



## **Model 9337 Series**

### **High Value Precision Resistance Standards**

### **Technical Manual**

#### **NOTICE**

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# Table of Contents

<b>1</b>	<b>Introduction</b>	<b>1-1</b>
1.1	Unpacking and Inspection	1-1
1.2	Warranty	1-2
1.3	To Obtain Warranty or Calibration and Repair Service	1-3
1.4	Safety Information	1-4
<b>2</b>	<b>9337 Series Standard Specifications</b>	<b>2-1</b>
2.1	9337 Model Series Uncertainty Specifications	2-1
2.2	General Specifications	2-2
<b>3</b>	<b>Overview</b>	<b>3-1</b>
3.1	General	3-1
3.2	Series Design Layouts	3-2
3.2.1	1 T $\Omega$ to 10 P $\Omega$ Standard Values	3-2
3.3	Custom Values	3-3
<b>4</b>	<b>Calibration and Performance Verification</b>	<b>4-1</b>
4.1	Introduction	4-1
4.2	Calibration Overview	4-1
4.3	Calibration Interval and Performance	4-1
4.4	Calibration Temperature Point	4-2
4.5	Equipment and Standards Required for Calibration	4-3
4.6	Routine Calibration	4-4
4.7	High to Ultra-High Ohms Calibration Using Teraohmmeter	4-6
<b>5</b>	<b>Maintenance</b>	<b>5-1</b>
5.1	Replaceable Parts	5-1
5.1.1	Common Parts (All Models)	5-1

# List Of Figures

FIGURE 1 - 9337 SERIES.....	3-1
FIGURE 2 - 9337 SERIES FROM 1 TΩ TO 20 PΩ.....	3-3

## List Of Tables

TABLE 1 - 9337 MODEL SERIES UNCERTAINTY SPECIFICATIONS	2-1
TABLE 2 - LIST OF RECOMMENDED TEST CURRENTS OR VOLTAGES FOR RESISTANCE VALUES	4-5
TABLE 3 - TERAOHMMETER CALIBRATION DATA WORKSHEET	4-7

## 1 INTRODUCTION

This manual provides an overview of the 9337 Series of Air Resistance Standards and also contains the necessary information required to perform a calibration or verification test. General product information, description of case styles and performance specifications are also included.

This manual applies to all models of the 9337 Series of Resistance Standards unless otherwise noted. This includes custom values that are ordered.

The phone number in the USA and Canada to obtain Product Support, Calibration Service or Replacement Parts is (800) 310-8104.

To Contact Guildline Instruments, the following information is provided.

USA and Canada Telephone: (613) 283-3000

USA and Canada Fax: 1-613-283-6082

Outside US and Canada Telephone: + [0] [1] 613 283-3000

Outside US and Canada Fax: + [0] [1] 613 283-6082

You can also contact Guildline Instruments Limited via their Email or Websites.

Email is: [sales@guildline.com](mailto:sales@guildline.com)

Website is: [www.guildline.com](http://www.guildline.com)

### 1.1 Unpacking and Inspection

Every care is taken in the choice of packing material to ensure that your equipment will reach you in perfect condition. If the equipment has been subject to excessive handling in transit, the fact will probably be visible as external damage to the shipping carton.

In the event of damage, the shipping container and cushioning material should be kept for the carrier's inspection.

Carefully unpack the equipment and check for external damage to the standard. If the shipping container and packing material are undamaged, they should be retained for use in return shipments. If damage is found notify the carrier and Guildline immediately.

## 1.2 Warranty

Guildline Instruments warrants its products to be free of defects in manufacture and normal operation for a period of two (2) years from the date of purchase, except as otherwise specified. This warranty applies only in the country of original purchase and only to the original purchaser, who is also the end user. Equipment, which is defective or fails within the warranty period, will be repaired or replaced at our factory without charge at the discretion of Guildline Instruments.

In addition, standards and systems manufactured by Guildline Instruments are warranted to be free of defects in overall system operation for a period of two (2) years from the date of receipt by the original purchaser.

