



9334A Series

ULTRA-PRECISE "AIR" RESISTANCE STANDARDS

Very High Stability Calibration Laboratory Resistance Standards



9334A SERIES FEATURES

- ◆ 12 Month Stabilities Low as 2 ppm!
- ◆ Wide Operating Range 18 °C to 28 °C!
- ◆ Resistance Range 1 μΩ to 100 GΩ!
- ◆ ISO/IEC 17025 Calibration!
- ◆ Low Temperature Coefficients!
- ◆ Compact and Ruggedized!
- ◆ Nominal Initial Accuracy < 2 ppm!
- ◆ Voltage Hysteresis < 0.1 ppm!
- ◆ High Power Rating, Low Power Coefficients!
- ◆ Guard and Shield Compliant!
- ◆ Direct Plug-In Models for Wavetek 1271 and 1281 DMMs!
- ◆ 1 GΩ Direct Plug-In for Agilent 3458A
1 GΩ and 10 GΩ Direct Plug-In for Fluke 8508A DMMs!
- ◆ Special Values Available On Request!

GUILDLINE INSTRUMENTS 9334A SERIES of Resistance Standards are designed as very high stability calibration laboratory standards for high accuracy resistance calibration in air, without the need for stabilization in a temperature controlled bath.

They can be used as working standards or highly reliable and rugged transportable transfer standards. They are extremely useful for the calibration of resistance ranges of multi-function calibrators and high accuracy DMMs, as well as being used in more classical standards and calibration laboratory applications.

Hysteresis error is typically better than negligible to 0.1 ppm when stressed at three times the maximum voltage, and less than 0.3 ppm over a temperature cycle from 0 °C and 40 °C.

Connections to these resistance standards are by conventional 4-terminal connection up to 1 MΩ and two terminal connections for values above 1 MΩ. Models 9334AH-1G and the 9334AW-1G are designed to answer a difficult calibration need for owners of the HP/Agilent 3458A and the Wavetek/Datron 1271 & 1281 model DMMs.

The 9334A Series Precision Resistance Standards are available in a wide range of off the shelf and custom values to satisfy demanding applications between 1 μΩ and 100 GΩ.

Recommended instrument verification at the 1 GΩ and 10 GΩ points (with voltages up to 200 V) and typical connection methods make it difficult to obtain very stable readings. Special 9334A models are designed to fit directly into the appropriate DMM's input terminals, without the necessity of external leads and the inherent problems of noise pickup. These special models handle voltages up to 1500 V!

The 9334AH-1GΩ and 9334AH-10GΩ are also specially designed to support the calibration of the Fluke 8508 and Agilent 3458A DMMs.

Special values such as 0.25 Ω, 25 Ω, and 200 Ω are available for precision thermometry. Standards available for Quantum Hall Effect applications include 6.4532 kΩ and 12.9064 kΩ. If linearity verification of a long scale DMM is your challenge, 1.9x cardinal resistance points are available. If you have a special resistance application between 1 μΩ and 100 GΩ, Guildline can supply a precision standard to fulfill your requirement.

For The Ultimate In Resistance Standard Check Out The **6634A TEMPERATURE STABILIZED RESISTANCE STANDARD!**



