9230A SERIES

PRECISION DC CURRENT SHUNT STANDARDS

The Most Accurate and Widely Recommended DC Shunt Available Today!

Guildline Instruments 9230A SERIES of precision DC current shunts / standards are true 4-terminal devices intended for the precise measurement of DC current. They are constructed using elements made from a Guildline proprietary metal alloy and are supported on an insulating base for mechanical stability.

The 9230A shunts have a perforated metal cover to allow adequate cooling while providing physical protection for the elements and safety for the technician using the shunt. The design of the 9230A includes special features to reduce the effects of power dissipation and associated self-heating errors. These shunts are designed to operate in air at the full rated currents listed.

THE 9230A SERIES OF PRECISION DC CURRENT SHUNTS ARE TRUE 4-TERMINAL DEVICES CAPABLE OF THE MOST DEMANDING MEASUREMENTS OF DC CURRENT

The metal alloy used for the resistors has a very low temperature coefficient and the size and number of elements chosen give the optimum surface area to dissipate heat (i.e. power) in air at the specified full-scale current for a particular model. The performance of the 9230A shunts can be improved by operating them with Guildline's 92310 Forced Air Unit. For even better performance they can be operated at < 10 W in a temperature-controlled environment, such as an air bath or fluid bath.

The terminations of the shunts are selected to provide low thermal EMF potentials, and to ensure that the applied current is distributed in a consistent manner.

The care and attention to the design of the 9230A's has produced a series of shunts with a very wide dynamic range, from zero to full rated current. The 9230A shunts are also heat treated to provide excellent long-term stability. Operated below 30 % of rated current, and maintained in a constant temperature air or oil bath, the 9230A's stability enables it to be used as a standard reference resistor.

FEATURES

- Extremely Low Self-Heating Effects
- Low Temperature Coefficients
- Low Thermal EMF's
- Wide Dynamic Range
- Controlled Current Distribution
- < 10 ppm Long Term Stability
- Air or Oil Cooled Applications
- Series Ranges from 10 A to 3,000 A
- 3 Point Current Calibration Provided
- Available Forced Convection Option Improves Heat Dissipation

An optional 92310 Forced Air Convection Unit, complete with power supply, is available to improve performance in comparison to operation in ambient air. The 92310 is recommended for use with power levels above 25 W. For power levels below 25 W, the Shunt can be used in ambient air with no cooling. The 92310 Forced Air Convection Unit **is designed to fit all models of the 9230A Current Shunts.** The 92310 is not designed for use with the older 9230 shunt series.

92310

All Guildline's 9230A shunts can be operated at full current without cooling, but must incorporate a power coefficient into the uncertainty for the higher power levels.

9230A-15

The 9230A-15R is the direct replacement for the older version model 9230/15 shunt for performance and is rated only for a maximum of 25 W.

Three Guildline designs are employed through the range of our shunts. For models requiring 150 A of current and less, custom alloy wire is used as shown to the right. Our best-selling 9230A-30 model falls into this range. This model has the same ohmic value (i.e. 0.1 Ω) as the older series 9230/15 but can handle twice the current (i.e. up to 30 A)! The 9230A-30 shunt provides better performance than the 9230/15 and is an excellent replacement providing the same voltage outputs as called out in many established procedures developed by Keysight (i.e. Agilent), Ametek, Tektronix and other leading Power Supply manufacturers.

9230A-300

For models from 300 A to 500 A, Guildline utilizes higher power copper current input terminals and also uses a custom alloy for the resistive material. The number one selling model in this design is our 9230A-300 shown to the left. Like all Guildline Shunts, notice the circular current connections and precision cut-outs to channel the current allowing for the best in repeatability and stability for current measurements.

9230A-1500

For models from 1000 A to 3,000 A, a different Guildline design is used as shown to the right. This design incorporates plates made of a custom alloy with specially designed current connections providing the best in specifications and stabilities. The 1000 and 1500 Ampere Models utilize 7 connection points for current cables. The symmetrical geometry of the 9230A terminal connections provides an even distribution of current across the shunt. For example, you can use the end connection for a single cable, or connect pairs of cables opposite each other when multiple cables are used. The connection points have a stainless steel helicoil insert to provide durability when using bolts or Guildline's tightening knobs.

9230A-3000

The Model 9230A- 3000, with a 10 μΩ resistance value, is specified for currents up to 1500 A with natural air convection and up to 3000 A with the 92310 forced air unit. However the 9320A-3000, like all Guildline shunts, can be used up to full rated current in ambient air. The 9230A-3000 has 11 connections points at both ends, with a symmetrical pattern, and stainless steel helicoil inserts.

No other manufacturer can provide these levels of accuracy for currents of this magnitude!