Third party system components purchased by Guildline carry the warranty of the original equipment manufacturer and will be accepted for claim by Guildline Instruments at our factory only after warranty authorization by the original manufacturer.

### **Limitation of Warranty**

Warranty coverage does not apply to equipment which has failed due to misuse, neglect, accident or abnormal conditions of operation or if modifications or repairs have been made without prior written authorization of Guildline instruments.

Temperature probes are not warranted against failure due to mechanical shock.  
Fuses, lamps and non-rechargeable batteries are not warranted against breakage.

### **Damage in Shipment to Original Purchase**

Instrument(s) should be thoroughly inspected immediately on receipt for visible damage. Any damage should be reported to the carrier and further inspection and operational tests should be carried out if appropriate to determine if there is internal damage. Contact Guildline Instruments before returning for repair. The Customer or purchaser must complete all final claims with the carrier.

Regular charges will apply to non-warranty service. External service charges and expenses will be billed at cost plus handling.



# Section 1

## 1.3 To Obtain Warranty or Calibration and Repair Service

**Call for a Return Material Authorization (RMA) number. RMA's are required for all Warranty Returns and/or Calibration and Repair Service Requests.** Telephone, Fax and email addresses to contact Guildline are provided previously.

Guildline Instruments will pay for all warranty costs including shipping from Guildline to the original shipment point. However, if the instrument is purchased within one country and shipped to another, Guildline will only pay for shipping to the original ship to country or customer point. The customer is responsible for paying for the shipping costs to return an item to Guildline.

### **USA Warranty Return Address.**

USA Customers should use the following address to return instruments for warranty service or calibration support.

Guildline Instruments Limited  
C/O AN Deringer  
835 Commerce Park Drive  
Ogdensburg, NY 13669

Mark on the outside of the box:

RMA # \_\_\_\_\_

Model # \_\_\_\_\_

Serial # \_\_\_\_\_

The Statement: "Canadian manufactured goods being returned for repair."

### **For all other countries, including Canada please ship to:**

Guildline Instruments Limited  
21 Gilroy Street, PO Box 99  
Smiths Falls, ON K7A 4S9

Mark on the outside of the box:

RMA # \_\_\_\_\_

Model # \_\_\_\_\_

Serial # \_\_\_\_\_

The Statement: "Canadian manufactured goods being returned for repair."



## 1.4 Safety Information

**These Standards can be used with Equipment capable of voltages up to 1000 V. The operator should be aware of the environment in which these standards are used.**

**WARNING: Use caution when working with voltages above 30 V ac rms, 42 V ac peak, or 42 V dc. These voltages pose a shock hazard.**

The 9337 Resistance Standards are designed to work within specifications to 100 mW of power and 1000 Vdc or less. Applying more than the recommended power or voltage will damage the unit and voids the warranty.

Do not use the Resistance Standard in wet environments.

Never use the Resistance Standard with the cover removed or the case open.

When making electrical connections, connect the common test lead before connecting the live test lead; when disconnecting, disconnect the live test lead before disconnecting the common test lead.

Inspect the Resistance Standard for damage such as cracked connectors prior to use. If unit has a burned smell or smoke is visible during use, discontinue use immediately.

If test equipment used with Resistance standards overloads or trips, this could be a sign that the resistance standard requires repair..

Inspect all test leads used with the Resistance Standard for damaged insulation or exposed metal. Check all test leads for continuity.

Ensure all test leads are correctly connected prior to applying current or voltage.

Do not use resistance standards around explosive gas, vapor or dust.

## 2 9337 SERIES STANDARD SPECIFICATIONS

### 2.1 9337 Model Series Uncertainty Specifications

Table 1 shows the specifications for the 9337 series. For custom models, please consult your calibration certificate to determine stabilities and maximum limits.

