

Providing the Latest Innovations in Precision High Resistance Measurements



## FEATURES

- Bridge and Direct Measurement Modes of Operation
- Resistance Range 100 kΩ to 20 PΩ
- “True Ratio” Provides Multi-Ratios from 1:1 up to 100:1
- Test Voltages 1 to 1000 V
- Optional Current Measurement from 20 μA to 2 pA
- Better Performance & More Functionality than Commercially Available Dual Source Bridges
- Easy-to-Use Front Panel with a Single ‘Push-of-a-Button’ to Make a Measurement
- Automatic Ranging for Voltage and Other Measurement Parameters
- Logging and Analysis of Measurements
- Automation of Multiple Measurements with Guildline 6564 Resistance Scanner
- Surface and Volume Resistivity Measurements with 65221 Test Fixture
- IEEE-488.2 and RS232C with SCPI Commands

**GUILDLINE Instruments NEW 6540 Dual Measurement High Resistance Bridge** provides the best uncertainties of any commercially available high resistance measurement instrument available today.

With a measurement range from 100 kΩ to 20 PΩ, the 6540 provides two measurement modes. Bridge Mode allows technicians to use a reference standard and multiple ratios for best uncertainty, or Direct Mode allows a resistance to be measured without a reference standard.

**GUILDLINE’S NEW 6540 DUAL MEASUREMENT HIGH RESISTANCE BRIDGE PROVIDES THE LOWEST UNCERTAINTIES OF ANY COMMERCIAL HIGH RESISTANCE STANDARD!**

The Bridge Mode uses a standard reference resistor and compares the known value to the resistance being measured via ratio measurements. The available range of ratios is from 1:1 to 100:1 for the reference resistors. These ratio measurements are similar to a dual source bridge in that the reference resistor and unknown resistor are connected at the same time.

The 6540 Direct Measurement model allows the instrument to measure an unknown resistance without requiring a reference standard. Basically, connect the unknown resistor, press a button to start, and read the measurements.

The 6540 incorporates an advanced innovative design that dramatically simplifies operation, provides automation, and significantly reduces life cycle support of high resistance measurements. In normal laboratory environments, the 6540 provides much better uncertainties than any other commercial high resistance measurement instrument available today.

Using a Guildline 6564 High Resistance Scanner, fully automated multiple measurements can be made, greatly improving measurement and calibration throughput.

# 6540 Dual Measurement High Resistance Bridge

## Understanding the 6540 Automated Dual Measurement High Resistance Bridge

Historically, high resistance measurements were difficult to make with low uncertainty due to environmental and EMI considerations, design and limitations of available standards, and complexity of test setups such as using a dual source system. Measurements with a DMM are limited in range, available test parameters, and have higher uncertainties.

The 6540 design eliminates or reduces environmental effects such as temperature, EMI, and operator proximity. It provides two (dual) measurement capabilities allowing users to take full advantage of standards and operator skill levels within the laboratory environment. Also note that the 6540 is a low impedance standard. This means as you measure higher value resistance, the loading affect of the high resistance is minimized, allowing for much better uncertainty in the measurement. The 6540's unique *temperature controlled measurement chamber* behind the input and source terminals keeps all internal measurement circuitry at a stable temperature. This chamber is also heavily shielded for protection against EMI noise. The 6540 measurement circuitry, by design, is not affected by presence of an operator thus greatly simplifying measurement procedures.

The design of the 6540 measurement circuitry is based on the stability of a single Voltage Source that only requires an annual verification. The 6540 Measurement circuitry is on the low side of the voltage and has low impedance, thus provides more stable and more accurate measurements. For life cycle cost considers, the 6540 incorporates a simplified artifact calibration approach, requiring just a single 100 MΩ Standard Resistor and a DMM (i.e. for voltage) with a full calibration required only once every three years.

### Bridge (Ratio) Measurement Mode

In Bridge mode, an operator connects both a reference standard (i.e.  $R_s$ ) and unknown resistance (i.e.  $R_x$ ) at the same time and uses a ratio measurement (i.e. ratios from 1:1 to 100:1). The 6540 uses the **same source and same measurement circuitry to measure both** resistors eliminating any errors due to mismatched standards. In Bridge Mode, the 6540 takes a measurement on the Reference Resistor ( $R_s$ ) connected (Figure 1). Then automatically switches the measurement and circuitry to the unknown Resistance ( $R_x$ ) shown in figure 2. The 6540 internally calculates and displays the measurement results with the equation (simplified):

