



# DISCOVER THE „ BLUE BOX” DIFFERENCE

## Temperature Metrology Products Guide



**Measurements International**  
*Metrology is Our Science, Accuracy is Our Business™*

## Metrology is our Science, Accuracy is Our Business™

Measurements International (MI) is the world's premier metrology company. MI provides innovative Standards Technology for both the Metrology and AC Power Industries. For the Metrology industry MI designs, develops, and manufactures electrical and temperature metrology instruments using AccuBridge® technology. For the AC power industry MI designs, develops and manufactures high-voltage transformer test instruments, capacitance/inductance bridges, voltage dividers, wattmeters and current transformers using the AccuLoss® and two-stage-compensated current transformers. All instruments are manufactured with the highest quality in support of our customer's organization.

## **NEW** AccuBridge® 6020T Automated Primary Thermometry Bridge

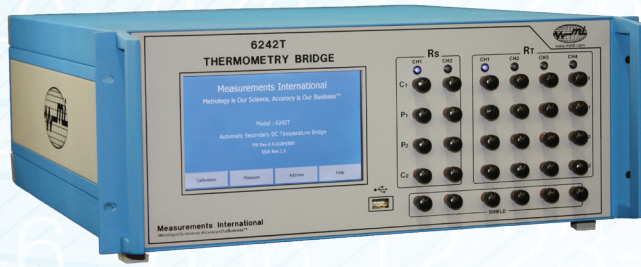
- Accuracy Whole Range (SPRT  $R_0 \geq 2.5\Omega$ ) 15 ppb\*
- Accuracy (Ratio 0.5 to 4.05) < 15ppb \*\*
- Resolution: 1 ppb
- AccuBridge® Technology
- Ratio, Resistance and Temperature measurement
- Touch Screen and Software Operation
- Not affected by Temperature change
- English and Chinese operating systems



Proven Performance: Not only does Measurements International offer you the technology of choice of major NMI's and unmatched accuracy and uncertainty levels, but these capabilities have been proven many times over!

The Model 6020T is designed specifically for thermometry applications and provides the best accuracy and convenience based on the most recent developments in current comparator technology. With reversal rates as low as 2 seconds, the 6020T provides fast, continuous measurements with high immunity to thermals and furnace noise. The ratio accuracy can be verified against two stable standard resistors. The Model 6020T achieves its specifications for a wide range of operating conditions.

\* with selection of proper standard resistors



## AccuBridge® 6242T Secondary Thermometry Bridge

- Accuracy Whole Range (SPRT  $R_0 \geq 2.5\Omega$ ) 0.1ppm\*
- Accuracy (Ratio 0.5 to 14) < 0.1ppm\*\*
- Front Panel 6 Channel Scanner
- Keep Warm Currents
- Linearity <5 ppb
- Resolution: 1ppb

## AccuBridge® 6242T Secondary Thermometry Bridge

The 6242T tends to be used more in the secondary lab or industrial monitoring environment with a maximum ratio of 14:1 and accuracy of 0.1ppm. The main difference between the 6242T and the other temperature bridges is in cost and accuracy. The 6242T has a built in 6 channel scanner where 2 channels are dedicated to the Standard Reference Resistor and 4 channels for the SPRT or industrial grade SPRTS.

The MI line of ADCC thermometry bridges offer users world class uncertainties while maintaining the useability that is familiar to primary resistance labs all over the world. No other thermometry or resistance bridge can claim the Metrologist's Choice...!



## AccuBridge® 6010D Automated Resistance Thermometry Bridge

- Accuracy Whole Range (SPRT  $R_0 \geq 2.5\Omega$ ) 40ppb\*
- Accuracy (Ratio 0.5 to 14) < 40ppb\*\*
- Resolution: 1 ppb
- AccuBridge® Technology
- Ratio, Resistance and Temperature measurement
- Touch Screen and Software Operation
- Not affected by Temperature change
- English and Chinese operating systems

