



# 6535 SERIES

## AUTOMATED HIGH RESISTANCE MEASUREMENT SYSTEMS

Modular and Upgradable Fully Automated High Resistance Measurement Systems



### FEATURES

- Two Modes of Operation, Bridge Mode and Direct Measurement
- Standard Base Resistance Measurement from  $1\text{M}\Omega$  to  $100\text{T}\Omega$
- eXpanded Resistance Measurement Range from  $100\text{k}\Omega$  to  $20\text{P}\Omega$
- eXpanded Performance (and Range) @ 8 ppm for  $1\text{M}\Omega$  to  $1\text{G}\Omega$  &  $< 50\text{ppm}$  for  $10\text{G}\Omega$  to  $1\text{T}\Omega$
- Highly Controlled Temperature Environment Ensures Reliable Measurements
- Transfers Traceability of Primary Standards from NMI's or Other Sources
- Multi-Ratios up to 1000:1 in Bridge Mode
- Test Voltages from 1 to 1000 Volts
- Optional Current Mode to measure currents from  $10^{-2}$  to  $10^{-13}\text{A}$
- Scanner Capabilities to 1000V and 64 Channels
- Automated procedures for Calibrating High Resistance Decade Boxes
- Surface and Volume Resistivity Measurements with optional Test Fixtures
- Simple Artifact Verification Procedure Ensures the 6535 Remains within Specifications

**GUILDLINE Instruments 6535** High Resistance Measurement System consists of Guildline's new 6530 TeraOhm Bridge-Meter, our new 6564 High Resistance Scanner and Temperature Stabilized 6636 High Resistance Standards. The System comes complete with Guildline's TeraCal™ Software providing full automation. Individual data sheets for these instruments and standards can be located on the Guildline Website.

**THE 6535 RESISTANCE MEASUREMENT SYSTEM IS THE MOST TECHNOLOGICALLY ADVANCED, HIGHLY MODULAR AND EASIEST TO USE HIGH RESISTANCE SYSTEM AVAILABLE ON THE MARKET TODAY!**

Guildline's 6535 High Resistance Measurement System provides demanding users around the world the best in DC High Resistance Measurement performance and value for the range of  $100\text{k}\Omega$  to  $20\text{P}\Omega$ . Incorporating some of the most unique standards available for measurement, this system is the only "turn-key" Automated High Resistance Measurement System available today.

The System is highly configurable to meet wide ranging workload requirements. The 6535 is capable of dual modes of operation with direct resistance measurements from  $100\text{k}\Omega$  to  $20\text{P}\Omega$  with voltages to 1000 Volts. Similarly, the 6535 System provides a Bridge Ratio mode to allow the absolute best uncertainty found in any commercialized high resistance measurement system.

In addition, the Current Mode Option allows the System to measure direct current from  $10^{-2}$  to  $10^{-13}\text{A}$ . With the use of the 6636 resistance standards, the 6535 System can also generate traceable, low uncertainty, very small currents.

Existing Guildline 6520 Teraohmmeters can be upgraded to any of the four 6530 Models which will provide better performance and uncertainties. At the same time a 6520 customer can upgrade to a complete 6535 System at a substantially reduced price.

# 6535 Series of High Resistance Measurement Systems

Guildline's 6535 unique design and modularity allows customers to purchase what they need today to support their existing calibration and research needs; and be assured of an upgrade path to support their future requirements. The system is typically delivered ready for use in a small equipment rack. In fact, a system with a built in 6636 Six Element Resistance Standard, A 16 Channel High Resistance Scanner, and the 6530 TeraOhm Bridge-Meter **is only 14" in total height (35.5 cm)**.

A 6535 System has built-in EMI shielding and internal temperature stability. The 6530 TeraOhm Bridge-Meter measurement circuitry is both temperature stabilized and heavily shielded. The 6636 Resistance Standard used in the system is also temperature stabilized and shielded. This greatly reduces the environmental effects. Other high resistance measurement instruments, including dual source bridges, are very sensitive to electrostatic, EMI and temperature affects.

**Complete Modularity and Expandability:** National Metrology Institutes, Electrical Power Companies, Calibration Companies, Militaries and other customers are continually upgrading their calibration procedures. As their requirements for high resistance and low current measurements expand, they are purchasing the upgrade options provided for the 6535 System. Guildline is the only manufacturer in the world to provide these modular expansion features for a high resistance measurement system. Just look at the ways to make your 6535 System even better:

**Improved Uncertainty / Accuracy:** Customers can upgrade from the Base Model 25 ppm uncertainty for the 1 M $\Omega$  to 1 G $\Omega$  range to the Expanded Performance Models (i.e. XP and XPR) uncertainties of 8 ppm for the 1 M $\Omega$  to 1 G $\Omega$  range, and < 50 ppm for the 10 G $\Omega$  to 1 T $\Omega$  range. This allows customers to improve their uncertainties as new instruments are released into the market place.

