GUILDLINE INSTRUMENTS

OPERATOR MANUAL

FOR

MODEL 9330A SERIES

DC RESISTANCE STANDARDS

FOR USE IN OIL

OM9330A-A1-00
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1. INTRODUCTION

The Guildline Model 9330A Series of DC Resistance Standards, ranging from 1 Ω to 10 MΩ, are designed as very high stability calibration laboratory standards for high accuracy resistance calibration in oil (see Figure 1).

They can be used as working standards, or highly reliable and rugged transportable transfer standards. They are extremely useful as a reference standard with a DC Resistance or Temperature Bridge; the calibration of 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 values is required.

Figure 1-1 : 9330A Resistance Standard

9330A Reference Standards use multiple resistor elements that are individually graded and matched to offer the best perfomance possible, both with respect to their stability and temperature/voltage coefficients. The resistors are securely mounted to the inside of a rugged aluminum enclosure with openings designed to maximize the flow of oil through the standard. Improvements in their construction minimizes the effects of thermal emf's and elimination of leakage at the terminals. Five binding post connections on the top are provided (see Figure 1). The C1 and C2 connections are used to apply the test current or voltage to the resistor. The P1 and P2 connections are used to measure the resistance. The fifth connection is for chassis ground. These rugged Resistance Standards are designed to last for many years.

Note that during the calibration of a 9330A, the resistor has been immersed in oil. Traces of this oil may still be evident when the resistor is received. These oil traces do not indicate a problem with the resistor or leakage in the resistor.

Maintenance of the resistor consists only of routinely inspecting the unit for physical damage and cleanliness. They should be cleaned with isopropanol, and a soft brush or cloth. Special care should be taken to ensure the terminal connectionss and insulators are clean.

Figure 1-2 : 9330A Resistance Standard

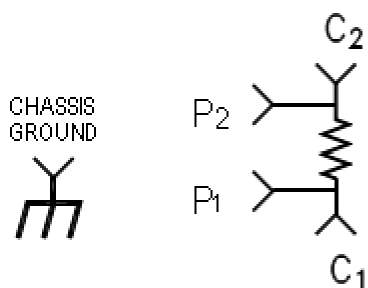

Figure 1-3 : 4 Wire 9330A Schematic

2. 9330A SERIES SPECIFICATIONS

GENERAL SPECIFICATIONS						
Environmental	Temperature			Humidity		
Operating	18 °C to 28 °C			<70 % RH non-condensing		
Storage	-20 °C to 60 °C			15 % to 80 % RH		
Dimensions	Height		Diameter		Weight	
	mm	Inches	mm	Inches	kg	lbs
9330A Models 0.001 & 0.01	156.2	6.15	78.7	3.1	0.30	0.7
9330A Models 0.1 to 100k	105.4	4.15	78.7	3.1	0.36	0.8
9330A Models 1M & 10M	109.2	4.3	78.7	3.1	0.36	0.8

Model (Nominal Ω)	Nominal Value (Ω)	Initial[1] Tolerance ± µΩ/Ω	Stability[2] Iniial 12 Months ± µΩ/Ω	Stability[2] 2^{nd} Year ± µΩ/Ω	Maximum Excitation	Temperature Coefficient < µΩ/Ω / °C	Voltage Coefficient < µV/V / °C
9330A-0.001	0.001	20	15	10	6 A	5	NA
9330A-0.01	0.01	10	10	5	3.2 A	2	NA
9330A-0.1	0.1	2.5	2.5	2	1 A	0.3	NA
9330A-1	1	2	2.5	1.5	320 mA	0.25	NA
9330A-2.5	2.5	2	2.5	1.5	200 mA	0.25	NA
9330A-10	10	2	2	1.5	100 mA	0.2	NA
9330A-25	25	2	2	1.5	64 mA	0.2	NA
9330A-100	100	2	2	1.5	32 mA	0.2	NA
9330A-300	300	2	2	1.5	18 mA	0.2	NA
9330A-400	400	2	2	1.5	16 mA	0.2	NA
9330A-1k	1 k	2	2	1.5	10 mA	0.2	NA
9330A-10k	10 k	2	2	1.5	3.2 mA	0.2	0.01
9330A-100k	100 k	3	2	1.5	1 mA	0.3	0.03
9330A-1M	1 M	5	4	3	0.32 mA	0.3	0.05
9330A-10M	10 M	15	5	4	100 µA	3	0.1