## AccuBridge® 6010D Automated Resistance Thermometry Bridge

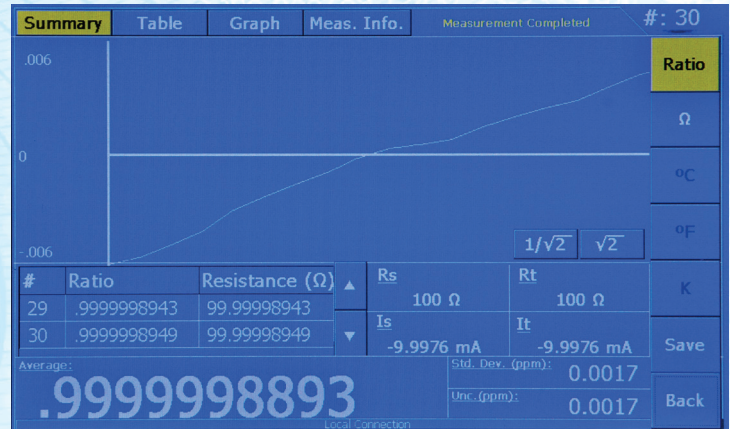
Recognized as the worlds leading Automated Resistance/Thermometry Bridge, the 6010D is ideal for both resistance and temperature measurements. With a maximum ratio of 14:1 and accuracy of 0.04ppm the 6010D is equally at home in a temperature laboratory or a resistance laboratory.

\*\* with a standard resistor of 10 Ohms

# The Front Panel Touch Screen Display

## Your tool for Control and Analysis...

**The Summary tab screen displays measurement parameters as well as graphical information for current measurement and can be viewed in ratio, Ohms, and in Degrees Celsius, Fahrenheit or Kelvin values.**



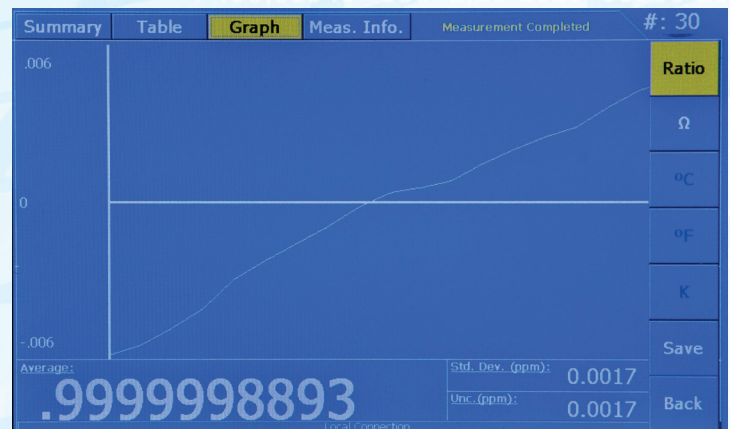
**The Measurement Information screen displays measurement parameters for the current measurement such as applied current, number of samples, reversal rate and value of the standard resistor being used.**

The Measurement Information screen displays measurement parameters for the current measurement. The table below shows the following data:

$R_s$		$R_t$		Ratio
Type	Resistor	Type	Resistor	Unit
Absolute Value	100	Absolute Value	100	$\Omega$
$I_s$ (mA)	-9.9976 mA	$I_t$ (mA)	10	$^{\circ}C$
		Serial #	0000	$^{\circ}F$
Settle Time (s):	8	# Meas. :	30	K
Sample Time (s):		# Statistics :	20	
Save File Name:	Data Not Saved	Filter:	10	Save

Additional parameters shown: Average: .9999998893, Std. Dev. (ppm): 0.0017, Unc. (ppm): 0.0017.

**The graph screen displays a graphical representation of the individual measurement data plots.**



**The Table screen list is a chronological list of measurement results in ratio, resistance, and temperature.**

The Table screen list is a chronological list of measurement results in ratio, resistance, and temperature. The table below shows the following data:

#	Ratio	Resistance ( $\Omega$ )	Unit
22	.9999998902	99.99998902	$\Omega$
23	.9999998909	99.99998909	$^{\circ}C$
24	.9999998915	99.99998915	$^{\circ}F$
25	.999999892	99.9999892	K
26	.9999998924	99.99998924	
27	.9999998932	99.99998932	
28	.9999998939	99.99998939	
29	.9999998943	99.99998943	
30	.9999998949	99.99998949	

