Model 6622T Series

DCC Thermometry Bridges

Accurate **WIDE RANGE** *DCC Thermometry Bridges*

6622T SERIES FEATURES

- Accuracy to 0.025 mK (i.e. best uncertainty at 0.1 ppm)
- Extended Performance (XP) Model Provides Best Accuracy at 0.013 mK (i.e. best uncertainty at 0.05 ppm)
- Wide Range From 0.1 Ω ~ 100 kΩ, Supporting a Wide Variety of SPRT's, PRT's, RTD's Including Ruthenium Oxide RTD's Used In Cryogenic Applications
- Built in Temperature Conversion for ITS-90 and IPTS-68
- Optimized for Operation at Low Power Levels and Higher Speeds
- Optional Thermometry Adaptor with Programmable Pre-Heat and Full Automation Capability
- Graphical and Statistical Display
- Resolution: ± 0.001 ppm of Full Scale
- Linearity: ± 0.01 ppm of Full Scale
- Wide Range of Ratios: 0.1:1 ~ 100:1
- Fully Programmable IEEE 488.2
- BridgeWorks™ Data Acquisition Software
- Unique Calibration Support Strategy
- Complete Measurement Systems Available

GUILDLINE INSTRUMENTS MODEL 6622T THERMOMETRY Bridge Series expands upon the success of 6622A Series Resistance Bridges by utilizing engineering ingenuity to offer leading uncertainties and stabilities for Temperature Bridges. This design introduces unique innovations in hardware and software for a wide range Thermometry Bridge Series **accommodating SPRT's, PRT's, various RTD's, and thermistors.** The measurement range of the 6622T Series is from 0.1 Ω to 100 kΩ.

There are two models in the 6622T Thermometry Bridge Series providing increasing levels of accurary and are **well suited for temperature calibration and research**. The use of a DCC bridge in thermometry is beneficial as it has inherently **better noise immunity** to external electromagnetic noise and mechanical disturbance.

One of the **key features** of Guildline's Thermometry bridges is that they are verified at the **lower currents** found in thermometry.

The 6622T Provides the Widest Range of Temperature Measurement of Any Commercially Available Temperature Bridge Today!

6622T Series 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 µA and 150 mA to satisfy a wide range of sensitivity requirements. To account for self heating of an SPRT, Root 2 value current can be conveniently chosen from the instrument front panel or via software.

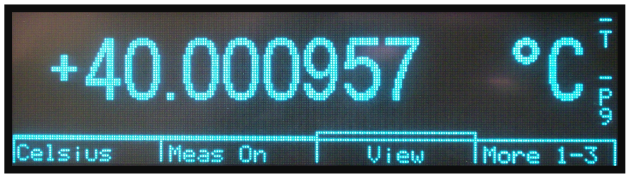
The 6622T Thermometry Bridge Series has an **intuitive internal menu system** that addresses temperature requirements without the need for external software or manual calculations. The calculation and temperature conversions are done internally via firmware and the results are viewed graphically via the front panel in **resistance ratio, Ω, °C, °F, and °K**. The Bridge menu supports various temperature scales such as the ITS-90, the IPTS-68 and IEC-751.

This easy-to-use front panel greatly reduces an operator's learning curve. An IEEE 488.2 communication port is a standard configuration, allowing computerized operation.

6622T DCC Thermometry Bridge Series

Design and Innovation

See what you have been missing! The on screen graphical display and associated data buffers can visually track temperature and the realization of fixed points! The 6622T is the only thermometry bridge available with this **on-instrument data and graphics capability**, which greatly simplifies **tracking temperature changes** and monitoring fixed point realization.



The **comprehensive menu** allows users to view the measurement data in either graphical or text format. The last 1000 entries are kept in the 6622T's memory and individual entries can be examined. **A user can either view** the present measurement result, a Summary detailing the Minimum, Maximum, Average, Standard Deviation, or the Graphic Trace of the measurement. Every effort has been taken in the 6622T Thermometry Bridge design to reduce noise and error. **Thermal EMF effects are eliminated** by automatic current reversal.