9334A SERIES OF PRECISION AIR RESISTANCE STANDARDS

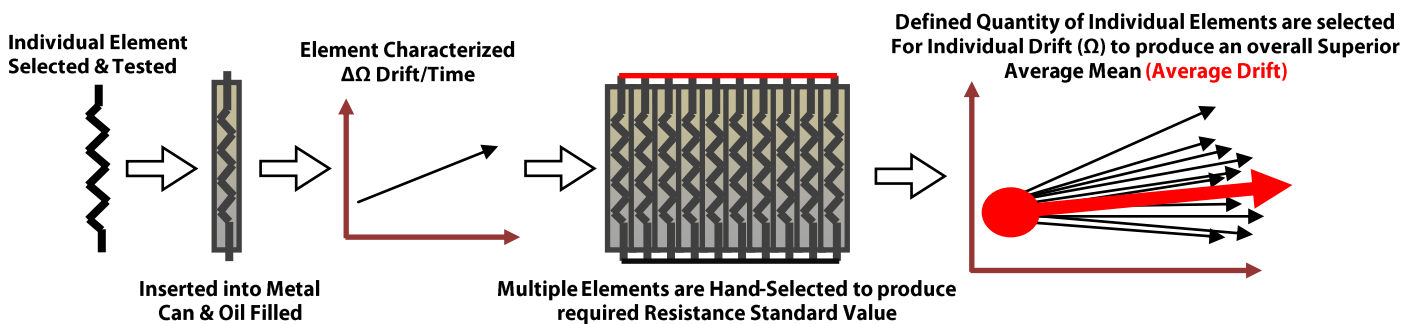
The 9334A Resistance Standards are the world's most accurate air resistance standards available today. During manufacturing, the temperature coefficients are verified by actually measuring each standard at 3 temperature points (i.e. at 21 °C, 23 °C, and 25 °C) using a primary level Direct Current Comparator Bridge and an air or oil bath. This ensures that the resistance standard meets the published temperature coefficient specification over the standards recommended range. For example at 10 kΩ, with a wide laboratory environment of 23 °C with control to ± 3 °C, the worst case effect due to temperature will be a remarkable 0.2 ppm!

The design of Guildline's 9334A Series Resistance Standards is based on over 58 years of innovation, design knowledge, and manufacturing experience in building resistance standards. Guildline resistance standards are made with multiple elements in parallel or series rather than using a single element as per competitive products.

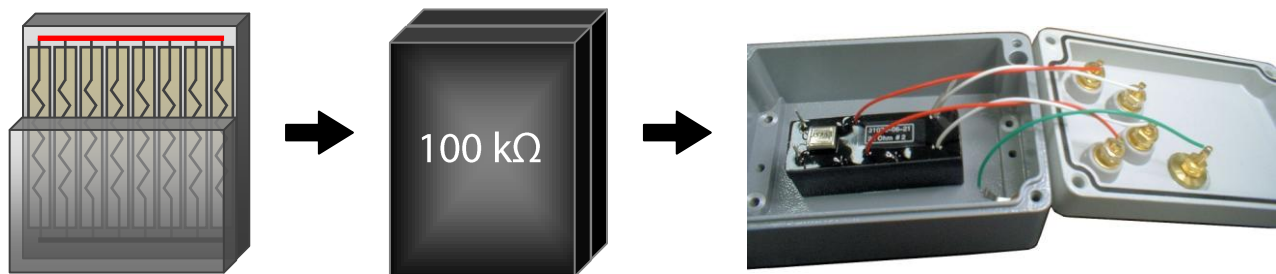
This approach lowers the drift that is seen with a single element and reduces the internal noise generated inside the reference resistor. The result is industry leading annual drift rates.

For values from 1 mΩ to 100 GΩ, the design starts with every resistance element going through an exacting process that ensures quality and long term stability. This process is diagrammed as shown:

Resistance Element Build Up



The multiple elements are sealed in epoxy for protection against humidity, are bonded to a thermal block, and are placed into the provided EMI shielded outer case with high quality terminals attached.



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.

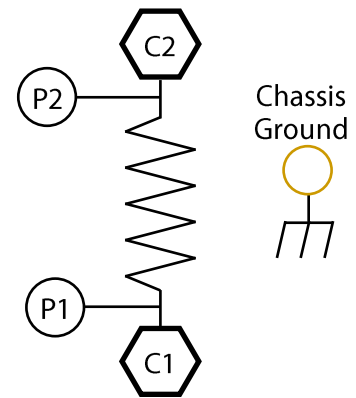
The 9334A Series are designed for use with Direct Voltage or Direct Current. For AC Voltage and AC Current applications see our 7334A Series of AC Resistance Standards and our 7340 / 7350 Series of AC Shunts.