$$R_{xc} = R_{sc} * R_{xm} / R_{sm}$$

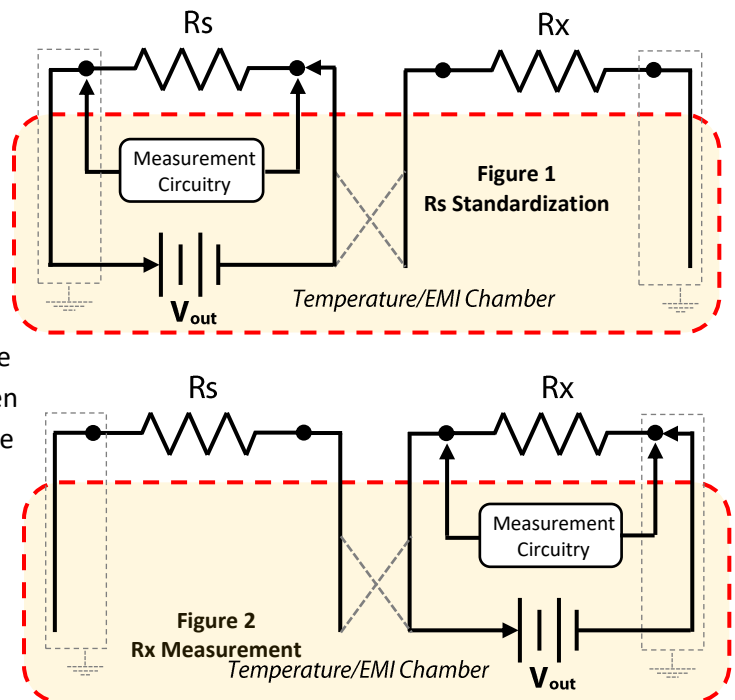
Where:

$R_{xc}$  = Display Ratio value of  $R_x$  on the 6540

$R_{xm}$  = Actual Measured resistance value of  $R_x$

$R_{sc}$  = Resistance value of the  $R_s$  standard

$R_{sm}$  = Measured resistance value of  $R_s$



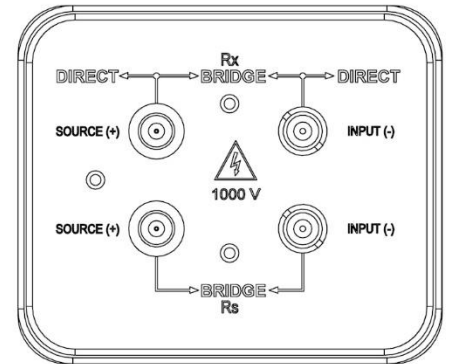
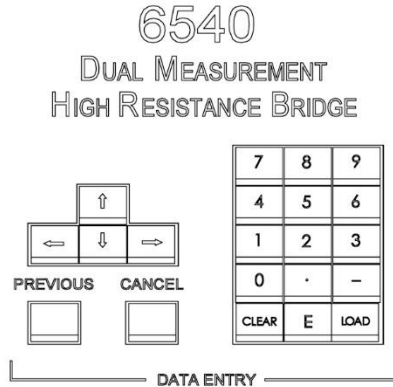
# 6540 Dual Measurement High Resistance Bridge

Simple and easy to Use! Immune to Environmental affects! Contrast the 6540 to other measurement methods that require multiple voltage sources that must be calibrated and matched, need electrometers or null detectors, and are susceptible to environmental effects such as EMI and temperature. And along with simplicity the 6540 performs better and is less expensive to purchase and operate than competitive products.

The 6540 can be operated from the front panel manual control or from either one of the two standard communication control buses. Multiple measurement information such as the calculated ratio, calculated resistance, and standard deviation are provided from the front panel or are available via published SCPI commands. Add a Guildline 6564 High Resistance Scanner and multiple test setups can be run without operator intervention.

## Direct Measurement Mode

For Direct Measurement Mode, the 6540 acts as a DMM Style measurement standard as shown in Figure 3. The 6540 is completely EMI shielded, temperature controlled and very easy to operate. Simply connect the unknown resistor (DUT or Rx) to the terminals as shown in the diagram and press



Start. That's it. You will have measurements not affected by environmental conditions, operator presence, or laboratory conditions. These results will have the absolute best uncertainties provided by any direct resistance reading standard made today. The 6540 provides two levels of uncertainty specifications to meet your requirements.

The first is a Relative 12 month specification. This specification allows customers to calibrate the 6540 and use their own calibration uncertainties to determine their actual uncertainties. The second specification is a 12 month absolute specification that includes the calibration uncertainty based on Guildline's 17025 Accreditation. These specifications will still be valid for  $\pm 5\text{ }^{\circ}\text{C}$  (i.e. because of the internal temperature stabilized chamber) and are valid when operators are in close proximity (i.e. because of a low impedance measurement and superior EMI shielding).