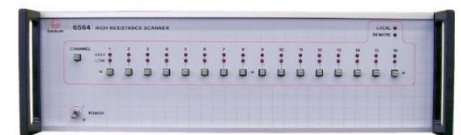
**Expanded Resistance Measurement Range:** Customers can upgrade from the Base Model ranging from 100 M $\Omega$  to 100 T $\Omega$  to the eXpanded Range and eXpanded Performance & Range (XP and XPR) Models which measure from 100 k $\Omega$  up to 20 P $\Omega$  with lower uncertainties. This allows customers to expand their measurement capabilities and calibration scope as their requirements change.

**Current Option:** This option allows currents to be measured from 10<sup>-2</sup> to 10<sup>-13</sup> A. A 6535 System with Current Option can be used to calibrate low current meters such as nano-amp meters. With the 6636 Temperature Controlled Resistance Standard, stable and traceable low value currents can also be generated.

**Scanner Channels:** The 6535 System can be purchased with 8 to 64 channels allowing a wide range of standards and instruments to be connected and calibrated automatically without operator intervention.

**Resistance Standard:** The 6535 System incorporates the 6636 High Resistance Standards.

This Resistance Standard provides user specified decade values with 4 to 6 Resistance values in one 3 U High chassis. Multiple 6636 Resistance Standards can be used with the System. You are only limited by available Scanner Channels. The 6636 comes standard with a 30°C internal temperature set point, however the temperature set point can be changed to meet user requirements (See 6636 Data Sheet for details).



6564 Scanner Front View



# 6535 Series of High Resistance Measurement Systems

Existing Guildline 6520 Teraohmmeters can be upgraded to any of the four 6530 Models which will provide better performance and uncertainties. At the same time a 6520 customer can upgrade to a complete 6535 System at a substantially reduced price and protect their complete investment on the 6520.

The quality of the 6535 system extends to the Equipment Rack, PC Controller and wiring. The rack is a heavy duty 19-inch standard rack with a system power module. The rack also includes a rear door, dual fans, a high-quality grounding plane, an optional slide out laptop tray and has all the standards mounted with ALL wiring installed. A laptop PC controller with TeraCal™ software installed, and a National Instruments GPIB controller with drivers installed, completes this turn-key system.

This automation and functionality provided by the 6535 System improves the calibration uncertainties, range of equipment that can be supported, and the efficiency of calibration laboratories and research facilities. The 6535 High Resistance Measurement System can either be operated manually or in a computerized mode via the Standard IEEE-488 communication. This includes the ability to perform automatic data acquisition, real time graphing of results, real time uncertainty analysis, history logging, charting, and regression analysis. All user definable test variables, such as resistance standard to use, excitation voltage, etc can be programmed on a per test basis. These features give users full control and flexibility in automating routine calibration procedures and maximizing workload capabilities.



Production line testing, calibration of electrometers, semiconductor testing, capacitance leakage measurement, film surface and volume resistivity measurement, and other applications can all be automated by using the 6535 System. In the current mode, the 6530 Series can also be used to measure chemical reaction rates, photo-electric effects and ionization effects.

With a wide selection of options available, the power of the 6535 System is greatly increased. Added features include the ability to automatically record the ambient temperature, humidity and pressure via the 65220 environmental option or via user provided equipment. The information is logged and time stamped so a change in any of these conditions, which may have affected the measurement, is readily available. Other options include Shielded and Environmental enclosures, Surface and Volume Resistivity fixtures, Calibration Kits, and Lead Kits. Refer to the 6530 Option datasheet for description of available options – all of which work with the new 6535 High Resistance Measurement System.



The modularity of the 6535 High Resistance Measurement System is based on over 60 years of innovation, design knowledge, and manufacturing experience that Guildline has in building resistance measurement instruments. With a single System, the requirement for laboratory space is greatly reduced. There is also a corresponding reduction in the power requirements and associated heat generation when compared with numerous instruments required from multiple manufacturers to meet the same requirements.

**Lower Capital and Operating Costs:** A 6535 System can be purchased at lower cost than individual resistance standards and also costs much less than a commercial dual source bridge which requires two very stable voltage sources, a bridge, and a detector. And not only is the initial purchase cost less, but the ongoing annual calibration costs are less with a 6535 System.

