and subsequently must be verified or re-calibrated on a periodic time schedule. Competitors misleadingly state that their Bridges are self-calibrating but, their Bridges are calibrated the same way as all commercial bridges including Guildline's – via external resistance standards and/or an external ratio bridge like a Cryogenic Current Comparator.

Historically the verification that a precision DCC Bridge is operating as per its last calibration was challenging. A Harmon type transfer standard was needed for the verification of a bridge's non 1:1 measurement ratios along with high technical skill levels. With the introduction of the 6640T Series, and previous 6622A multi-ratio Bridges, the verification of performance can be carried out with ease. Verification of the bridge performance can also provide insight into the bridge's short and long-term stability to improve user's confidence levels and uncertainties.

The 1:1 measurement ratio can be easily calibrated and verified by interchange measurement tests using two stable standard resistors of same nominal values, as illustrated by the block diagram to the right. Bridge 1:1 measurement ratio error  $e_i$  (in ppm) is calculated using the following formula:

$$e_i = (1/2) \cdot |R_1 \cdot R_2 - 1| \cdot 10^6$$

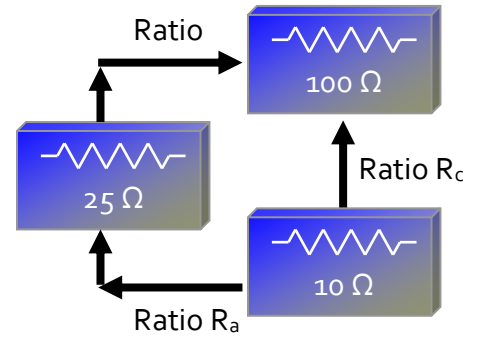




# 664oT AMS Series of Temperature Bridges

It is important to note that Non 1:1 measurement ratios, such as 4:1 and 10:1 ratios cannot be calibrated or verified via an interchange method. This is due to the fact that main variables such as the toroid windings, electronic path, power levels, etc are not the same when the connected resistors are reversed (i.e. interchanged). No NMI uses an interchange method to calibrate non 1:1 ratios!

However, the calibration of a Guildline 664oT Temperature Bridge can be easily verified by closure measurement tests using three stable standard resistors, as illustrated by the block diagram to the right. If a 664oT passes the verification, there is no need to have the Bridge re-calibrated. Bridge non 1:1 measurement ratio error  $e_c$  (in ppm) is calculated using the following formula:



$$e_c = (1/3) \cdot |R_a - R_b \cdot R_c| / R_a \cdot 10^6$$

Note: Resistance values in these block diagram are only representative values and are selected for the illustration of methodology only. Other ratios can be verified in the same manner.

## Warranty and Service

Is based on over 60 Years of Guildline innovation in engineering and design. The **664oT TEMPERATURE BRIDGES** provide **complete expandability and flexibility** that meet your current and future measurement needs. Options that satisfy real measurement needs and provide complete investment protection! How can you improve? Simple! Offer an industry leading **2-Year Warranty** to show your confidence. All 664oT Series of DCC Temperature Bridges come with a 2-year Warranty that covers both parts and labour.

ORDERING INFORMATION	
664oT-B	Base Accuracy, Range 100 kΩ, Front Terminals
664o-XP	Extended Performance, Range 100 kΩ, Front Terminals
	*All Bridges include Calibration Certificate, Operator and Software manual, and one set of Rs/Rx Low Thermal Leads
/R	Adds Resistance Option to Bridge
/RC	Report of Calibration Available at Nominal Charge
/RT	Specifies Rear Terminals
SM664o	Service Manual (Extra Charge)
<b>664oT SERIES OPTIONS</b>	
3210	8 Channel Thermometry Adapter with Pre-Heat
7330	AC/DC Oil Based Resistor (Specify Value)
5600	Automated Fluid Bath (Specify Size)
6634A	Temperature Stabilized Resistance Standard (Specify Values)
SCW-30:18AWG	30 Meters Shielded, Copper, Low Thermal Wire (SCW) 18 Gauge
SCW-30:22AWG	30 Meters Shielded, Copper, Low Thermal Wire (SCW) 22 Gauge

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