**Table 1 - 9337 Model Series Uncertainty Specifications**

#### High Values (2 Wire Configurations)

Model	Nominal Resistance Value ( $\Omega$ )	Initial <sup>1</sup> Tolerance $\pm$ ppm	12 Month Stability <sup>3</sup> (+/- ppm)	Temperature Coefficient $\pm$ ppm/ $^{\circ}$ C	Voltage Coefficient $\pm$ ppm/ $V_{dc}$
9337-1T	1T	1000	500	<300	<2
9337-10T	10T	3000	750	<500	<2
9337-100T	100T	5000	1000	<800	<2
9337-1P	1P	2%	2000	<1000	<2
9337-10P	10P	30%	2%	<5000	<5
9337-X	Customer Specified Value		Specifications Provided Upon Request		

**Note 1:** Initial Tolerance is the maximum variation of resistance mean value as adjusted initially at the point of sale.

**Note 2:** Calibrated in air at 23  $^{\circ}$ C traceable to the SI unit of electric resistance. Calibration uncertainties expanded and expressed at the 95% level of confidence. An ISO/IEC 17025 accredited certificate and report of calibration stating the calibrated value and estimated uncertainty is provided with each resistor.

**Note 3:** Maximum Voltage Rating: 1000 volts

**Note 4:** Special Values available on request

Note about Voltage and Temperature coefficients.

The Standards used for calibration are capable of much higher voltages that typically found on common instruments used with these resistance standards. For example, a 9337-100M is calibrated by Guildline with the value reported at 100 V. If this 100M was connected to a Keysight (Agilent) 3458A, the DMM is only capable of 5 V at 100 M and 1G $\Omega$ . This means that there is a 95 V Voltage coefficient minimum that must be added to the expected results when comparing results from the two voltages used. Taking 95 x 0.5 ppm/Volt (i.e multiply by the Voltage Coefficient) you have an additional adder of 47.5 ppm that must be added to the measurement result.

With a Fluke 8508, special care must be taken as to understanding the type of stimulus being presented to the Resistor under test. According to Fluke operators manual, in Lo Current mode, for 200M, the current used is 10 nA. This means that the maximum voltage available would be 10 nA x 100 M or 0.1 V. In the High Voltage mode, the current is increased to 1µA or an available voltage of 100 V. If the user is not aware of these modes, there is a potential of a 50 ppm error due to selecting the wrong mode of operation on the 8508.

Temperatures greatly affect high to ultra high resistance values. In some cases a single degree of temperature can affect a high value resistor by as much as 80% of the standards drift specification. Special care must be given to calibration in a stable temperature environment. Additionally, care must be given to ensuring that the temperature coefficient uncertainty is accounted for when the calibration temperature is more than 1°C from the usage temperature.

## 2.2 General Specifications

GENERAL SPECIFICATIONS - ALL MODELS				
<b>Environmental</b>	Temperature		Humidity	
Operating	18 °C to 28 °C		<50% RH non-condensing	
Storage	-20 °C to 60 °C		15% to 80% RH	
<b>Dimensions</b>	Height	Width	Depth	Weight
mm	82 mm	124 mm	79 mm"	0.63 kg
inches	3.8"	4.9"	3.1"	1.4 lbs

## 3 OVERVIEW

### 3.1 General

Guildline's 9337 Series of Ultra High Value Resistance Standards range from 1 T $\Omega$  to 10 P $\Omega$  and are 3 terminal devices with a design that minimizes the effect of current leakages from the source and output connectors. The high stability is achieved by the innovative use of a resistance divider network.

The Guildline 9337 Series of Ultra High Value Resistance Standards are excellent as high stability calibration laboratory standards for high accuracy resistance calibration in air, between 1 T $\Omega$  and 10 P $\Omega$ . The standards are also suitable for use as calibration standards for the Guildline Models 6530, 6520, 6500A and 6500 Digital Teraohmmeters, and the calibration of other high ohms measuring instruments.