# 6535 Series of High Resistance Measurement Systems

**What About the Competition?** The 6530 XP and XPR models provide the best uncertainties of any commercially available high resistance measurement instrument including commercially available dual source bridges. For example, if you look at Measurements International (MI) 6600A Dual Source Bridge – and measuring 100G – you will find a “relative” uncertainty of 15 ppm – exactly the same as a 6530-XPR Ratio Specification. However the 6530 specifications represent total uncertainty including covering an ambient  $\pm 3^{\circ}\text{C}$  Temperature Range and the calibration uncertainty. The MI specifications do not include calibration uncertainty and do not include temperature effects.

MI states that their dual source bridge technology replaces unreliable TeraOhmmeter/Electrometer technology. Yet the MI 6600 Dual Source Bridge has an electrometer inside the unit! MI also states that the 6600 has complete automation but this is not possible with a dual source design. The reference resistor must be changed when measuring DUTs (Device Under Test) of different nominal values. In comparison Guildline's 6535 System provides completely automated measurements. In addition, the 6535 System has auto ranging so a customer simply has to connect a DUT and hit 'Start'. With IEEE 488.2 and TeraCal Software (or SCPI programming) also provided with a 6535 - we are not sure how much more automated you can make a System.

To properly calibrate a dual source bridge, such as a MI 6600A, two voltage sources must be calibrated plus the internal electrometer in order to make direct measurements. The two voltage sources provided with the MI 6600A are in fact manufactured by Transmille and have secondary level performance. Similarly, the internal electrometer used by the 6600A is not manufactured by MI. More importantly none of the measurement circuitry used in a MI 6600A is temperature stabilized or placed inside a proper EMI shielded chamber. This means that their high resistance measurements are very susceptible to environmental effects, including operator proximity or movement. In comparison ALL measurement circuitry of a Guildline 6535 High Resistance Measurement System is contained inside a temperature stabilized chamber and multi-layer EMI shield. It is well known in the metrology community that temperature stability and proper EMI shielding are key for good high resistance measurements!

# 6535 Series of High Resistance Measurement Systems

## 6530 SERIES SPECIFICATIONS

Measurement Range <sup>1</sup> (Ohms)	Applied Voltage <sup>2</sup> Threshold	24 Hour Bridge Mode 1:1 and 10:1 (± ppm of Reading <sup>3</sup> ) 23°C ± 2°C				Direct Measurement Mode <sup>3</sup> 12 Month Uncertainty (± ppm of Reading <sup>3</sup> ) 23°C ± 2°C			
		Base <sup>4</sup>	XR <sup>4</sup>	XP <sup>4</sup>	XPR <sup>4</sup>	Base	XR	XP	XPR
90k to 200k	1V	NA	50	NA	40	NA	200	NA	150
200k to 2M	1V	NA	15	NA	8	NA	200	NA	150
2M to 20M	1V	25	15	8	8	250	200	150	150
20M to 200M	1V to 10V	25	15	8	8	150	100	80	80
200M to 2G	1V to 100V	25	15	8	8	200	150	150	150
2G to 20G	1V to 1000V	25	20	10	10	600	500	400	400
20G to 200G	10V to 1000V	25	20	15	15	800	700	600	600
200G to 2T	100V to 1000V	80	70	50	50	1200	1100	1000	1000
2T to 20T	1000V	500	200	120	120	3500	3000	2500	2500
20T to 200T	1000V	700	500	200	200	6000	5000	4000	4000
200T to 2P	1000V	NA	1500	NA	800	NA	20,000	NA	15,000
2P to 20P	1000V	NA	3500	NA	2000	NA	250,000	NA	200,000

1. Ranges are automatically selected or may be chosen manually.
2. The maximum test voltage is selectable. In Auto Range, Voltage is set by 6530 TeraOhm Bridge-Meter.
3. 12 Month Specification applies after 6530 one hour warm up.
4. Bridge Mode does not include instabilities of the Transfer Resistance Standard or the test resistance (e.g. dielectric effects, Voltage coefficient, etc)