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: Initial 12-month stability is for after the first year of ownership. The initial 12-month drift is higher due to stabilization of elements. 2nd year stability is after the first 24 months of ownership and is used as the maximum yearly drift specification.
Note 3: Calibrated under DC excitation in oil at 25 °C, traceable to the SI unit of electrical resistance. Calibration uncertainties expanded and expressed at the 95 % level of confidence. A calibration certificate and report of calibration stating the calibrated value and estimated uncertainty is provided with each resistor and is ISO/IEC 17025 Accredited.

3. Calibration and Performance Verification

3.1. Introduction

The following section describes the calibration and performance verification procedures for the 9330A Series of Resistance Standards. It is recommended that Resistance Standards be calibrated between 1 mW and 10 mW of power, as per Table 3.1. Calibration is performed at DC Current Levels.

3.2. Calibration Overview

This calibration procedure covers the entire range of the 9330A Series of Resistance Standards.
It is highly recommended that a 9330A Resistance Standard be calibrated within a controlled temperature environment, ideally in oil for ohmic values up to 100 kΩ.

If calibrating in Air, it is recommended that a Temperature Stabilized Air Bath be used. The Standard Calibration Laboratory Temperature of 23 °C is the recommended temperature. Note that there is a temperature coefficient that must be accounted for in the uncertainty contributions if using at a temperature that is different from the last calibration. The Guildline 5032 Temperature Air Bath (shown to the right) is recommended to provide a stable temperature environment for calibration or use. This Laboratory Grade Air Bath maintains the temperature environment around the resistance standard to ± 0.03 °C of set point and also provides a desirable RF and EMI Shielded environment.

Figure 3-1 : 5032 Programmable Temperature Air Bath

If calibrating in Oil, it is recommended that the bath be stable to 3 mK or less. The Guildline 5600 Precision Fluid Bath is the recommended bath. For Oil Baths, it is recommended that the oil temperature be between 23°C and 25°C for calibration. A 5600 Series Precision Fluid Bath is shown below.

Figure 3-2 : 5600 Series Precision Fluid Bath

3.3. Calibration Interval and Performance

It is recommended that the 9330A series be calibrated or verified at 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.

Each 9330A is manufacturered to provide some of the best (i.e. lowest) uncertainies 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 enviroment; and other uncertainties appplicable to that calibration.

Guildline offers ISO/IEC 17025 Accredited DC Resistance Calibration Services from its Smiths Falls, Canada Location. We can provide some of the lowest uncertainties available. 9330A customers may find that Guildline's Calibration Service is an excellent 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.

3.4. Calibration Temperature Point

The 9330A Series of Resistance Standards up to 100 kΩ are normally calibrated in oil at 25 °C. Higher ohmic values are normally calibrated in air at 23 °C. The calibration currents or voltages points for each standard value is listed in Table 3.1.

3.4.1. Equipment and Standards Required for Calibration

The following Resistance Standards and Test Equipment are required for calibration.
Calibration Standards in the ohmic range of 0.001 Ω to 100 kΩ:
Note: Normal Ohms Resistance – 4-Wire resistances in the range 0.001 Ω to 100 kΩ with currents less than 145 mA. Values in this range are calibrated in a controlled oil temperature of 25 °C.