DC Bridges, like the 6622T, have inherently **better immunity to external electromagnetic** and mechanical noise relative to AC Bridges. This is based on the underlying direct current comparator technology used for DC Bridges which is not subject to switch contact and other parasitic resistances, **nor capacitance or inductance effects** on the internal measurement components and connection leads. The **unique architecture** of the 6622T Bridge and a **control algorithm** further removes gain and offset errors in the **nanovolt balance detector** and the **precision toroid**. The end results are shown by **long term accuracy and linearity** without the need for routine, frequent calibrations. 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. Immunity to noise is very important because of the electromagnetic noise generated by furnaces and baths that are present in Thermometry Laboratories. Finally **DC Bridges are not susceptible** to temperature variations or warm up times. The result is that 6622T DC Thermometry Bridges have much better stability and noise resistance than AC temperature Bridges, such as those provided by ASL.

The model 6622T thermometry bridge can be used in either a **fixed or dynamic reversal rate** mode of operation. In fixed reversal rate mode, **automatic current polarity reversal** is **user programmable** from 4 seconds to 27 minutes with two measurements per reversal. Dynamic reversal rate mode is only available in computerized measurements, where the bridge software **optimizes the polarity reversal rate** in real time. In temperature applications, this feature makes it easy to **track a fast changing temperature**. **Guildline's 6622T Bridge can make measurements** every two seconds, which eliminates any concerns that DC Bridges are slower than AC Bridges. This measurement time is more than fast enough to **track temperature changes**. In fact a two second measurement rate is much faster than the time required for PRTs and Fixed Points to stabilize.

Two Internal Buffers are used by the 6622T Series **for Temperature Measurements.** The 6622T Series of Bridges incorporates **two independent buffers** which dramatically improves thermometry measurements by giving a customer the tools to make educated choices and obtain optimum results. When making a measurement the 6622T will begin to collect data in both a Summary and a Detail buffer. By watching the **summary buffer** or **graphics display** a metrologist can visually see a **temperature measurement settle into plateau**. Once into plateau a user can switch over to the summary data screen and see a statistical analysis of both the Summary and the **Detail buffers** which includes the **mean and the standard deviation**. At this point both the summary and detail buffers have identical information. However now that the test is settled you can clear the Detail buffer and let it build up a new data set that contains only information taken at the plateau level. This will give you a new **average, standard deviation, and graphical view of your measurement**, which can be used for your official reported reading. Meanwhile all the information on the full test realizing the plateau is still retained in the Summary buffer and on a computer, if connected.

Both buffers can be **independently cleared** at any time and come with **their own graph**. The individual points can be viewed in the detail buffer and **captured to a computer** over the remote interface. The **statistical analysis** of both buffers can be viewed in the summary screen. This analysis provides mean, standard deviation, minimum value, maximum value, and sample counts for both independent buffers.

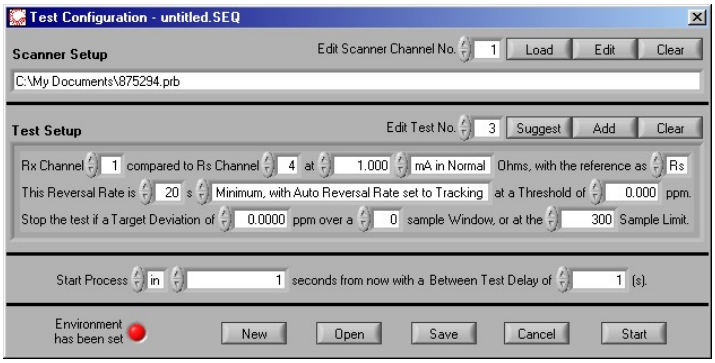
With **Guildline's 6622T Thermometry Bridge**, customers only need to deploy and support a **ONE-BRIDGE SOLUTION** to meet their temperature calibration needs, and optionally their **resistance measurement needs**. For customers this means a substantial reduction in staff training and capital spending. The **flexibility to purchase options** and upgrades for the 6622T Bridge means that new calibration procedures can be implemented inexpensively **without additional training** and support that is required when new calibration instruments are purchased from multiple vendors.