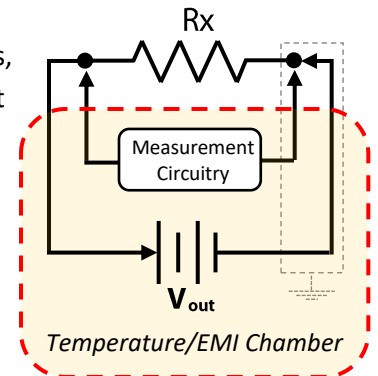


Figure 3 -6540 Direct Measurement Mode

## OPTIONAL CURRENT MEASUREMENT

An optional current measurement is available for the 6540. Providing a wide range from 10  $\mu\text{A}$  down to 2 pA, the 6540 provides some of the best uncertainties for low current measurement available today. The measurement circuitry, like the bridge, is contained within a temperature and EMI chamber. This allows a wide temperature range for the laboratory environment. Specifications for the current option are absolute and include Guildline's traceable uncertainties.

12 Month Absolute Specifications ( $\pm\%$ ) $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$								
Range	20 $\mu\text{A}$	2 $\mu\text{A}$	200 nA	20 nA	2 nA	20 pA	200 pA	2 pA
Accuracy	$\pm 0.1\%$	$\pm 0.1\%$	$\pm 0.2\%$	$\pm 0.2\%$	$\pm 0.2\%$	$\pm 0.2\%$	$\pm 2\%$	$\pm 10\%$

# 6540 Dual Measurement High Resistance Bridge

To maximize the capabilities of this Dual Measurement Bridge, Guildline offers the best in High Resistance Standards including up to 10 PΩ and can provide High Resistance Standards in a Temperature Controlled and EMI Shielded Environment.

Consider that in Bridge mode, the 6540 is capable of a 5 ppm ratio measurement at 1 GΩ over a 5 °C laboratory temperature range. If you are using a Resistance Standard (Rs) that has a 6 to 10 ppm/°C temperature coefficient – temperature becomes a major contributor to the measurement uncertainty.

Guildline has recognized these contributors and has multiple solutions.

For example, the Guildline Model 6636 Temperature Controlled High Value Resistance Standard provides the same temperature control and EMI shielding for environmental affects that the 6540 incorporates. This makes the 6636 a perfect solution for Bridge Ratio measurements which depend on a stabilized Resistance Standard.

Already have your Resistance Standards or require a controlled environment for the Device Under Test? Consider the 5030 Series of Programmable Temperature Air Baths. These Stainless steel, double-walled, dual fan, 1 mK settable resolution Air Baths will not only provide excellent temperature control, but also provide protection against affects such as Noise or EMI due to the excellent shielding and grounding that these Air Baths provide! The Model 5032 has the capabilities for full automation, using IEEE or RS 232. The 5032 is unique in that it has a 2<sup>nd</sup> PRT for measuring the internal temperature anywhere inside the bath which can be read directly from the front panel or read via a SCPI command.

And speaking of automation. You can complete the system with either our 8 or 16 channel 6564 High Resistance Scanner and then simply run multiple resistance measurements without operator intervention. A customer can easily perform multiple and difficult high resistance measurements with a cost effective and time saving solution.

6636 Temperature Stabilized Resistance Standard



5032 Programmable Air Bath



For example, a complete range of resistance standards from 100 kΩ to 100 TΩ can be calibrated in a single day without operator intervention. The 6564 Scanner can handle the high output voltage (i.e. up to 1000 V) of the 6540 Dual Measurement Bridge and the entire range of the 6636 Resistance Standards, while adding minimal uncertainty for measurements less than 100 TΩ's.

Guildline is the only company that can offer so much in such a compact and complete solution for high resistance measurements.

# 6540 Dual Measurement High Resistance Bridge

## 6540 DUAL MEASUREMENT HIGH RESISTANCE BRIDGE SPECIFICATIONS

### Bridge Mode

Rs	Max Resolution	Voltage Range <sup>2</sup>	12 Month Ratio Accuracy <sup>3</sup>		
			1:1	10:1	100:1
100 kΩ <sup>1</sup>	0.00001 kΩ	1 V	7	7	20
1 MΩ	0.0000001 MΩ	1 V	7	7	20
10 MΩ	0.000001 MΩ	1 V to 10 V	6	6	20
100 MΩ	0.00001 MΩ	1 V to 100 V	3.5	6	20
1 GΩ	0.0000001 GΩ	1 V to 1000 V	5	7	20
10 GΩ	0.000001 GΩ	10 V to 1000 V	7	10	30
100 GΩ	0.00001 GΩ	100 V to 1000 V	10	15	70
1 TΩ	0.0000001 TΩ	1000 V	20	70	120
10 TΩ	0.000001 TΩ	1000 V	70	100	
100 TΩ	0.00001 TΩ	1000 V	180		
1 PΩ	0.0000001 PΩ	1000 V	800		
10 PΩ	0.000001 PΩ	1000 V	2000		