The input and output terminals are still the same type of "N" connectors as the 9336 values, but the main element is configured in a different design. 1 T $\Omega$  and above elements use a 3

**Figure 1 - 9337 Series**



terminal design that minimizes the effect of current leakages from the source and output connectors. The high stability is achieved by use of a resistance divider network. Note in the diagram below, Resistor Values  $R_i$  (Input Resistor) and  $R_o$  (Output Resistor) are actually

composed and built as described for the 3 terminal design as shown in section 3.2.3.

The Divider Resistor ( $R_d$ ) is a very high precision resistor used to adjust the values of the Input and Output Resistors (i.e.  $R_i$  and  $R_o$ ) to give the desired nominal value. This design provides for a very high quality and stable standard and is not as reactive to environmental parasites as typically found in other high value resistance standards. This configuration (shown left) is also sometimes referred to as a delta-wye configuration.

This divider network design produces excellent measurement and highly stable results when used with ultra-precise High Resistance Measurement Standards such as Teraohmmeters and Active Arm Bridges.

The 9337 Resistance Standards are the worlds most accurate air resistannce standards available today. During manufacturing, the temperature coefficients are verified by actually measuring each standard at 3 temperature points (i.e. at 21°C, 23°C, and 25°C) using a primary level Direct Current Comparator Bridge and an air or oil bath. This ensures that the resistance standard meets the published temperature coefficient specification over the standards recommended range.

The 9337 Series can be used as working standards, or highly reliable and rugged transportable transfer standards. They are extremely useful for the calibration of the resistance ranges of multi-function calibrators and high accuracy digital multimeters, as well as for use in more classical standards and calibration laboratory applications where the need for high accuracy resistance values are required.

Guildline standards are the best by design and by manufacture. One key advantage of Guildline Resistance Standards is that each Resistance Value is made up from multiple resistance elements, not just a single element which is the technique used by most manufacturers.

### 3.2 Series Design Layouts

#### 3.2.1 1 TΩ to 10 PΩ Standard Values

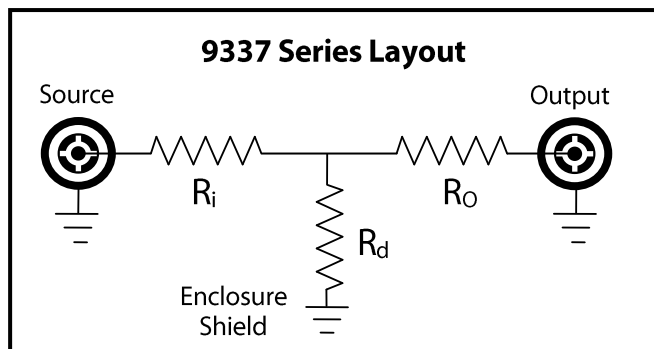
1 TΩ and above elements use a 3 terminal design that minimizes the effect of current leakages from the source and output connectors. The high stability is achieved by use of a resistance divider network. Note in the diagram below, Resistor Values  $R_i$  (Input Resistor) and  $R_o$  (Output Resistor) are actually composed and built as described for the 3 terminal design.

9337 Values use a pair of input/output Type N connectors to provide the termination for the standard. The "SOURCE" terminal connects to the supply of the measurement system, while the "OUTPUT" terminal connects to the measurement/detector. This layout schematic is shown to the right. The "SOURCE" connector connects to the supply of the measurement system, while the "OUTPUT" connector connects to the measurement/detector.

The Divider Resistor ( $R_d$ ) is a very high precision resistor used to adjust the values of the Input and Output Resistors (i.e.  $R_i$  and  $R_o$ ) to give the desired nominal value. This design provides for a very high quality and stable standard and is not as reactive to environmental parasites as typically found in other high value resistance standards. This configuration (shown below) is also sometimes referred to as a delta-wye configuration.

In the case of the 6530 TeraOhm Bridge-Meters, 6520 and 6500(A) Digital Teraohmmeters - the "SOURCE" terminal connects to the high voltage output connector and the "OUTPUT" terminal connects to the electrometer input. If necessary, the temperature of the enclosure may be monitored and a correction factor applied to the value of the resistance.