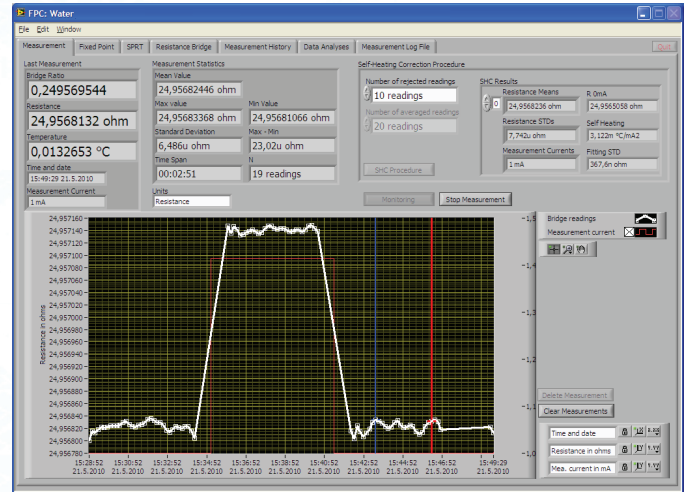
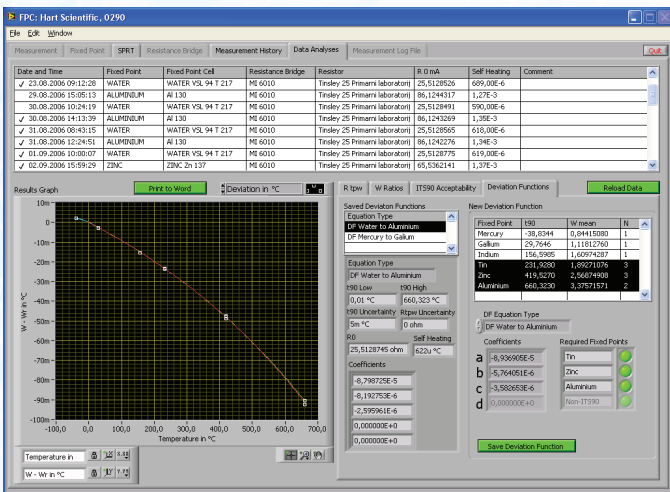
Additional parameters shown: Average: .9999998893, Std. Dev. (ppm): 0.0017, Unc. (ppm): 0.0017.

# Accu-T-Cal Software

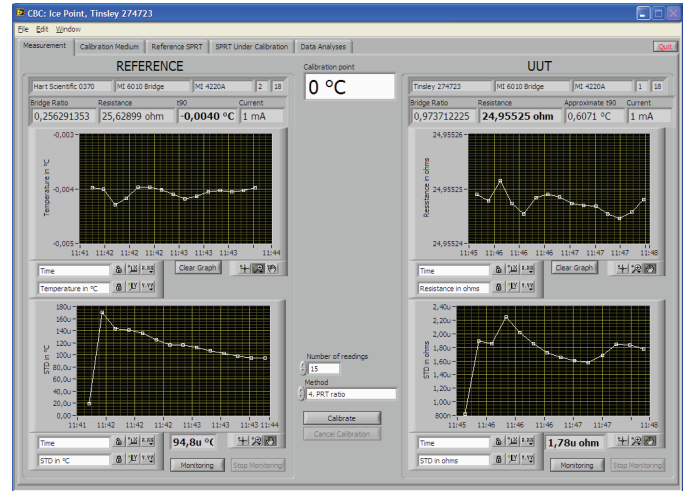
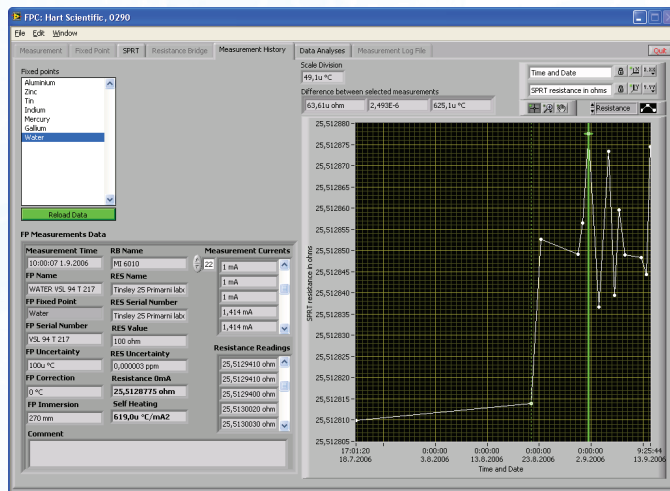
- **Compatible with all MIL bridges**
- **Calibration of fixed point cells**
- **Calibration by comparison**
- **Automatic self-heating correction**
- **Easy measurement setup**
- **Detailed data analysis**

Measurements International's Accu-T-Cal™ SW is a software package for the automation of measurements and calibrations of Platinum Resistance Thermometers (PRTs).

Standard Platinum Resistance Thermometers (SPRTs) can also be calibrated by comparison. In this method the SPRT under test is calibrated by comparing its reading with the reading of a reference thermometer, placed at the same temperature in the temperature controlled calibration medium. The reference thermometer and the UUT are measured with the same resistance bridge. Measurement method allows appropriate handling of readings from both thermometers to minimize possible sources of errors resulting from short term stability of the calibration medium temperature and measurement speed of the bridge.