6622T Bridgeworks Software

Not only does Guildline provide unique features with our DCC Thermometry Bridge hardware, but also we offer complete automation solutions via our software. **BridgeWorks** can completely automate setup, control, measurements, and measurement reporting and is provided free with each 6622T thermometry bridge.

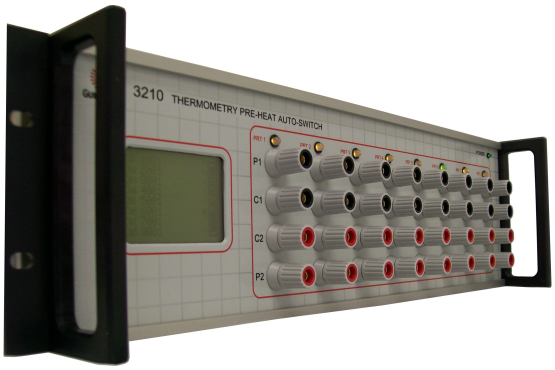
BridgeWorks software is extremely powerful, yet **straight forward and user friendly**. The software comes with all useful and convenient features found in commonly used **window based** commercial software programs. **On-line context help** is available to provide added assistance in understanding the functions of the software. BridgeWorks is **developed in LabVIEW©** offering direct compatibility with 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. Additionally, utilities reside within the software to enhance and **simplify the calibration of SPRT's and PRT's.**

When the 6622T Thermometry Bridge is used with Guildline's unique 3210 Thermometry Auto-Switch with Programmable Pre-Heat functionality**,** the software can turn the bridge into a **multiple-channel** calibration and measurement system. Timed, sequenced or scheduled single or multiple tests can be initiated while the bridge is unattended.



All user **definable test variables**, such as excitation current, reversal rate, etc can be **programmed on a per test basis,** giving the **users full control and flexibility** in conducting well designed experiments. For a **complete, automated temperature** measuring system, a 6622T bridge can be used with Guildline's 3210 Thermometry Auto-Switch, and **Guildline's 6634A Temperature Stabilized Resistance Standard**.

BridgeWorks software offers many routine **thermometry functions such as SPRT calibrations** to ITS-90 scale. It also provides comprehensive graphic display, math 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.



The optional 3210 Thermometry Adaptor with pre-heat enables multiple Resistance Temperature Devices to be calibrated at the same time along with providing programmable pre-heat capability. The Guildline **SPRT Adaptor** is the only **scanner/adaptor** that can provide **programmed pre-heat currents on a per channel** basis. Other manufacturers do not have pre-heat capability or only provide a single, fixed, preheat current.

The performance of the 6622T Thermometry Bridge is based on **over 55 years of innovation**, design knowledge, and manufacturing experience that Guildline has in building temperature and resistance measurement instruments. Over **150** of the **6622 Series Bridges** and Measurement systems have been **sold world-wide** in the past ten years.

Multi-Ratio Capability is another Key Feature of Guildline's 6622T Thermometry Bridge Series. This feature is not normally found in temperature Bridges. There are three key benefits to multi-ratio temperature bridges: **1) better uncertainties, 2) fewer reference resistors** (as well as using more Decade Values), **and 3) customer intermediate verification checks of a bridge's calibration**. Point 1 allows the temperature bridge to **measure current changes at the low values** typically found with temperature measurements (i.e. 100 Ω PRT at 1 mA), **while maintaining the reference resistor at a higher current level** (such as a 1Ω Standard at 100 mA). This is important because the **reference resistor will have better uncertainties at higher current** levels and it is typically calibrated at the higher current level.

The following Table shows the impact of multi-ratio and the use of decade Resistance Standards (as well as the 25Ω value) for Thermometry Applications. This table provides examples of the temperature ranges that can be supported by a single standard resistor.