## OPTIONAL 6530 CURRENT MEASUREMENT SPECIFICATIONS

Current Range (A)	6530 Series 1 Year Uncertainty (± %) 23°C ± 5°C			
	Base Model	6530-XR	6530-XP	6530-XPR
1 µA ► ◀ 10 µA	± 0.1%	± 0.1%	± 0.1%	± 0.1%
100 nA ► ◀ 1 µA	± 0.1%	± 0.1%	± 0.1%	± 0.1%
10 nA ► ◀ 100 nA	± 0.2%	± 0.2%	± 0.2%	± 0.2%
1 nA ► ◀ 10 nA	± 0.2%	± 0.2%	± 0.2%	± 0.2%
100 pA ► ◀ 1 nA	± 0.2%	± 0.2%	± 0.2%	± 0.2%
10 pA ► ◀ 100 pA	± 1%	± 1%	± 1%	± 1%
1 pA ► ◀ 10 pA	N/A	± 2%	N/A	± 2%
100 fA ► ◀ 1 pA	N/A	± 10%	N/A	± 10%

1. The temperature coefficient only needs to be used when the laboratory operating environment is outside the 23°C ± 2°C.

9334A's, 9336's and 9337's Resistance Standards are calibrated at one recommended and specified current or voltage. Guildline can calibrate at additional voltages or currents for a nominal fee. To calculate error due to voltage coefficients, simply look at the voltage the unit was calibrated with and the voltage the resistor is being used at. For example, if a 100MOhm resistor was calibrated at 100 Volts, but being used at a 50 Volt level, then the voltage coefficient uncertainty can be calculated by (100V - 50V = 50V). 50V x 0.2 ppm/V = 10 ppm uncertainty error contributed to voltage differences. Voltage Coefficients are provided for all Guildline Standard Resistors above 1 MOhm.

# 6535 Series of High Resistance Measurement Systems

**6636 Resistance Specifications** (refer to 6636 Data Sheet for Complete Specifications)

Nominal Resistance (Ohms)	Initial Tolerance <sup>1</sup> (+/- ppm)	12 Month Stability <sup>2</sup> (+/- ppm)	Temp Coefficient (+/- ppm/°C)	Maximum Voltage (Volts)
10 M	35	6	0.2	1000 V
100 M	50	15	0.2	1000 V
1 G	100	35	0.2	1000 V
10 G	200	100	1	1000 V
100 G	500	200	10	1000 V
1 T	1000	500	15	1000 V
10 T	3500	750	25	1000 V
100 T	6000	1000	35	1000 V

**Note 1:** Nominal initial tolerance is defined as the maximum variation of resistance mean values as initially adjusted at the point of sale.

**Note 2:** Stability is exclusive of the effects of applying power above 20 mW, but not exceeding the maximum voltage, in terms of hysteresis and short term temperature stabilization.

GENERAL SPECIFICATIONS			
Communication		IEEE 488.2 (SCPI Based Language Instructions)	
System Power Requirements		VAC: 100V, 120V, 220V and 240V ± 10% / 50 or 60Hz ± 5%	
System Operating Temperature to Full Specifications		23°C ± 3°C	73°F ± 7°F
System Maximum Operating Range (<50% RH)		+10°C to +40°C	+50°F to +104°F
System Temperature Storage Range		-20°C to +60°C	-4°F to +140°F
Operating Humidity	< 50% RH, non-condensing	Storage Humidity	15% to 80% RH
System Dimensions <sup>1</sup> Includes Rack (Width x Height x Depth)			Weight
445 mm x 445 mm x 610 mm		17.5" x 17.5" x 24"	52 kG 115 lbs

1. System dimensions and weight will depend on installed standard and options. Values provided are for a typical configuration with the System Rack, 6530 Bridge, One 16 Channel Scanner and a 6636-6 Standard.

ORDERING INFORMATION	
System Ordering Format	Where
<b>6535-XXX/SXX/RX-LV/CIS-XXX/Options</b>	
6535-	Is Standard System Designation (includes Rack and Integration)
XXX/	Specify TeraOhm Bridge-Meter (Specify Base, XR, XP or XPR) (Wired)
SXX/	Specify Number of Scanner Channels (Specify 8 to 64) (Wired)
RX-LV/	Resistance Standard with Decade Elements 10MΩ to 100TΩ (Wired)
	Specify RX as 6636 Element Number (4, 5 or 6 Elements) and LV is <u>Lowest Decade Start Value</u> Required (eg 10M, 100M, 1G, etc)
CIS-XXX/	Values= LPT (Laptop) or DSK (Desktop) with IEEE/TeraCal™ Software
/RC	Report of Calibration Available at Additional Charge
/A	Current Calibration Available at Additional Charge
/SM6535	Service Manual Available at Additional Charge
System Includes System Rack, All Standards Installed, Wired, Integrated and Tested.	
Operators and Software Manuals Included	
Calibration Certificate and Certificate of Conformance Included	
System Model Ordering Example ➡	<b>6535-XR/S16/R610M/CIS-LPT</b>

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