Preferred Equipment Requirement:
Complete 6625A Resistance Measurement System (See Below for Alternative Acceptable Equipment Models)
5600 Series Fluid Bath (for calibration in Oil) OR
5032/5030 Series Laboratory Grade Temperature Air Bath (for calibration in Air)

Laboratory Grade Primary Resistance Standard (Acceptable Models)
Guildline Instruments 6634A or 6634B Temperature Stabilized Resistance Standard
Guildline Instruments 9330, 9330A or 7330 Oil Standards maintained in a Guildline Guildline 5600 Fluid Bath or Guildline 5032/5030 Air Bath
Guildline Instruments 9334A or 7334 Air Standards maintained in a Guildline 5032/5030 Air Bath

Low Thermal Lead Sets or Low Thermal Wire (Acceptable Models)
Guildine 6622A Precision Lead Set For Resistance Bridge
Guildline SCW 18 or 22 Guage Low Thermal Wire

Or Alternative Measurement Equipment:

(a) Direct Current Comparator Resistance Bridge (Acceptable Models)
    Guildline Instruments 6640Q DCC Resistance Bridge
    Guildline Instruments 6622A Series DCC Resistance Bridge
    Guildline Instruments 6675 or 6675A Series DCC Resistance Bridge

(b) Optional (For Automation and Connections)
    Guildline 6664B/C 4-Wire, 8 or16 Channel Low Thermal Scanner (For Automation)
    Guildline Bridgeworks Software

3.5. Routine Calibration

This routine calibration procedure describes the calibration currents and/or voltges required for the 9330A 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 (DCC) Resistance Measurements. This includes a full understanding of the DCC Bridge operation's and the precautions necessary to avoid introducing errors 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 a 6664B/C Scanner.

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 3.1 recommended calibration points are for 10 mW of Power. While Table 3.1 lists recommeded calibration points, actual calibration points should include consideration for the intended and/or application of the resistance standards.

Table 3-1 : List of Recommended Test Currents For Resistance Values (i.e. for 10 mW)

9330A Model	Recommended Current
9330A-0.001	3.2 A
9330A-0.01	1 A
9330A-0.1	316 mA
9330A-1	100 mA
9330A -2.5	63.2 mA
9330A -10	31.6 mA
9330A -25	20 mA
9330A -100	10 mA
9330A -300	5.8 mA
9330A -400	5 mA
9330A -1k	3.2 mA
9330A -10k	1 mA
9330A -100k	0.32 mA
9330A -1M	0.1 mA
9330A -10M	31.6 µA

3.5.1. Ohms Calibration (Air)

Use Table 3.2

(a) Place 9330A into 5030 Series Temperature Stabilized Air Chamber.

(b) Setup DCC Resistance Bridge for appropriate measurement (refer to Operator Manual).

(c) Set chamber temperature to 23 °C and allow to stabilize for a minimum of 12 hours.

(d) While Stabilizing record last calibration date and values in Table 3.2.

(e) While Resistor is stabilizing, set Bridge to appropriate settings as refered to in the Operator Manual for the DCC Bridge that is being used.

(f) After equipment and readings have stabilized, record the resistance and temperature in Table 3.2. If Air Temperature is different from the last calibration, account for any resistance changes due to temperature by applying the Temperature Coefficient of the 9330A Resistance Standard.

Table 3-2: Calibration Data Worksheet (AIR)

9330A Model ▶		Serial Number ▶	
	Calibration Dates ▶	**LAST CALIBRATION**	**CURRENT CALIBRATION**
	Applied Current (Table 2) ▶		
Current (I^2R) / Voltage (E^2/R)	Calculated Power ▶		

		LAST CALIBRATION	**CURRENT CALIBRATION**
Actual Readings	Temp Value 23 °C ▶		

	Drift Specifcation From Table 1 ▶	________ μΩ/Ω /________	◀ Note Time Frame(1 Year/6 Months Etc)
Calculated[1,2]	Drift @ 23 °C ▶	μΩ/Ω	

Note 1 – To Calculate Drift Specifications using the following formula:

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

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

Note 2 – For Air Calibration, Ensure any Temperature Coefficient if Different Temperature is ued is accounted for.