Probe Type	Resistance Range Ω	Temperature Range K	Probe Current mA	Standard Resistor Ω	Uncertainty (23 ± 2°C) XP Model	
					mK	ppm of Ratio
0.25 Ω HTPRT (Pt)	0.04 - 1.0	273 - 1343	10	1	0.075	0.3
2.5 Ω HTPRT (Pt)	0.4 - 10.0	273 - 1343	3	1	0.013	0.05
10 Ω RTD (Cu-10)	5.1 - 19.2	173 - 533	3	1 *(or 10)*	0.013	0.05
25.5 Ω SPRT (Pt)	4 - 100	73 - 933	1	10 *(or 1, 25)*	0.013	0.05
27 Ω RTD (Rh-Fe)	17 - 75	1.4 - 300	1	10 *(or 1, 25)*	0.013	0.05
100 Ω PRT (Pt)	17 - 340	73 - 873	1	25 *(or 10, 100)*	0.013	0.05
120 Ω RTD (Ni-120)	66 - 381	193 - 533	1	25 *(or 10, 100)*	0.013	0.05
2252 Ω Thermistor	300 - 7.4k	273 - 373	0.1	100 *(or 1k)*	0.050	0.2
10 kΩ Thermistor	2.6k - 30k	273 - 373	0.03	1k *(or 10k)*	0.250	1.0
2.2 kΩ RTD (RuO_2)	2.2k - 75k	0.02 - 4.2	0.01	1k *(or 10k)*	0.250	1.0

Verification of Performance

Historically the calibration of a precision Thermometry Bridge 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 6622A multi-ratio bridge, a verification of performance relative to the most recent calibration can be carried out with ease. Frequent 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.

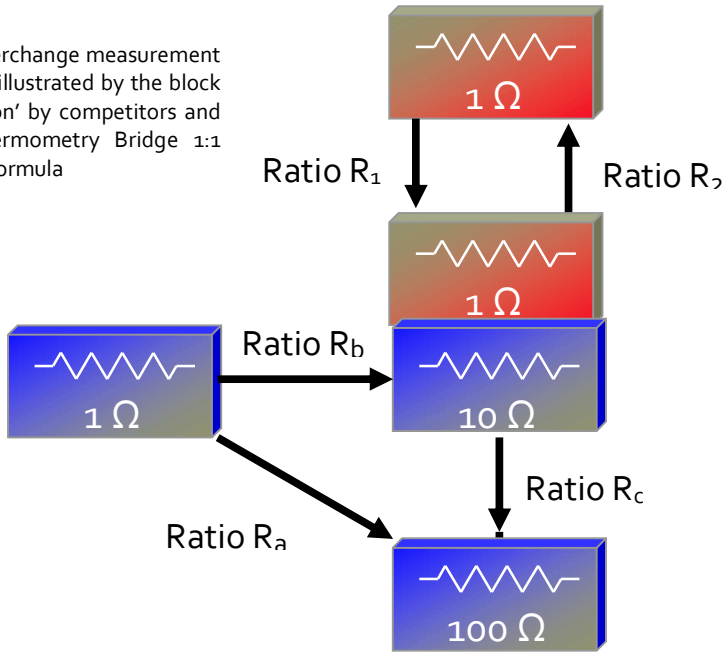
The 1:1 measurement ratio can be easily verified or calibrated by interchange measurement tests using two stable standard resistors of same nominal values, as illustrated by the block diagram to the right. This technique is referred to as 'self-calibration' by competitors and works with all manufacturers' thermometry bridges. The Thermometry Bridge 1:1 measurement ratio error e_i (in ppm) is calculated using the following formula

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

Non 1:1 measurement ratios, such as 10:1 and 100:1 ratios can be easily verified by closure measurement tests using three stable standard resistors, as illustrated by the block diagram to the right. 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 diagrams are only representative values and are selected for the illustration of methodology only.