9334A SERIES OF PRECISION AIR RESISTANCE STANDARDS

The 9334A Series starts with the **Low to Ultra-Low Values**. The internal design is unique and proprietary. With this design, Guildline is able to achieve amazing specifications. The available standard values in this range start at $1\ \mu\Omega$ and go all the way in decade values to $10\ \text{m}\Omega$. For values less than $1\ \text{m}\Omega$, the current (C) Terminals are easily identified by the large black knob terminals. These terminals can handle currents from $20\ \text{A}$ all the way up to $100\ \text{A}$. With their ultra-low drift specifications, just $5\ \text{ppm}$ per year for the $10\ \text{m}\Omega$ standard, these units are perfect for calibrating precision DC sources such as Transconductance Amplifiers, milli and micro Ohmmeters and precision sources. The resistor element is securely mounted to the inside of a hermetically sealed aluminum enclosure. The large C1 and C2 connectors are used for current connections and can handle currents up to $100\ \text{A}$. **5-way beryllium copper, gold plated binding posts** are provided for measuring the voltage drop. The fifth (gold) connector is for chassis ground. Lead Set 92302 is recommended when sourcing $20\ \text{A}$ to $100\ \text{A}$ of current across the "C1" and "C2" connectors to avoid conducting thermal energy into the resistance element through the terminal connection.



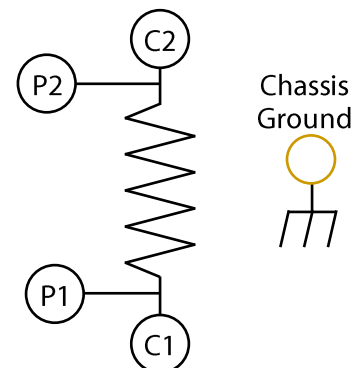
**9334A Series Layout
Design for Values of
 $1\ \mu\Omega$ to $100\ \mu\Omega$**



9334A Series Mid-Range values start at $100\ \text{m}\Omega$ and go all the way to $1\ \text{M}\Omega$. These are the world's most accurate, 4-terminal Resistance Standards available today. Look at the $1\ \Omega$ and $10\ \text{k}\Omega$ stability specifications. These resistance values are typical key artifact calibration points. The 9334A- $1\ \Omega$ and the 9334A- $10\ \text{k}\Omega$ are the only Air Resistance Standards available today with 1 year specifications that allow a full 4:1 artifact verification of a Fluke 5720. The 1 Year specification for the 9334A- $1\ \Omega$ is only $2.5\ \text{ppm}$, while the 9334A- $10\ \text{k}\Omega$ 1 year specification is only $2\ \text{ppm}$. This means no special characterization or 6 month calibration intervals for these values minimizing life cycle and calibration costs. The best in primary drift and other specifications means you are getting the best value for your money!

For 9334A Series Mid-Range value, the resistor elements are securely mounted to the inside of a hermetically sealed aluminum enclosure. **5-way beryllium copper, gold plated binding posts** provide low thermal connections. 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 voltage drop and thus the resistance. The fifth connection is for chassis ground

**9334A Series Layout
Design for Values
from $0.001\ \Omega$ to $1\ \text{M}\Omega$!**



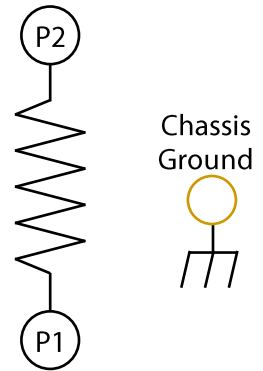
9334A SERIES OF PRECISION AIR RESISTANCE STANDARDS

9334A Series High to Ultra-High values are available in two-wire configurations. The HIGH VALUE MODELS start at 10 MΩ and continue to 100 GΩ with the best available specifications today from any commercial “Air” Resistance Standard. Like the low value models, the high value models come with a two-tier stability specification. The 1st year applies only to the first year of ownership, while subsequent years would use the 2nd year drift specification.

With the exception of the 10 MΩ Model which is rated to 1 kV DC, all high to ultrahigh value models can handle 1500 V DC. With the best yearly drift specification, the highest voltage handling capability, and the very low voltage coefficients, these standards are perfect for calibration of long scale DMM’s such as the Fluke 8508 (which can produce up to 200 V). They are also the best available solution for calibrating Meg-Ohmmeter, Electrometers and other high resistance applications. No need to worry about overloading these standards.