The Accu-T-Cal™ SW has built in procedure for evaluation and correction of the PRT's self heating, with user selectable steps at the measurement current. All measured data are available as graphical and tabular format and are automatically saved for detailed analysis and calibration report generation. Users can select evaluation of deviation function as per the ITS-90, or polynomial representation of the PRT's characteristics from the data obtained during calibration. Accu-T-Cal™ SW gives the user full freedom of selection or rejection of particular results from the analysis.



## **From a technical perspective....**

### **ADCC Accuracy**

#### **Resistance Bridges in Temperature Applications offer**

##### **UNMATCHED ACCURACY:**

Measuring SPRTs and PRTs with high levels of precision and low uncertainties requires the performance only found in resistance bridge systems. Such bridges also must include the critical capabilities that link resistance measurement technologies with temperature sensor measurement capabilities. This offers users the best basis for unmatched resistance thermometer metrology.

Core to primary level use of resistance bridges is the AccuBridge® Direct Current Comparator (or ADCC) measurement system. Based on the principal of a transformer's ampere turn ratios, a superior ratio measurement accuracy is specified over the full ratio range. Measurement International's 6xxx series of temperature bridges operate at ratios where the accuracy can be easily verified.

##### **CONFIDENCE IN PERFORMANCE:**

All of the ADCC Bridges have a built in calibration routine to calibrate and verify the linearity and accuracy of the bridges. This information is stored to a file for providing the necessary documentation and history files for audits. All three bridges are stable and do not drift with time. Compliment or interchange measurements can be used to verify the ratio accuracy. Only the reference resistors need calibrating providing traceability for the measurement. No special equipment is required for calibrating the bridges.

##### **MEASUREMENT SPEED AND THROUGHPUT:**

The ADCC Series of temperature bridge makes fast sub ppm measurements at a rate of ~2s with the 1st reading been displayed in ~20 seconds. All bridges are supplied with a USB interface for saving data or IEEE488 for remote computer control.

##### **THE ADCC DESIGN OBSOLETE'S THE NEED FOR AC BRIDGES:**

AC bridges were designed to minimize the effect of errors caused by thermal voltages. These thermal EMFs are generated as the result of dissimilar metals and temperature gradients. These are eliminated by reversing the test stimulus in successive measurements. This process of current reversal and averaging, together with true 4-wire resistance measurement has the effect of eliminating thermal EMFs and of ensuring an intrinsically stable zero with time and temperature. The 6242T and 6020T have the option of either ramping the currents or providing a true square wave reversal. Both  $\sqrt{2}$  and  $1/\sqrt{2}$  currents can be initiated at any time during the measurement.

Also the ADCC measurement processes inherently reject unwanted noise and provide a better quality bridge measurement, where AC bridges have difficulties in this area.

## Temperature Bridge Measurement Specifications

Thermometers	0.25 $\Omega$ , 2.5 $\Omega$ , 25.5 $\Omega$ , 100 $\Omega$ or any value 0.1 $\Omega$ to 10k $\Omega$
Standard Resistor Range	0.1 $\Omega$ to 1,000 $\Omega$
Measurement ratio range	6020T: 0 to 4:1 6010D/6242T: 0 to 14:1
Accuracy	6020T: <0.015 ppm of ratio 6010D: <0.04 ppm of ratio 6242T: <0.1 ppm of ratio
Reversal Rates	2, 3, 4 to 1000 seconds
External Standard	AC/DC or DC Standard Resistor
Sensor current	0.01, to 100 mA or $\sqrt{2}$ or $1\sqrt{2}$ times any value
Sensor current frequency	Switched DC
Bridge balancing modes	Automatic to 0.01 ppm
Self Check Modes	CAL (Verifies linearity of Bridge to < 0.005 ppm)
Lead Connections	True Four Wire Connections
USB	Stores all measurement Data
IEEE488	Input/Output
Measurement Time	20/60 seconds to full balance, 2/5 seconds incremental balance (6020T/6010D,6242T)
Warm up time	5 minutes
Operating Conditions	10 $^{\circ}$ C to 35 $^{\circ}$ C, 10% to 90% RH non-condensing
Power Requirements	100, 120, 220, 240 VAC $\pm$ 10% 50/60 Hz

All bridge accuracies are stated at the k=2 (95% confidence) level.