These shunts are the result of decades of Guildline research and design in building precision shunts. The 9230A Series incorporates many unique design features. Voltage terminals are provided at the top for easy access. Current connections are provided on each model to allow for symmetric cable connections regardless of the number of cables used, and the round terminals provide a consistent contact surface area for cable connections. Many other Guildline proprietary features go into the 9230A shunts giving them the best current measurement capabilities.

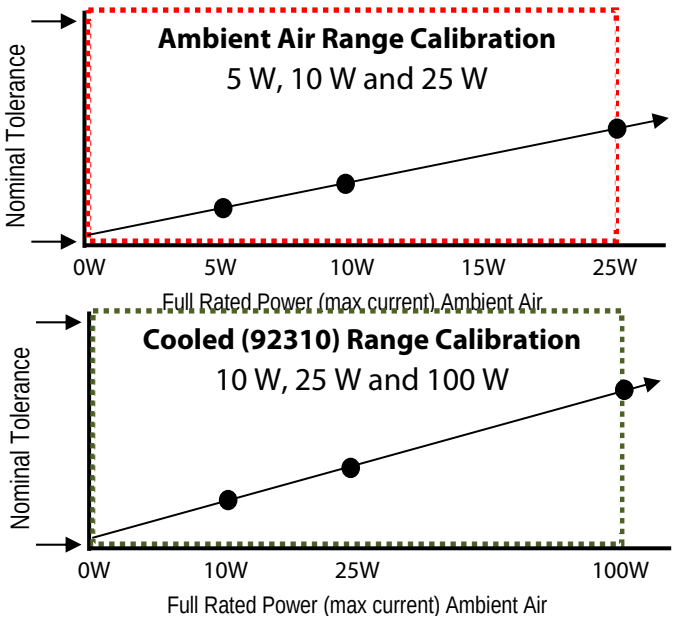
All shunts have a power coefficient which may be positive or negative so as the current is increased the resistance value will change with the applied power. The 9230A Series is designed so that for values less than 1000 A, the resistance change will be near linear across the full scale rated current range with only a small change in linearity above the 25 W dissipation level. These are the only shunts that are designed and manufactured today that have this linear characteristic. By design the 9230A Shunts have small power coefficients as well as relatively small temperature coefficients. For 9230A values greater than 1000 A, the slope of the resistance / power curve is much less than any other commercially available shunts. For the 9230A Series, the change of ohmic value across the operating range will not exceed the Nominal Tolerance Stated Value. The nominal tolerance is the maximum delta (Δ) resistance from minimum current applied to full rated current.

The 9230A Series Full Rated Current Specifications are provided for calibration in ambient air or with forced air cooling. Power coefficient uncertainties must be added when calibration results are extrapolated above the maximum calibrated test current. All 9230A shunts are calibrated at 3 current levels designed to provide users with calibrated resistance values for these applied current levels.

Ambient Air - when used in ambient air, (i.e. natural air convection) full rated current is specified. Shunts used in ambient air will be calibrated at nominal 5 W, 10 W and 25 W.

Cooled (92310 Option or Oil) - when the shunt is used with the 92310 option (forced air convection), the full rated current is specified for each shunt value. The calibration points are nominal 10 W, 25 W and 100 W for cooled operation.

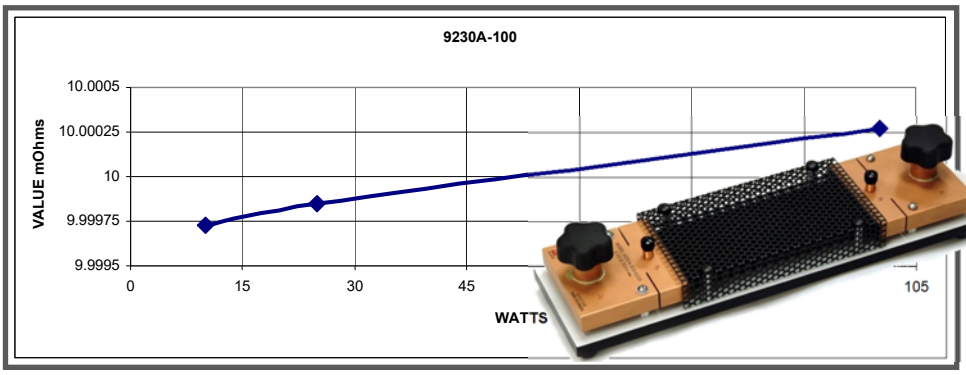
Models with a nominal resistance value incorporating a '5' (e.g. 9230A-500 which is 0.5 mΩ), the full rated current accuracy is slightly less than the stated nominal value. For example, with forced air the full rated current of the 9230A-500 is 450 A. You can still use the shunt up to 500 A, but a power coefficient must be added to the uncertainty for currents above 450 A.