This **Multi-Ratio capability allows users to extend** the calibration interval of the Thermometry Bridge while still maintaining a high level of confidence, thus **saving thousands of dollars each year in support** of the instrument. With an annual verification, a Guildline 6622T Thermometry Bridge typically can go five years between calibrations.

6622T Series Specifications

The following tables show the uncertainty contribution of the model 6622T Bridges to the total measurement. Because of the **wide range of Rx/Rs ratios available,** it is possible to measure UUT's with a **variety of Rs standards**. For example, a 100Ω UUT could be measured with a 1 Ω, 10 Ω or 100 Ω reference standard (Rs). To determine the bridge's contribution to measurement uncertainty, simply look at the Rs you are using, and go to the appropriate UUT range. The base model 6622T Bridge has a best uncertainty of 0.1 ppm, that is equivalent to ±25 µK for a 25.5Ω SPRT at 0 °C measured against a 25Ω reference resistor. The 6622T-XP Bridge has a **best uncertainty of 0.05 ppm/±13 µK**.

Rs 1 Ω	Rx/Rs Measurement Uncertainty (3 Years)				24 Hour Stability
	0.08Ω ▶ R_x ◀ 0.8Ω	0.8 Ω ▶ R_x ◀ 6.3Ω	6.3 Ω ▶ R_x ◀ 13.4Ω	13.4Ω ▶ R_x ◀ 107.5Ω	
Base Model	± 0.4 ppm	± 0.1 ppm	± 0.1 ppm	± 0.2 ppm	< ± 0.04 ppm
XP Model	± 0.3 ppm	± 0.05 ppm	± 0.05 ppm	± 0.1 ppm	< ± 0.04 ppm

Rs 10 Ω	Rx/Rs Measurement Uncertainty (3 Years)				24 Hour Stability
	0.08Ω ▶ R_x ◀ 0.8Ω	0.8Ω ▶ R_x ◀ 6.3Ω	6.3Ω ▶ R_x ◀ 13.4Ω	13.4Ω ▶ R_x ◀ 107.5Ω	
Base Model	± 0.4 ppm	± 0.1 ppm	± 0.1 ppm	± 0.2 ppm	< ± 0.04 ppm
XP Model	± 0.3 ppm	± 0.05 ppm	± 0.05 ppm	± 0.1 ppm	< ± 0.04 ppm

Rs 25 Ω	Rx/Rs Measurement Uncertainty (3 Years)				24 Hour Stability
	2.5Ω ▶ R_x ◀ 20Ω	20Ω ▶ R_x ◀ 157.5Ω	157.5Ω ▶ R_x ◀ 335Ω	335Ω ▶ R_x ◀ 2687Ω	
Base Model	± 0.4 ppm	± 0.1 ppm	± 0.1 ppm	± 0.2 ppm	< ± 0.04 ppm
XP Model	± 0.3 ppm	± 0.05 ppm	± 0.05 ppm	± 0.1 ppm	< ± 0.04 ppm

Rs 100 Ω	Rx/Rs Measurement Uncertainty (3 Years)				24 Hour Stability
	10Ω ▶ R_x ◀ 80Ω	80Ω ▶ R_x ◀ 630Ω	630Ω ▶ R_x ◀ 1340Ω	1.34kΩ ▶ R_x ◀ 10.75kΩ	
Base Model	± 0.4 ppm	± 0.1 ppm	± 0.1 ppm	± 0.4 ppm	< ± 0.04 ppm
XP Model	± 0.3 ppm	± 0.05 ppm	± 0.05 ppm	± 0.2 ppm	< ± 0.04 ppm

Rs 1 kΩ	Rx/Rs Measurement Uncertainty (3 Years)				24 Hour Stability
	100Ω ▶ R_x ◀ 800Ω	800Ω ▶ R_x ◀ 6.3 kΩ	6.3kΩ ▶ R_x ◀ 13.4kΩ	13.4kΩ ▶ R_x ◀ 107.5kΩ	
Base Model	± 0.4 ppm	± 0.1 ppm	± 0.1 ppm	± 1.0 ppm	< ± 0.04 ppm
XP Model	± 0.3 ppm	± 0.1 ppm	± 0.1 ppm	± 1.0 ppm	< ± 0.04 ppm