3.5.2. Ohms Calibration (Oil)

Use Table 3.3

(a) Ensure Resistor is cleaned and free of debris before step b.
(b) Place 9330A into 5600 Fluid Bath.
(c) Setup DCC Resistance Bridge for appropriate measurement (refer Operator Manual).
(d) Set chamber temperature to ___ °C (Record Oil Temperature used on Sheet) and allow to stabilize a minimum of 12 hours. Recommended Oil Temperature range is 23° to 25°C.
(e) While Stabilizing record last calibration date and values as listed in Table 3.3.
(f) While Resistor is stabilizing, set bridge to appropriate settings as refered to in the Operator Manual for the DCC Bridge that is being used.
(g) After equipment and readings have stabilized, record the resistance and temperature in Table 3.3.
(g) When all readings are recorded, go to Data Evaluation and Uncertainty Calculation. If Oil Temperature is differenent from the last calibration, account for any resistance changes due to temperature by applying the Temperature Coefficient of the 9330 Resistance Standard.

Note: Measurement Tips.

Consider the following when setting up the measurement

Verify that the maximum voltage or current 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.

Verify the reversal rate is appropriated for the measurement and the uncertainty desired.

Ensure that you know whether the measurement you are reading on the Bridge is either a ratio or actual ohms value.

If using a computer, verify that the number of samples and logging delay are appropriate.

If using a computer, set the environmental parameters in BridgeWorks .

Verify guard and ground connections (see Resistance Bridge Operator Manual).

If using a Scanner, ensure that the proper channels for Rx and Rs are selected.

Table 3-3: Calibration Data Worksheet (OIL)

9330A Model ▶		Serial Number ▶	
		LAST CALIBRATION	**CURRENT CALIBRATION**
	Calibration Dates ▶		
	Applied Current (Table 2) ▶		
Current (I^2R) Voltage (E^2/R)	Calculated Power ▶		

		LAST CALIBRATION	**CURRENT CALIBRATION**
Actual Readings	Temp Value 25 °C ▶		

	Drift Specifcation From Table 1 ▶	_________ µΩ/Ω / _________	◀ Note Time Frame(1 Year/6 Months Etc)
Calculated[1,2]	Drift @ 25 °C ▶	µΩ/Ω	

Note 1 – To Calculate Drift Specifications using the following formula:

For Drift @ Specified Oil Termpeature (In µΩ/°C) Calculate Change (µΩ/Ω) Using formula:

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

Note 2 – For Oil Calibration, Ensure any Temperature Coefficient if Different Temperature is used is accounted for.

4. Maintenance

Maintenance of the resistor consists of routinely inspecting the unit for physical damage and cleanliness. Cleanliness is especially important with respect to oil resistors. **Do not use isopropanol** or cleaners containing isopropal alcohol. These should be cleaned with :

- **Deionized water with mild detergent**: Use a small amount of mild, non-ionic detergent in deionized water applied to a lint-free cloth or swab. Clean carefully wipe and then rinse thoroughly with deionized water applied to a lint-free cloth to avoid leaving residue.
- **Electronics-grade contact cleaners** (alcohol-free variants): Products offer specialized cleaning solutions for sensitive electronic components and are alcohol-free. Look for non-residue, non-corrosive formulas designed for precision instruments.
- **Water-based cleaning solutions**: Some cleaning solutions made specifically for electronics or laboratory equipment are water-based and alcohol-free.

Special care should be taken to ensure that the terminal connectors are clean and are not cracked or damaged.

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 Limted via their Email or Websites.
Email is: sales@guildline.com
Website is: www.guildlinecom

Common Parts (All Models)

Part Number (GPN#)	Description
813-01102	Case Screws (4 Req’d)
010-01273	Binding Post (Red)
010-01274	Binding Post (Black)
010-05284	Binding Post (Gnd)