1 – 100 kΩ is minimum measurement

2 – Selectable from available voltages

3 – Ratios do not include Rs Uncertainty and are specified ( $\pm \mu\Omega/\Omega$ ) at k=2 (95% CL)

### Direct Measurement Mode

Range <sup>1</sup>	Full Scale	Max Resolution	Voltage Range <sup>2</sup>	12 Month Accuracy <sup>3</sup>	
				Relative	Absolute
100 kΩ	200 kΩ	0.00001 kΩ	1 V	100	120
1 MΩ	2 MΩ	0.0000001 MΩ	1 V	50	60
10 MΩ	20 MΩ	0.000001 MΩ	1 V to 10 V	50	60
100 MΩ	200 MΩ	0.00001 MΩ	1 V to 100 V	50	60
1 GΩ	2 GΩ	0.0000001 GΩ	1 V to 1000 V	50	60
10 GΩ	20 GΩ	0.000001 GΩ	10 V to 1000 V	100	140
100 GΩ	200 GΩ	0.00001 GΩ	100 V to 1000 V	100	150
1 TΩ	2 TΩ	0.0000001 TΩ	1000 V	500	575
10 TΩ	20 TΩ	0.000001 TΩ	1000 V	1000	1150
100 TΩ	200 TΩ	0.00001 TΩ	1000 V	1500	2000
1 PΩ	2 PΩ	0.0000001 PΩ	1000 V	10000	15000
10 PΩ	20 PΩ	0.000001 PΩ	1000 V	100000	150000

1 - Minimum resistance measurement is 20% of Range for selected range. 100 kΩ is minimum measurement

2 – Selectable from available voltages

3 – Accuracy is specified ( $\pm \mu\Omega/\Omega$ ) at k=2 (95% CL). Absolute accuracy includes Guildline Laboratory Environmental parameters and 17025 Accredited Uncertainties



# 6540 Dual Measurement High Resistance Bridge

## GENERAL SPECIFICATIONS

Voltages		Statistics (Detail and Summary)				
1, 2, 5, 10, 20, 50, 100, 200, 500, 1000 V <sub>DC</sub>		Min, Max, Avg, Std Dev, # Samples				
Bridge Mode Connectors (Rs/Rx)		Direct Mode Connectors				
Source (+)	Miniature High Voltage MHV (F)	+	Miniature High Voltage MHV (F)			
Input (-)	3 lug Triax (F)	-	3 lug Triax (F)			
Display Resolution	4 to 8 Digits (Selectable)	Input Impedance	100 k $\Omega$ (Bridge & Direct)			
Measurement time	5ms to > 1000 seconds	# User Profiles	36 Programmable			
Input Voltage (User Selectable)			Power			
50 or 60 Hz ( $\pm$ 5%)	100, 120, 220, 240 VAC ( $\pm$ 10 %)		50 VA			
Rear Interfaces						
IEEE 488.2	RS232C	Interlock (Safety)	Ext Trig			
Temperature Environment						
Stability	Operating			Storage		
1 $^{\circ}$ C	15 $^{\circ}$ C to 30 $^{\circ}$ C	59 $^{\circ}$ F to 86 $^{\circ}$ F		-30 $^{\circ}$ C to 70 $^{\circ}$ C	-22 $^{\circ}$ F to 158 $^{\circ}$ F	
Humidity (Non-Condensing)						
Operating	20 % to 50 % RH		Storage	15 % to 80 % RH		
Dimensions	(H)	(W)	(L)	Weight		
Metric (mm)	133.4	442	523	Instrument	25 lbs	11.4 kg
US (Inches)	5.25	17.4	20.6	Shipping	40 lbs	18.2 kg

## ORDERING INFORMATION

<b>6540</b>	Dual Measurement High Resistance Bridge with Range 100 k $\Omega$ to 100 T $\Omega$
<b>6540/XR</b>	Dual Measurement High Resistance Bridge with Extended Range 100 k $\Omega$ to 20 P $\Omega$
<b>-C</b>	Current Option – Add Current Option to Model
6540 Includes Manual, 2 Year Warranty and 17025 Accredited Calibration	

### 6540 OPTIONS (See 6530 Series Options datasheet for more information)

6564 Series	8 or 16 Channel, 1000 Volt High Resistance Scanners
9336/9337	See 9336/9337 Resistance Standards Data Sheet for More Information
6636	See 6636 Resistance Standards Data Sheet for More Information
65201	Penn Airborne Adapter
65221	Surface/Volume Resistivity Test Fixture
65222	Large Shielded Sample Enclosure
65223	Small Shielded Sample Enclosure
65224	Zero Link
65225	Lead Set
65226	Calibration Kit (Includes 65224 & 9336-100M)

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