For optimal results, the time constant must be considered for both calibration and usage. The time constant is a typical specification and defined as the time for the resistance value to settle to within 10 parts in 10^6 of its final value. Note that the time constant is typically less than 1 minute in a flowing oil bath. Measurement time is also dependent on the measurement device such as a 6622A Direct Current Comparator Bridge or Long Scale DMM.

9230A Series of Precision DC Current Shunt Standards

9230A DC Shunts are initially calibrated at three current points with up to 25 W in ambient air conditions and up to 100 W with cooling. ISO/IEC 17025 accredited calibrations are provided at no extra cost with a maximum accredited current capability of 1000 A. The standard calibration points for ambient air are: nominal current at 5 W, 10 W, and 25 W. When calibrated with the 92310 Forced Air Convection unit or in oil, the following standard calibration points are: nominal current at 10 W, 25 W and 100 W levels. These power based points allow customers to graph the performance of their shunts. A report of calibration is provided stating measured values and uncertainties. Expanded Uncertainty is expressed as a total uncertainty with a coverage factor of k = 2 (level of confident of 95 %). Calibration at 1 W level, or special points in air or flowing oil is available upon request.



The Stability specification applies if the Shunt is used as a Resistance Standard at a 1 W power level or less. **If the shunt is to be used above the 1 W level, then the shunt should be calibrated at this point for best calibration uncertainties.** Power Coefficients only need to be considered when a 9230A shunt is used outside the calibrated range. For example, you have a shunt calibrated in ambient air and you need to make a measurement at 50 W. You can make this measurement without the fan, but a power coefficient must be added to the total uncertainty. For this example, you would take 50 W (i.e. at measurement point) minus 25 W (i.e. last ambient calibration point) for a total of 25 W multiplied by the power coefficient. This value would be added to the Nominal tolerance. When used outside calibrated ranges, end users should account for changes in settling time as well.

9230A Specifications (12 Months)

Model [1]	Nominal Resistance Value (Ω)	Initial Tolerance [2] ± μΩ/Ω (ppm)	Full Rated Current (A) [1]		Full Rated Current Accuracy [3] ± μΩ/Ω (ppm) @ 23 °C ± 1 °C	Stability [4] ± μΩ/Ω (ppm)	Time Constant (Minutes) [5]	
			Ambient Air	w/Cooling			92310 Option	Ambient Air
9230A-10	1.0	100	5	10	100	10	3	6
9230A-15	0.5	100	7.5	15	100	10	3	6
9230A-15R [6]	0.1	400	15	NA	400	10	3	6
9230A-30	0.1	100	15	30	100	10	3	6
9230A-50	0.05	100	22.5	45	100	10	3	6
9230A-100	0.01	100	50	100	100	10	4	8
9230A-150	0.005	100	70	140	100	10	4	8
9230A-300	0.001	100	150	300	100	10	8	16
9230A-500	0.5m	100	225	450	100	10	8	16
9230A-1000	0.1m	250	500	1000	250	25	15	30
9230A-1500	0.05m	250	710	1420	250	25	15	30
9230A-3000	10μ	1000	1500	3000	500	50	20	45

9230A Specifications (12 Months) Continued

Model	Power Coefficient [7] (± μΩ/Ω (ppm))			Size (W x L x H)		Weight	
	92310 Option	Ambient Air	Flowing Oil	mm	inches	kg	lbs
9230A-10	2	8	0.5	114 x 356 x 85	4.5 x 14 x 3.4	1.4	3.1
9230A-15	2	8	0.5	114 x 356 x 85	4.5 x 14 x 3.4	1.4	3.1
9230A-15R [6]	2	8	0.5	114 x 356 x 85	4.5 x 14 x 3.4	1.4	3.1
9230A-30	2	8	0.5	114 x 356 x 85	4.5 x 14 x 3.4	1.4	3.1
9230A-50	2	8	0.5	114 x 356 x 85	4.5 x 14 x 3.4	2.1	4,6
9230A-100	2	8	0.5	114 x 356 x 139	4.5 x 14 x 5.5	2.2	4.9
9230A-150	2	8	0.5	114 x 356 x 139	4.5 x 14 x 5.5	2.5	5.5
9230A-300	2	8	0.5	114 x 406 x 96	4.5 x 16x 3.8	5.0	11.2
9230A-500	3	10	0.8	114 x 406 x 96	4.5 x 16 x 3.8	5.8	12.9
9230A-1000	8	20	2	117 x 539 x 145	4.6 x 21.2 x 5.3	13.0	28.7
9230A-1500	10	30	3	117 x 530 x 145	4.6 x 17.2 x 5.3	12.8	28.1
9230A-3000	15	30	5	122 x 424 x 216	4.8 x 16.7 x 8.5	29.1	64
92310 Option				121 x 242 x 69	4.75 x 9.5 x 2.7	1.0	2.2
Environmental	Operating: 10 °C to 40 °C <80 % RH non-condensing			Storage Operating: -30 °C to 70 °C <90 % RH non-condensing			

Note 1: Full Scale current specification is based on use in Ambient Air at 25 W, or use with Air Cooling at 100 W, so may not exactly match the nominal value of the shunt.