**Figure 2 - 9337 Series from 1 TΩ to 20 PΩ**



### 3.3 Custom Values

Any custom value from 1TΩ to 10PΩ is available upon request. For custom values, to determine the uncertainty, use the closest nominal value listed in the specification table. Actual uncertainties and measurements will be listed on the ISO/IEC 17025 Calibration Certificate.

# 4 CALIBRATION AND PERFORMANCE VERIFICATION

## 4.1 Introduction

The following section describes the calibration and performance verification procedures for the 9337 Series of Resistance Standards. It is recommended that Resistance Standards be calibrated at the current or voltage levels provided. These points are listed in Table 2.

## 4.2 Calibration Overview

This calibration procedure covers the entire range of the 9337 Series of Resistance Standards. The 9337 calibration procedure typically is based on using the 6530 Teraohm-Bridge Meter.

**Ultra High Ohms Resistance (Teraohmmeter):** The values range from 1 T $\Omega$  to 20 P $\Omega$  with calibration voltages from 100 V to 1000 V. Values in this range are calibrated in controlled air environment at 23 °C. An EMI Shielded environment is also recommended. Values in this range are measured by using a Teraohmmeter as a transfer standard and a traceable resistance standard.

## 4.3 Calibration Interval and Performance

It is recommended that the 9337 series be calibrated or verified on the manufacturer's recommended 12 month interval. As with all resistance standards it is highly recommended that past history be used to determine drift rates. Generally, resistance standards will drift in value more significantly in the first 12 months. After the initial 12 months, drift rates typically become smaller for all models.

It is highly recommended that each 9337 Series be calibrated within a highly controlled temperature environment.

Each 9337 is manufactured to provide some of the best (i.e. lowest) uncertainties when compared to other commercially available resistance standards. After recalibration the user should determine the Resistance Calibration Uncertainties by applying an uncertainty calculation that includes: uncertainties for drift, standards and equipment used; the calibration and laboratory environment; and other uncertainties applicable to that calibration.

Guildline offers ISO/IEC 17025 Accredited DC Resistance Calibration Services from its Smiths Falls, Canada Location. We can provide very good turn-around times with some of

the lowest uncertainties available today. 9337 Users may find the use of Guildline Calibration Services an excellent convenience as well as a great alternative to maintaining their own calibration facilities to support these standards. US customers can ship to a US address and Guildline makes all of the arrangements for shipping to and from Canada and for import and export.

#### 4.4 Calibration Temperature Point

The 9337 Series of Resistance Standards are normally calibrated at 23 °C.

The Guildline Instruments 5032 Temperature Air Bath (shown to the right) is recommended to provide the best calibration environment for “air-style” Resistance Standards. This Standard Laboratory Grade Air Bath maintains the temperature environment around the resistance standard to  $\pm 0.03$  °C of set point and also provides a highly desirable RF and EMI Shielded environment.

The calibration currents or voltages points for each standard value is listed in Table 2.

#### ***5032 Programmable Temperature Air Bath***





### 4.5 Equipment and Standards Required for Calibration

Note: Ultra High Ohms Resistance – resistances in the range 1 TΩ to 20 PΩ with calibration voltages from 100 V to 1000 V. High (and ultra-high) resistance requires voltage vs current as the stimuli. Values in this range are calibrated in air at 23 °C. These resistors are measured using a Teraohmmeter as a transfer standard and a traceable standard resistor.

