9334A Series

Ultra-Precise "Air" Resistance Standards

Very High Stability Calibration Laboratory Resistance Standards

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 Included
- 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

For the Ultimate Resistance Standard - Check Out the **6634A Temperature Stabilized Resistance Standard!**

Guildline Instruments 9334A Series of Resistance Standards are designed as very stable laboratory standards for high accuracy resistance calibration in air, without the need for a temperature controlled bath.

They can be used as working standards or highly reliable and rugged transfer standards. The 9334As are extremely useful for the calibration of resistance ranges of multi-function calibrators and high accuracy DMMs, as well as being used in classical calibration laboratory applications.

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.

Hysteresis error is better than 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 via 4-terminals up to 1 MΩ and via two terminals for values above 1 MΩ.

The 9334AH-1G and the 9334AW-1G Models provide a solution for the difficulties in calibrating the HP/Agilent 3458A and the Wavetek/Datron 1271 & 1281 model DMMs. These DMM's verification at high resistance (> 10 MΩ) make it difficult to obtain stable readings. The special 9334A models are designed to fit directly into the 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!

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 12.9064 kΩ. If linearity verification of a long scale DMM is your challenge, 1.9x cardinal resistance points are available.

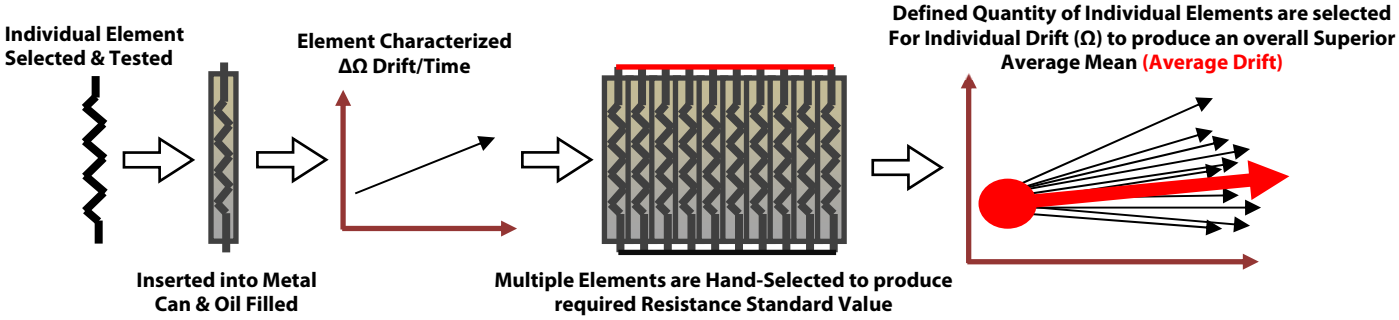
The 9334A Resistance Standards are the world's most accurate and stable air resistance standards. During manufacturing, the temperature coefficients are verified by measuring each standard at 3 temperature points (i.e. at 21 °C, 23 °C, and 25 °C) using a primary level Direct Current Comparator Bridge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

Guildline's 9334A Series Resistance Standards are based on extensive innovation, design knowledge, and manufacturing experience in building resistance standards since 1957. Guildline Resistance Standards are made with multiple resistors in parallel or series rather than using a single resistor as per most competitive products.

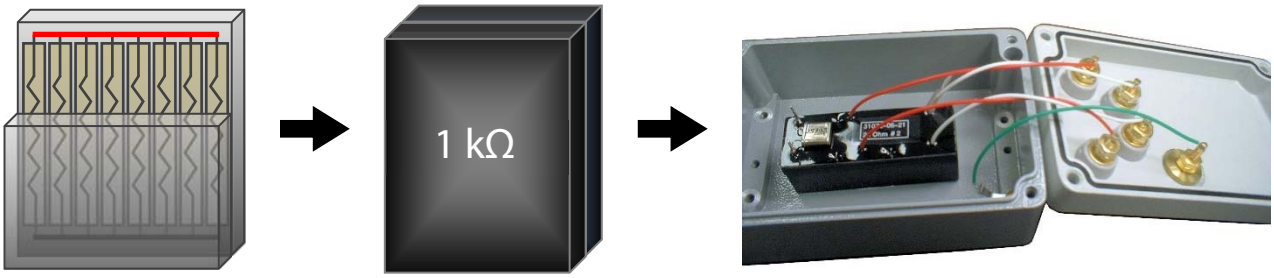
This approach lowers the drift that is seen if a single resistor is used and reduces the internal noise generated inside the reference resistor. The result is industry leading low noise during measurements and low annual drift rates.