For high to ultra-high values - three, **5-way beryllium copper, gold plated binding posts** provide connection points located on the top of the resistance standard. The P1 and P2 connections are used to both apply the test voltage to the resistor and to measure the resistance. The third connection is for chassis ground.

**9334A Series Layout
Design for Values from
10 MΩ to 100 GΩ!**



9334A Series “H” and “W” Standard Case Styles

In high resistance measurements, cables can pick up electrical noise. Air movement around the cables can also significantly impact the measurement reading stability. By plugging a resistance standard directly into the front panel of an instrument, resistance measurement stability is greatly enhanced and errors associated with cabling are removed. The 9334A Line of Standard Resistors offers a series of Direct Plug-In Models for calibration and verification of High End Performance Digital Multimeters (DMMs). These include the Keysight/Agilent/HP 3458A Series, the Fluke 8508 Series, and the Wavetek/Datron 1281/1271 Series of DMMs.

The “H” Series of 9334As incorporate terminal spacing for the Agilent/HP and Fluke series of DMMs. Because of its universal design, this Direct Plug In Series will work for either 2 terminal measurements or 4-wire measurements for any of these meters. The layout for the individual resistors (H and W) are marked on each resistor case. The 9334A “W” Series has the same specifications as the “H” series. However, due to the slight differences in the Wavetek/Datron DMM’s input terminal spacing, the “W” Model will only work with this series of DMMs.



9334A SERIES OF PRECISION AIR RESISTANCE STANDARDS

Specifications - Guildline encourages customers to fully evaluate all specification and their small print. For example; in temperature one manufacturer specification is 0.4 ppm PER degree from <23 °C> which indicates either positive or negative change as indicated by the symbols "<>". Hence +1 °C is 0.4 ppm and -1 °C is 0.4 ppm, which means a real Δ temperature coefficient of 0.8 for ± 1 °C change. Guildline uses the industry standard specification of ± 1 °C from 23 °C which means 0.2 ppm for this same 2 °C Change. Other manufacturers simply match Guildline range and specifications on paper, but when you examine their ISO/IEC Scope of Accreditation, they lack the standards to manufacture to their performance specifications listed, and to perform an ISO/IEC 17025 accredited calibration to their stated specifications. Guildline is proud to describe our build process and to provide pictures showing the quality of our standards both inside and outside.

There are two levels of specifications for stability for the 9334A Series. The 1st year stability is the maximum drift specification after the first year of ownership. Then, due to the unique design of these resistance standards, the 2nd year drift is the maximum drift specification for subsequent years of ownership. For example, if you purchased a 1 m Ω model (9334A-0.001), after 12 months of use, the annual recommended calibration should be no more than 15 ppm from initial calibration value. Then for the 2nd year of use, the unit should not drift any more than 10 ppm and as years of measurement data prove – the drift will get much better with time.

SPECIFICATIONS FOR LOW TO ULTRA-LOW VALUES (4-WIRE)

Model (Nominal Ω)	Initial ¹ Tolerance \pm ppm	Stability (\pm ppm) ²		Maximum Limits		Temperature Coefficient \pm ppm/°C	Voltage ⁴ Coefficient \pm ppm/V _{dc}
		Initial 12 Months ³	2 nd Year ³	Current (A)	Voltage (V)		
9334A-1 μ	500	250	50	100	0.0001	50	NA
9334A-10 μ	200	100	25	50	0.0005	25	NA
9334A-100 μ	50	25	15	20	0.002	8	NA
9334A-0.001	20	15	10	6	0.01	1.5	NA
9334A-0.01	10	10	5	3	0.03	0.5	NA

SPECIFICATIONS FOR MID-RANGE VALUES (4-WIRE)

