

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

FEATURES

- Extremely Low Self-Heating Effects
- Low Temperature Coefficients
- Low Thermal EMF's
- Wide Dynamic Range
- Controlled Current Distribution Through the Element
- < 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 Power Dissipation

The type of material selected for the elements 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 value. The performance of the 9230A shunts can be dramatically improved by operating them in a temperature controlled environment or immersing them in a stirred oil bath where power dissipation levels are less than 10 watts.

The terminations of the shunts are selected to give low thermal EMF potentials, and to ensure that the current applied 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, virtually from zero to full rated current. The 9230A shunts are also heat treated for 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.

9230A Series of Precision DC Current Shunt Standards

An optional 92310 Forced Air Convection Unit, complete with power supply, is available to allow operation at up to full rated current levels with materially improved repeatability and power coefficient performance in comparison to operation in ambient air. The 92310 is recommended for use with currents above 25 W. For currents 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.

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.



9230A-15

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 above. Our best-selling model falls into this range, the 9230A-30 model. 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. 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.

For models from 1000 A to 3,000 A, a different Guildline design is used. This design incorporates plates made of a custom alloy with specially designed current connections providing the best in specifications and stabilities.



9230A-1500

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



9230A-3000

9230A Series of Precision DC Current Shunt Standards

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. Round current connections are provided on each model to allow for symmetric cable connections regardless of the number of cables used, and to 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 ever provided.

All shunts have a power coefficient which may be positive or negative so as the current is increased the resistance value will shift. It does not matter whose shunts you have, the resistance will change with applied power. The 9230A Series are designed so that for values less than 1000 A, the resistance change will be near linear across the full scale rated current range and only a small change in this linearity affect above the 22 to 25 W dissipation levels. By design the 9230A Shunts have small power coefficients as well as relatively small temperature coefficients. These are the only shunts that are designed and manufactured today that have this linear characteristic as well as providing excellent power and 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, this amount of change 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.

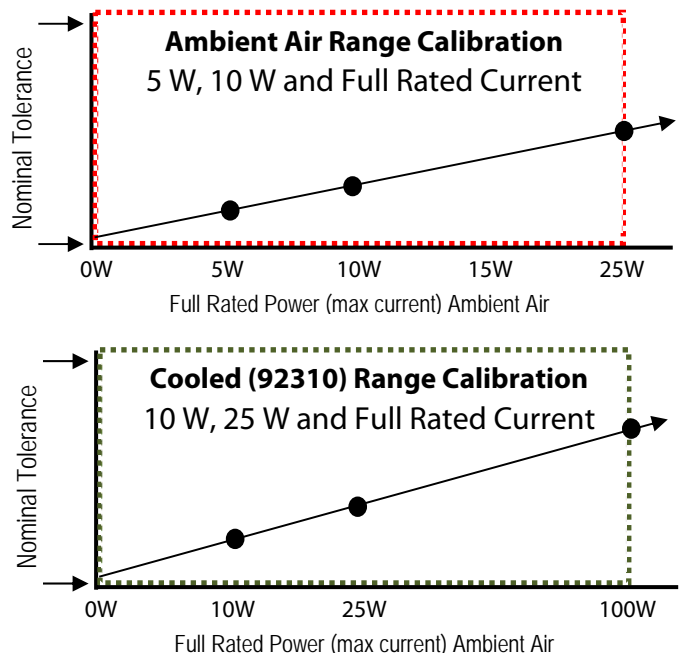
The 9230A Series Full Rated Current Specifications are provided for calibration with either natural convection or with forced air cooling. Power coefficient uncertainties must be added when calibration results are extrapolated above the calibrated test current values up to the full rated current capability of a specific shunt. 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 the specified full rated current unless otherwise requested.

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 the specified full rated current for cooled operation.

Models with a nominal resistance value incorporating a 5 (e.g. 9230A-500 which is 0.5 m Ω) the full rated current accuracy is slightly less than the stated nominal value. For example, in ambient air the full rated current is 225 A. You can still use the shunt up to 1/2 of the nominal current listed (i.e. 250 A) in ambient air, but a power coefficient must be added to the uncertainty for currents in the 225 A to 250 A Range. This holds true for cooling conditions. The current rating that is specified is 450 A, but you can still use the shunt for higher currents (e.g. from 450 A to 500 A), and increase the uncertainty based on the power coefficient.