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



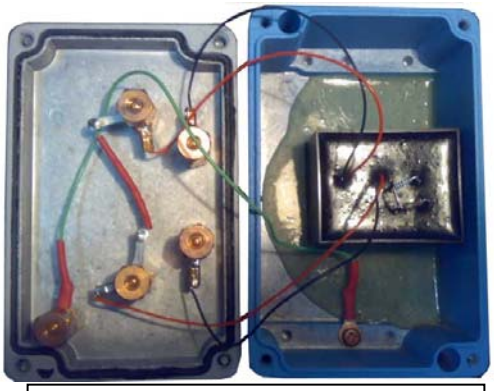
The multiple elements are sealed in epoxy for protection against humidity, are bonded to a thermal block, and are placed into the provided EMI shielded outer case with high quality gold plated terminals attached.



This multi-element design and associated manufacturing techniques are unique to Guildline Resistance Standards. Other manufactures also say they use a multi-resistor design, but they use a single main resistor (e.g. 1 kΩ) with multiple inexpensive trim resistors to get close to the nominal value. However, they (misleadingly) state that they use a multi-resistor design! Competitor's resistance standards also use cheaper components and multiple internal connections which results in a noisier resistor with poor secondary performance.

While anyone can state that their design is superior, a picture clearly shows the differences. On the left is a Guildline Resistance Standard. Note that you can see the spacing between the C1 and C2 Terminals showing that multiple resistors are used and sealed in epoxy to provide the main resistance element. In addition, you can see a sealed Vishay resistor on top of the epoxy case which is used as the trim resistor to get very close to the nominal ohmic value. In fact, the primary Vishay trim resistor has better performance than the mail resistors used by competitors. A picture of a competitive model (i.e. Measurements International) is shown to the right. You can see how the wires go from a 4 wire down to a single 2 wire connection where the unit is sealed. This means a single resistor is being used. Also note on the top right side of the square box all the cheap resistors that are used to trim the resistance value. The competition requires multiple trim resistors because of excessive drift of the single main resistor. In addition, the use of multiple internal connections, dissimilar metals, and overall poor build quality contribute to poor performance. The competition uses inexpensive components and cheap manufacturing. In comparison Guildline's Standards use the best design techniques, best components, and will perform for years as Primary Standards. Guildline is proud to describe our build process and to provide pictures showing the quality of our standards.

Inside View Guildline



Inside View Competitive Model

The 9334A Series starts with the Low to Ultra-Low Values. The internal design of Guildline's low value resistance standards is unique and proprietary. With this design, Guildline provides the best performance for ohmic values below 1 mΩ of any commercially available resistance standard. The available standard values in this range start at 1 µΩ and go all the way in decade values to 10 mΩ. For values less than 1 mΩ, the current (C) Terminals are easily identified by the large black knob terminals. These terminals can handle currents from 20 A all the way up to 100 A. With their ultra-low drift specifications, just 5 ppm per year for the 10 mΩ 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. **Beryllium copper, gold plated binding posts** are provided for measuring the voltage drop. The fifth (gold) connector is for chassis ground.

9334A Series Mid-Range values start at 100 mΩ and go all the way to 1 MΩ. These are the world's most accurate and stable 4-terminal Resistance Standards available. The **9334A-1Ω and the 9334A-10kΩ 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 drift specification for the 9334A-1Ω is only 2.5 ppm,** while the 9334A-10k 1 year specification is only 2 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 values, 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 as seen in the picture to the left.

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. The 9334A-1M Ω Resistance Standard handles 1000 V and all 9334A values above 10 MΩ handle up to 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, 8558A and 8588A which can handle higher voltages. 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 as can be seen in the above picture.

9334A Series "H" and "W" Standard Case Styles

In high resistance measurements, cables can pick up electrical noise and air movement around the cables can also significantly impact the measurement stability. By plugging a resistance standard directly into the front panel of an instrument, the stability is materially 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 85xx 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.