Model (Nominal Ω)	Initial ¹ Tolerance \pm ppm	Stability (\pm ppm) ²		Maximum Limits		Temperature Coefficient \pm ppm/°C	Voltage ⁴ Coefficient \pm ppm/V _{dc}
		Initial 12 Months ³	2 nd Year ³	Current (mA)	Voltage (V)		
9334A-0.1	5	4	4	1000	0.1	0.3	NA
9334A-1	2	2.5	2.5	320	0.32	0.2	NA
9334A-10	2	2.5	2.5	100	1	0.2	NA
9334A-25	2	2.5	2.5	64	1.6	0.2	NA
9334A-100	2	2.5	2.5	32	3.2	0.2	NA
9334A-400	2	2.5	2.5	16	6.3	0.2	NA
9334A-1k	2	2.5	2.5	10	10	0.2	NA
9334A-10k	2	2.0	2.0	3.2	32	0.2	0.01
9334A-100k	3	4	4	1	100	0.3	0.03
9334A-1M	5	4	4	.32	320	0.3	0.05

9334A SERIES OF PRECISION AIR RESISTANCE STANDARDS

SPECIFICATIONS FOR HIGH TO ULTRA HIGH VALUES (2-WIRE)

Model (Nominal Ω)	Initial ¹ Tolerance \pm ppm	Stability (\pm ppm) ²		Maximum Limits		Temperature Coefficient \pm ppm/ $^{\circ}$ C	Voltage ⁴ Coefficient \pm ppm/ V_{dc}
		Initial 12 Months ³	2 nd Year ³	Current (μ A)	Voltage (V)		
9334A-10M	15	5	5	100	1000	2.5	0.1
9334A-100M	35	20	10	15	1500	6	0.2
9334A-1G	50	25	10	1.5	1500	6	0.3
9334AH-1G	50	25	10	1.5	1500	6	0.3
9334AW-1G	50	25	10	1.5	1500	6	0.3
9334A-10G	100	100	20	0.15	1500	25	0.5
9334AH-10G	100	100	20	0.15	1500	25	0.5
9334A-100G	350	200	50	0.015	1500	250	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: 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: Initial 12 month drift is for first year of ownership only. The initial 12 month drift is higher due to stabilization of elements. After the initial 12 months, the two year specification is used as the maximum yearly drift specification.

Note 4: Voltage hysteresis: negligible to < 0.1 ppm. Temperature hysteresis: < 0.3 ppm between 0 $^{\circ}$ C and 40 $^{\circ}$ C

Note 5: Special/Custom Values available upon request including 1.9x values.

GENERAL SPECIFICATIONS

Temperature (All Models)		Operating Humidity (Non-Condensing)		Storage Humidity (Non-Condensing)	
Operating	Storage	(Models \leq 1 M Ω)	(Models \geq 10 M Ω)	(Models \leq 1 M Ω)	(Models \geq 10 M Ω)
18 $^{\circ}$ C to 28 $^{\circ}$ C	-20 $^{\circ}$ C to 60 $^{\circ}$ C	15 % to 70 % RH	15 % to 50 % RH	15 % to 80 % RH	15 % to 80 % RH

Dimensions	Height		Width		Depth		Weight		Shipping Weight	
Models > 100 $\mu\Omega$	88 mm	3.5"	124 mm	4.9"	79 mm	3.1"	.63 kg	1.4 lbs	1 kg	2.2 lbs
Models \leq 100 $\mu\Omega$	97 mm	3.8"	124 mm	4.9"	79 mm	3.1"	1.1 kg	2.4 lbs	2 kg	4.4 lbs

ORDERING INFORMATION

9334A-Model	Resistance Standard (List Decade Ohmic Value For Model)
9334AH-Model	List Value. For Keysight (Agilent/HP) and Fluke Long Scale DMM's
9334AW-Model	List Value - For Wavetek 1281 and 1271 Models
9334A-X	Customer Specified Value (State Value)
	ISO/IEC 17025 Accredited Calibration Certificate Included
/TM	Technical Manual Included
Lead-10	Low Thermal Lead Set with Gold Plated Bananas
92302	100 Ampere Lead Set
/Temp	Additional Customer Specified Temperature Point (Charge)
/Voltage	Additional Customer Specified Voltage Point (Charge)
/Current	Additional Customer Specified Current Point (Charge)
Other Lead Sets and Services Available. Please Contact Guildline for more information.	

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