Note 2: Defined as maximum variation of resistance value as initially adjusted at time of sale, temperature 23 °C ± 2 °C.

Note 3: Full Rated Current Accuracies apply to the 25 W (Ambient) and 100 W (Cooled) calibration points for each model. For 9230A Models with a nominal resistance containing a '5', a power coefficient must be applied to the accuracy specification when used at a current that exceeds the Full Rated Current.

Note 4: When used as a standard resistor at 1 watt Level only.

Note 5: Typical specification defined as the time for the resistance value to settle to within 10 parts in 10^6 of the final value for any change in applied current. The time constant is typically 1 minute for flowing oil.

Note 6: The 9230A-15R is the direct replacement for the 9230/15 version shunt. The 9230A-30 has the same resistance value as the 9230A-15R and can be used up to 30 A (with the 92310).

Note 7: Power coefficient must be added to the uncertainty when used as a shunt above the calibrated range of currents.

Lead Sets - Guildline also produces the best High Current Leads to work with your 9230A Series Shunts. The cable lug connection is done at a very high pressure that greatly reduces the contact resistance, thus providing exceptional thermal stability. These leads are available in ratings of 20 A, 30 A, 100 A, 150 A, 300 A, and 500 A currents. Standard lengths vary from 1 to 2 meters and Guildline can make them in any length and with many different terminations. Lead sets also include a shielded low thermal twisted pair lead for the voltage measurement on the potential terminals.

9230A Series of Precision DC Current Shunt Standards

Guildline continues to manufacture the 9211A multi-tap shunt/resistance standard. The 9211A model has been updated to be identical to the 9211B model and replaces the 9211B model. The 9211A has nine ranges with a maximum current of 300 A. The unit consists of nine shunts with a 4-terminal configuration. The design optimizes a number of important factors such as the effects of self-heating, size, weight, ease of operation and wide measuring range. The 9211A provides a wide range precise current measuring capability when used with a potentiometer or digital voltmeter as a readout.

The shunt resistors are mounted in air to minimize size and weight, and to provide efficient ambient cooling. Self-heating is a negligible source of error with ambient temperatures from 20 °C to 30 °C.

AC Shunts - Need to have AC as well as DC performance! Our 7340 and 7350 Series of AC/DC Shunts are available in a variety of ohmic and current values and provide the lowest uncertainties and phase angle shift found in any AC/DC Shunt. Housed in a ruggedized EMI shielding case, these models provide a wide frequency bandwidth of up to 100 kHz calibrated and up to 2 MHz uncalibrated. The maximum current is 100 A for the 7340 Series and 25 A for the 7350 Series. Adaptors and cables sets are also available for these models.

ORDERING INFORMATION	
9230A-Model	DC Current Shunt (List Amperage Value For Model)
9230A-X	Customer Specified Value (State Amperage and Ohmic Value)
/OM9230A	Operator Manual included at no charge.
92310	Forced Air Convection Unit (fits all standard models)
92301/92304	20 A, 1 Meter/x Meter Lead set (Current and Sense Leads)
92318/92319	30 A, 1.5 Meter/x Meter Lead set (Current and Sense Leads)
92302/92305	100 A, 1 Meter/x Meter Lead set (Current and Sense Leads)
92321/92322	150 A, 1.5 Meter/x Meter Lead set (Current and Sense Leads)
92303/92306	300 A, 1.5 Meter/x Meter Lead set (Current and Sense Leads)
92307/92308	500 A, 2 Meter/x Meter Lead set (Current and Sense Leads)
92309/92311	1000 A, 2 Meter/x Meter Lead set (Current and Sense Leads)
92312/92313	2000 A, 2 Meter/x Meter Lead set (Current and Sense Leads)
92314/92315	3000 A, 2 Meter/x Meter Lead set (Current and Sense Leads)
*Other Precision Leads Are Available – Call and tell us your requirements	
ISO 17025 Accredited Calibration up to 1000 A	
/Temp	Additional Customer Specified Temp Cal Point (Charge)
/Current	Additional Customer Specified Current Point (Charge)

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