#### **Use Standards:**

Guildline 6535 High Resistance Measurement System or

Guildline Instruments Model 6530 Digital Programmable Teraohmmeter with TeraCal Software with a Characterized Resistance Standard for Short Term Transfer. Models Include:

6636 Temperature Stabilized Resistance Standard or

9337/9337 Series Standard Air Resistors in a Temperature Controlled and EMI Shielded Environment

Guildline 65220 Environmental Monitor (to Record Temp and Humidity)

5030 Series Laboratory Grade Temperature Air Bath which provides both Temperature Control and EMI Shielding

#### **Or (Alternative Standards)**

Alternative Measurement Standard with Short Term Transfer Techniques

Guildline Instruments Model 6530, 6520 or 6500A Digital Programmable Teraohmmeter Resistance Standard for Short Term Transfer:

6636 Temperature Stabilized Resistance Standard

9337/9337 Series Standard Air Resistors in a Temperature Controlled Environment

Guildline 65223 Sample Shielded Enclosure

#### **Optional**

Guildline 6564 2-Wire, 8 or 16 Channel Scanner (For Automation of 1MΩ to 100 GΩ)

(Note – the Scanner model must be capable of operating at 1000 V)

Guildline TeraCal Software

Digital Thermometer (Acceptable Guildline Models 9535, 9540A, 9540B, 9540 or 5150)

### 4.6 Routine Calibration

This routine calibration procedure describes the calibration currents and/or voltages required for the 9337 Resistance Standards. The procedure is intended to be used as a reference for qualified metrology personnel who have a primary level standards laboratory with equipment available to support an instrument of this level of standards accuracy.

Qualified personnel means that the technician or metrologist performing the calibration has the necessary level and understanding on Direct Current Comparator Resistance Measurements and full understanding of the DCC Bridge operation's and will take precautions to avoid introducing errors from sources such as guard errors, thermal emfs, temperature and or EMI errors, connector and lead errors, and other sources of measurement errors. The procedure assumes operators will make adequate allowance for equipment stabilization and measurement settling times.

For the best uncertainties with least influence on the measurements, it is recommended that the procedure use automation technologies such as Bridgeworks Software, IEEE Control and 6664B/C or 6564 Low Thermal Scanners.

#### **Calibration Notes For All Models**

Always check availability of equipment and standards prior to starting the calibration. If the required equipment is not available, do not proceed with the calibration.

Ensure all equipment used is within the calibration validity interval.

Before beginning the calibration, inspect the UUT and all leads for damage and cleanliness. If the UUT is not in suitable condition for calibration, please clean or repair before proceeding.

Most of Table 2 recommended calibration points. For higher values (when Bridge is used in Voltage Mode), points listed may be less than 1 mW due to limitations of the Bridge and/or usage factors. While Table 2 lists recommended calibration points, actual calibration points should include consideration for the intended and/or application of the resistance standards. For example, if a high value resistor is intended to be used from 5 V to 100 V, then the calibration should include enough points that the voltage coefficient of the resistor is minimized or accounted for.

**Table 2 - List of Recommended Test Currents or Voltages For Resistance Values**

9337 Model	Recommended Voltage	Foot Note	Comments
9337-1T	1000 Vdc	1	Teraohmmeter Required
9337-10T	1000 Vdc	1,2	Teraohmmeter Required
9337-100T	1000 Vdc	1,2	Teraohmmeter Required
9337-1P	1000 Vdc	1,2	Teraohmmeter Required
9337-10P	1000 Vdc	1	Teraohmmeter Required

1 – Alternative Method can use 6530, 6520 or 6500A with Resistance Standard using Short Term Transfer Methods

2 – Optional Calibration Points can be used in place of the standard calibration point or added to the standard point for calibration.

### 4.7 High to Ultra-High Ohms Calibration Using Teraohmmeter

- (a) Place 9337 into 5030 Series Chamber set to 23 °C.
- (b) Place the 65220 Environmental Monitor next to the 9337 Resistance Standard and connect to the rear input of the 6530 Teraohmmeter.
- (c) Set the 6530 Teraohmmeter to appropriate settings as referred to in the Operators Manual.
- (d) Perform a SHORT TERM TRANSFER for the range that the 9337 Resistor will be using. This transfer is described in the 6530 Teraohmmeter Manual or is automated using the TeraCal Software.
- (e) After equipment and readings have stabilized (4-8 hours), record the resistance in Table 4 reading and record the actual temperature as read by the 65220 Environment Monitor or optional Digital Thermometer.
- (f) Repeat this process for additional voltages as required.
- (g) When all readings are recorded, go to Data Evaluation and Uncertainty Calculation.