The 9334A Series is designed for use with Direct Voltage or Direct Current. For AC Voltage and AC Current applications see our 7334A Series of AC/DC Resistance Standards and our 7340 / 7350 Series of AC Shunts. For secondary Precision Air Resistance Standards, check out our new 9333 Series which are built in a similar manner to our 9334A Resistance Standards. The specifications and performance of the 9333 Resistance Standards outperform many other manufactures primary resistance standards.

Specifications - Guildline encourages customers to fully evaluate all specifications. For example, in temperature one manufacturer's 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 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 a ±1 ˚C Change. Other manufacturers simply match Guildline range and specifications on paper, but their ISO/IEC 17025 Scope of Accreditation does not have the required uncertainty to verify their claims.

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; the 2nd year drift is the maximum drift specification for subsequent years of ownership. For example, if you purchased a 1 mΩ model (9334A-0.001), after 12 months of use the measured value should be no more than 15 ppm from the initial calibration value. Then after the 2nd year of use, the unit should not drift any more than 10 ppm. Over time the drift of a Guildline Standard will decrease.

Specifications for Low to Ultra-Low Values (4-Wire)

Model (Nominal Ω)	Initial [1] Tolerance ± ppm	Stability (± ppm) [2]		Maximum Limits		Temperature Coefficient ± ppm/°C	Voltage [4] Coefficient ± ppm/V_{dc}
		Initial 12 Months [3]	2nd Year [3]	Current (A)	Voltage (V)		
9334A-1µ	500	250	50	100	0.0001	50	NA
9334A-10µ	200	100	25	50	0.0005	25	NA
9334A-100µ	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 ± ppm	Stability (± ppm) [2]		Maximum Limits		Temperature Coefficient ± ppm/°C	Voltage [4] Coefficient ± ppm/V_{dc}
		Initial 12 Months [3]	2nd Year[3]	Current (mA)	Voltage (V)		
9334A-0.1	5	4	3	1000	0.1	0.3	NA
9334A-0.25	5	4	3	640	0.16	0.3	NA
9334A-1	2	2.5	1.5	320	0.32	0.2	NA
9334A-1.9	2	2.5	1.5	210	0.4	0.2	NA
9334A-2.5	2	2.5	1.5	200	0.5	0.2	NA
9334A-10	2	2.5	1.5	100	1	0.2	NA
9334A-25	2	2.5	1.5	64	1.6	0.2	NA
9334A-100	2	2.5	1.5	32	3.2	0.2	NA
9334A-200	2	2.5	1.5	23	4.5	0.2	NA
9334A-300	2	2.5	1.5	18	5.3	0.2	NA
9334A-400	2	2.5	1.5	16	6.3	0.2	NA
9334A-1k	2	2.5	1.5	10	10	0.2	NA
9334A-10k	2	2	1.5	3.2	32	0.2	0.01
9334A-12.9064k	2	2	1.5	2.8	36	0.2	0.01
9334A-19k	3	3	2	2.3	44	0.3	0.02
9334A-100k	3	4	3	1	100	0.3	0.03
9334A-1M	5	4	3	0.32	320	0.3	0.05

Specifications for High to Ultra High Values (2-Wire)

Model (Nominal Ω)	Initial [1] Tolerance ± ppm	Stability (± ppm) [2]		Maximum Limits		Temperature Coefficient ± ppm/°C	Voltage [4] Coefficient ± ppm/V_{dc}
		Initial 12 Months [3]	2nd Year[3]	Current (µA)	Voltage (V)		
9334A-10M	15	5	4	100	1000	3	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 °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 after the first year of ownership only. The initial 12-month drift is higher due to stabilization of elements. After the initial 24 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 °C and 40 °C
Note 5: Special/Custom Values available upon request.

General Specifications

Temperature (All Models)		Operating Humidity (Non-Condensing)		Storage Humidity (Non-Condensing)	
Operating	Storage	(Models ≤1 MΩ)	(Models ≥10 MΩ)	(Models ≤1 MΩ)	(Models ≥10 MΩ)
18 °C to 28 °C	-20 °C to 60 °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 µΩ	88 mm	3.5"	124 mm	4.9"	79 mm	3.1"	.63 kg	1.4 lbs	1 kg	2.2 lbs
Models ≤ 100 µΩ	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
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 Precision Leads Are Available – Call and tell us your requirements	

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