### Optional Accessories:

#### Scanners:

4210A	10-Channel Matrix Scanner
4216A	16-Channel Matrix Scanner
4220A	20-Channel Matrix Scanner

#### Temperature Baths:

9300A	Ultra High Stability Programmable Air Bath
9300	High Stability Air Bath
9400A	Resistor Oil Bath

#### Resistors:

9331	Standard Air Resistors
9210A	MI-Type One Ohm Oil Resistors

#### Misc.

6XXX-BNC	BNC connectors
SPSCW	Silver Plated Solid Copper Wire



**1987**  
Measurements International (MI) is founded. Developed  
Four Terminal Automated Resistance Scanner Model 4220A

**1990**  
Developed first commercial Automated Potentiometer based on the Binary Voltage  
Divider Technology (BVD), Model 8000A Range 1mV to 10V Accuracy  $< 5 * 10^{-8}$

**1992**  
Develops first commercial automated Direct Current Comparator Resistance  
Bridge (DCC) Model 6010A, Range 1  $\Omega$  to 10K $\Omega$ , Accuracy  $10^{-7}$

**1993**  
Developed first commercial automated High Resistance Bridge for the  
measurement of resistors. Range 10k $\Omega$  to 100M $\Omega$ , Accuracy  $10^{-6}$

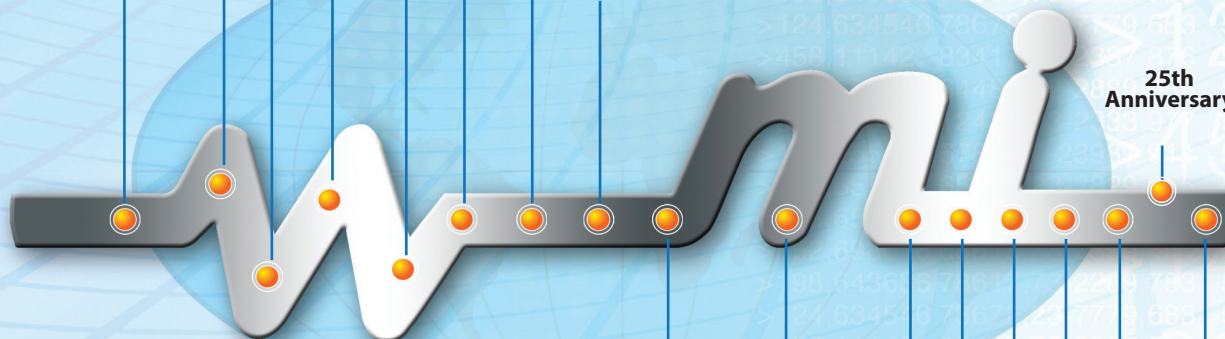
**1993**  
MI USA was founded

**1997**  
Re-develops DCC Technology which resulted in the world famous 6010B  
Resistance Bridge from 0.001 $\Omega$  to 10k $\Omega$ , Accuracy  $10^{-7}$

**1998**  
Develops 20,000 A Direct Current Comparator for the LHC at CERN

**2002**  
Develops the world's first and only portable cryogenic QUANT $\Omega$  (QHR)  
System Model 6800A Accuracy  $1 * 10^{-8}$

**25th  
Anniversary**



**2003**  
Developed the world's first room temperature  
Direct Current Comparator DCC Bridge (6010Q) for cryogenic applications  
Accuracy  $2 * 10^{-8}$

Develops first commercial automated High Resistance Bridge based on the  
binary voltage divider technology to 100V, Model 6000B Accuracy  $2 * 10^{-8}$   
MI Europe was founded

Develops first self calibrating Direct Current Comparator Ratio Bridge.  
Model 6242B with touch screen display.  
Range 1 $\Omega$  to 100M $\Omega$  Accuracy  $5 * 10^{-8}$

Develops world's first AccuBridge™ Technology DCC Resistance Bridge  
with complete self calibration.  
Range 0.1 $\Omega$  to 100K $\Omega$  Accuracy  $2 * 10^{-8}$

Develops first commercial Dual Source Bridge Technology for the  
measurement of high value resistors Range 10K $\Omega$  to 100T $\Omega$   
Voltage 1V to 1000V

Develops first automated Direct Current Comparator Resistance Bridge Model 6010D  
with touch screen display Range 0.01 $\Omega$  to 100k $\Omega$ , Accuracy  $4 * 10^{-8}$

Develops first automated high current 3000A Direct Current Comparator  
DCC Shunt Measurement System Ratio 1,000,000:1

Developed first Benchtop High Resistance Bridge



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