Rs 10 kΩ	Rx/Rs Measurement Uncertainty (3 Years)				24 Hour Stability
	1kΩ ▶ R_x ◀ 8kΩ	8kΩ ▶ R_x ◀ 63kΩ	63kΩ ▶ R_x ◀ 134kΩ	Optional	
Base Model	± 0.4 ppm	± 0.1 ppm	± 0.3 ppm	Optional	< ± 0.04 ppm
XP Model	± 0.3 ppm	± 0.1 ppm	± 0.3 ppm	Optional	< ± 0.06 ppm

1 - Specifications are based on 20 second reversal rate, 100 µW power dissipation in R_x and environment temperature of 23°C ±2°C.
2 - Lowest possible R_x is defined as $R_{x(low)} = R_s \times .08$ and Maximum possible R_x is determined by $R_{x(high)} = R_s \times 107.5$.

6622T DCC Thermometry Bridge Series

General Specifications		
Measurement Range (Ω)		10^{-3} ~ 10^{5}
Resistance ratio range		0.1:1 ~ 100:1
Linearity		± 0.01 ppm of full scale (Full scale defined as 1:1, 10:1 and 100:1)
Display resolution (ppm)		± 0.001 ppm
Temperature coefficient of resistance ratio measurement		0.01 ppm/°C of reading
Automatic current reversal rate (in seconds)		2 s to 1637 s programmable, increment of 1 s
Communication		IEEE 488.2 (SCPI Based)
Test current (for measurement to 100 kΩ)	Usable range (±30V compliance) (A)	20 µA ~ 150 mA
	Resolution (µA)	2 µA
	Accuracy [error(ppm) + offset(A)]	±200 ppm ± 10 µA
Dimensions and weight		465(D)·440(W)·200(H) mm, 27kg
Environmental		Operating: 18~28°C, 20%~50%RH / Storage: –20~60°C, 15%~ 80%RH
Power Requirements		100V, 120V, 220V or 240V ± 10%, 50/ 60Hz ±5%, 200VA

Warranty

55 Years of Guildline innovation in engineering and design, solutions that satisfy real measurement issues, and outstanding craftsmanship and we offer an industry leading **2-Year Warranty** to show you our confidence. The 6622T Thermometry Bridges come with a 2-year warranty, at no extra cost.

Service and Support

We have the widest range of resistance accredited, from **0.1 µΩ all the way to 10 PΩ**. Whether you own a Guildline product and have other manufacturer's standards, **call today** and see what we can do for you.

Ordering Information

Model	Description
6622T-B	Base Thermometry Bridge, 0.1 ppm (best uncertainty)
6622T-XP	Base Thermometry Bridge, 0.05ppm (best uncertainty)
6622A-09	Rack Mount Kit
/RC	Report of Calibration Available at Nominal Charge
/RT	Specifies Rear Terminals versus Front Terminals (Default)
SM6622T	Service Manual (Extra Charge)
	6622T Series Options
3210	8 Channel Thermometry Adapter with Pre-Heat
Bridgeworks-UPG	Upgrades Bridgeworks-T to Bridgeworks-C
/Controller	Controller Computer System with IEEE and Software Integrated
IEEE-USB	NI IEEE-488.2 Interface for a USB (Win 98/NT/ME/2K/XP)
IEEE-2m	NI IEEE-488.2 Interface cable, 2m double shielded
6634A-X	Temperature Stabilized Resistance Standard for 6622T Series
6664C	8 or 16 Channel, 2 Amp Low Thermal Scanners
6664A-11	SCW Lead pair with gold plated banana plug, 1m in length
6664A-12	SCW Lead pair with gold plated banana plugs, 2m in length
SCW/18-30	30 Meters Shielded, Copper, Low Thermal Wire 18 Gauge
Many other leads and accessories to include system integration and IEEE are available.	

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