**Note: Measurement Tips.**

Consider the following when setting up the measurement

Verify that the maximum voltage applied in the measurement will not exceed the specs for the UUT or the STD. In no case should you exceed 100 mW of applied power or 1000 Vdc.

Shielding the UUT will greatly improve stability of the reading. Using the 65223 or the 5030 Air Bath will provide the necessary shielding.

If using a PC set the environmental parameters in TeraCal.

Verify guard and ground connections (see 6530 Manual).

If using a Scanner, ensure that the proper channels are selected.

**Table 3 - Teraohmmeter Calibration Data Worksheet**

9337 Model ▶		Serial Number ▶	
Previous Cal Date ▶		Current Cal Date ▶	
Test Parameters <sup>1</sup>	Voltage	V	Cap
		pF	Thresh
	V		
Reference Resistor Serial Number ▶		Calibration Date	
Charted Reference Value <sup>2</sup>		Reference Uncertainty	

65220 Environmental Monitor Readings	Temperature	Humidity	Barometric Pressure
Current Cal	Ref1 Measurement	UUT Measurement	Ref2 Measurement
Temp Value 23 °C ▶			Corrected Reading <sup>2</sup>

		LAST CALIBRATION	CURRENT CALIBRATION
Corrected Readings	Temp Value 23 °C ▶		

Drift Specification From Table 1 ▶	_____ ppm/_____	◀ Note Time Frame(1 Year/6 Months Etc)
Calculated <sup>3</sup>	Drift @ 23 °C ▶	
		ppm

**Note 1 – Transfer method:**

For the transfer method to remain valid the test setting with respect to **capacitor** and **threshold MUST** remain the same for both reference and UUT measurements.

**Note 2 – To Calculate Corrected Reading using the following formula:**

For Corrected Reading (In Ω) Calculate Value Using formula:

$$\text{UUT Measurement} + [\text{Charted Reference Value} - ((\text{Ref1 Measurement} + \text{Ref2 Measurement})/2)]$$

**Note 3 – To Calculate Drift Specifications using the following formula:**

For Drift @ 23 °C (In ppm) Calculate Change (PPM) Using formula:

$$((\text{Current Cal}_{\text{Temp Value 23 °C}} - \text{Last Cal}_{\text{Temp Value 23 °C}}) / \text{Last Cal}_{\text{Temp Value 23 °C}}) * 1\text{E}^6$$

# 5 MAINTENANCE

Maintenance of the resistor consists only of routinely inspecting the unit for physical damage and cleanliness. Cleanliness is especially important on the high value resistors (1 MΩ and greater). These should be cleaned with isopropanol and a soft brush or cloth. Special care should be taken to ensure that the terminal connectors are clean and are not cracked or damaged.

## 5.1 Replaceable Parts

The following tables list the replaceable parts. **Note that once a part has been replaced, the unit may be required to be recalibrated.**

To Contact Guildline Instruments, the following information is provided.

USA and Canada Telephone: (613) 283-3000

USA and Canada Fax: 1-613-283-6082

Outside US and Canada Telephone: +[1] 613 283-3000

Outside US and Canada Fax: [1] +613 283-6082

You can also contact Guildline Instruments Limited via their Email or Websites.

Email is: [sales@guildline.com](mailto:sales@guildline.com)

Website is: [www.guildline.com](http://www.guildline.com)

### 5.1.1 Common Parts (All Models)

Part Number (GPN#)	Description
813-31082	Case Screws
925-23468	Desiccant
841-04000	Split Lock Washer
19746-01-01	Terminal Washer
30175-01-15	Insulator Top Post
30176-01-15	Insulator Bottom Post
018-02200	Rubber Feet