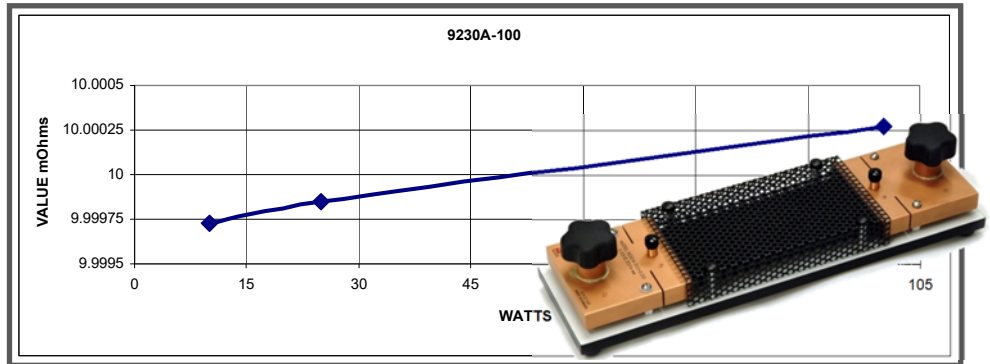
For optimal results, the time constant must be considered for both calibration and usage. The time constant is a typical specification and defined as the time for the resistance value to settle to within 10 parts in 10⁶ of its final value for any change in applied current. Note that the time constant 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 and up to 25 W in ambient air conditions and 100 W with cooling up to maximum of 1000 A. ISO/IEC 17025 accredited calibrations are also available (maximum accredited current capability is 1000 A). The standard calibration points for ambient air are: nominal 5 W, 10 W, and the specified full rated current power level. When calibrated with the 92310 or in oil, the following standard calibration points are: nominal

10 W, 25 W and the specified full rated current power level. 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 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) ³		Full Rated Current Accuracy ⁴ ± μΩ/Ω (ppm) @ 23 °C ± 1 °C	Stability ⁵ ± μΩ/Ω (ppm)	Time Constant (Minutes) ⁶	
			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	14	100	10	3	6
9230A-15R ⁷	0.1	400	15	NA	400	10	3	6
9230A-30	0.1	100	15	30	100	10	3	6
9230A-50 ³	0.05	100	22.5	45	100	10	3	6
9230A-100	0.01	100	50	100	100	10	4	8
9230A-150 ³	0.005	100	70	140	100	10	4	8
9230A-300	0.001	100	150	300	100	10	8	16
9230A-500 ³	0.5m	100	225	450	100	10	8	16
9230A-1000	0.1m	250	500	1000	250	25	15	30
9230A-1500 ³	0.05m	250	710	1420	250	25	15	30
9230A-3000	10μ	1000	1500	3000	500	50	20	45

9230A Series of Precision DC Current Shunt Standards

9230A SPECIFICATIONS (12 MONTHS) CONTINUED

Model	Power Coefficient ⁸ ($\pm \mu\Omega/\Omega$ (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 ⁷	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 16 x 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 is based on 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 \pm 2 °C.

Note 3: Maximum currents for listed Specifications are applicable for ambient air and for air or oil cooling (e.g. with the 92310 Forced Air Unit).

Note 4: Full Rated Current Accuracies apply to the maximum full rated current uncertainties and conditions (i.e. air or cooled) listed. For currents exceeding the full rated currents listed, Power coefficients must be applied to determine total specification at the applied current power level. For example, the 1000 A model can be used to 500 A in ambient air and to 1000 A with forced air, and will meet stated specifications. However for use in ambient air a power coefficient must be applied for currents above 500 A.

Note 5: When used as a standard resistor at 1 watt Level only.

Note 6: Typical specification defined as the time for the resistance value to settle to within 10 parts in 10⁶ of the final value for any change in applied current. The time constant is typically 1 minute for flowing oil.

Note 7: 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 8: 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. Incorporating a unique, very high compression connection, contact resistance at the terminals is greatly reduced, 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 manufacturer 9200, 9210, 9211B and 9711B Series of multi-tap shunts/resistance standards. Available models provide from 6 to 9 self-contained ranges with maximum currents up to 300 A. These shunts are a true 4 terminal shunt. The design optimizes a number of important factors such as the effects of self-heating, size, weight, ease of operation and total measuring range. They provide 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, yet self-heating is a negligible source of error from 20 °C to 30 °C. Self-heating has only a small effect for a still wider range of ambient temperatures. The resistors are made of a selected alloy wire and are non-inductively wound, up to 1 A. The unit consists of nine (9) shunts, of the 4-terminal configuration.

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)
/TM9230A	Technical 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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