Model 9211B Series

Multi-Tap DC Current Shunt

Technical Manual

TM9211B-A-00
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1.0 INTRODUCTION

This manual provides an overview of the 9211B DC Multi-Tap Current Shunt and also contains the necessary information required to perform a calibration or verification test. General product information, product description and performance specifications are also included.

The phone number in the USA and Canada to obtain Product Support, Calibration Service or Replacment Parts is (800) 310-8104.

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: + [0] [1] 613 283-3000
Outside US and Canada Fax: + [0] [1] 613 283-6082

You can also contact Guildline Instruments Limted via their Email or Websites.

Email is: sales@guildline.com
Website is: www.guildline.com

1.1 Warranty

Guildline Instruments warrants its products to be free of defects in manufacture and normal operation for a period of two (2) years from the date of purchase, except as otherwise specified. This warranty applies only in the country of original purchase and only to the original purchaser, who is also the end user. Equipment, which is defective or fails within the warranty period, will be repaired or replaced at our factory without charge at the discretion of Guildline Instruments.

In addition, systems engineered by Guildline Instruments are warranted to be free of defects in overall system operation for a period of two (2) years from the date of receipt by the original purchaser.

Third party system components purchased by Guildline carry the warranty of the original equipment manufacturer and will be accepted for claim by Guildline Instruments at our factory only after warranty authorization by the original manufacturer.

Limitation of Warranty

Warranty coverage does not apply to equipment which has failed due to misuse, neglect, accident or abnormal conditions of operation or if modifications or repairs have been made without prior authorization of Guildline instruments.

Temperature probes are not warranted against failure due to mechanical shock.
Fuses, lamps and non-rechargeable batteries are not warranted against breakage.

Damage in Shipment to Original Purchase

Instrument(s) should be thoroughly inspected immediately on receipt for visible damage. Any damage should be reported to the carrier and further inspection and operational tests should be carried out if appropriate to determine if there is internal damage. Contact Guildline Instruments before returning for repair. The customer or purchaser must complete all final claims with the carrier.

Regular charges will apply to non-warranty service. External service charges and expenses will be billed at cost plus handling.

1.2 To Obtain Warranty or Calibration and Repair Service

Call for a Return Material Autorization (RMA) number. RMA's are required for all Warranty Returns and/or Calibration and Repair Service Requests. Telephone, Fax and email addresses to contact Guildline are provided previously.

Guildline Instruments will pay for all warranty costs including shipping to and from the original shipment point. However, if the instrument is purchased within one country and shipped to another, Guildline will only pay for shipping to and from the original ship to country or customer point.

1.2.1 USA Warranty Return Address

USA Customers should use the following address to return instruments for warranty service or calibration support.

Guildline Instruments Limited
C/O AN Deringer
800 Proctor Avenue
Ogdensburg, NY 13669

Mark on the outside of the box:
RMA # _____________
Model #_____________
Serial #_____________
The Statement: "Canadian manufactured goods being returned for repair."

1.2.2 Returns All Other Countries

For all other countries, including Canada please ship to:

Guildline Instruments Limited
21 Gilroy Street, PO Box 99
Smiths Falls, ON K7A 4S9

Mark on the outside of the box:
RMA # ______________
Model #______________
Serial #______________
The Statement: "Canadian manufactured goods being returned for repair."

1.3 Safety Information

WARNING: During usage and calibration high voltages or high currents may be present. Use caution when working above 40 Volts DC or currents above 1mA. Such voltages or currents can cause death.

The 9211B DC Shunts are designed to work within operating specifications. Applying more than the recommended current will damage the unit.

Inspect the 9211B for damage such as cracked connectors prior to use. If the unit has a burned smell or smoke is visible during use, discontinue use immediately.

If test equipment used with DC Shunts overloads or trips, this could be a sign that the 9211B requires repair.

Inspect all test leads used with the Multi-Tap DC Current Shunt for damaged insulation or exposed metal. Check all test leads for continuity.

Ensure all test leads are correctly connected prior to applying current or voltage.

Do not use Multi-tap DC Current Shunts around explosive gas, vapor or dust.

2.0 9211B SPECIFICATIONS

2.1 Uncertainty Specifications

The specifications apply from Full Rate Current down to 10 % of the full rated current. For example the 300 A Range can be used from 300 A down to 30 A or the 100 A Range can be used down to 10 A. Ensure current cables used can handle the full rated current.

Resistance (Ω)	Full Rated Current Range (A)	1 Year Accuracy [1,2] (%)	Temperature Coefficient (μΩ/Ω /^{0}C)	Power Dissipation at Rated Current (mW)
10,000	0.000 1	± 0.01	5	0.001
1,000	0.000 1	± 0.01	5	0.01
100	0.001	± 0.01	5	0.1
10	0.01	± 0.01	5	1
1	0.1	± 0.01	5	10
0.1	1	± 0.01	10	100
0.01	10	± 0.01	10	1000
0.001	100	± 0.05	30	10 W
0.000 333 333	300	± 0.1	30	30 W

Note 1: Calibrated in air at 23 ± 1 ^{O}C referred to the unit of resistance as maintained by a National Metrology Institute, and expressed as a deviation from nominal with a total uncertainty and coverage factor of k = 2.

Note 2: A traceable report of calibration stating the measured values and uncertainty is provided with each unit at test currents of 1/10 of rated current and full rated current to a maximum of 100A and a minimum of 0.1 mA,

2.2 General Specifications

GENERAL SPECIFICATIONS				
Environmental	Temperature		Humidity	
Operating	5 ^{o}C to 38 ^{o}C	40 ^{o}F to 100 ^{o}F	<70 % RH non-condensing	
Storage	-20 ^{o}C to 55 ^{o}C	-40 ^{o}F to 131 ^{o}F	<90 % RH non-condensing	
Exterior Dimension (Rack Mount)	222 mm (H)	482 mm (W)	183 mm (D)	13.6 kg
	8.7" (H)	19" (W)	7.2" (D)	30 lbs

3.0 OVERVIEW OF THE 9211B

3.1 General

The Model 9211B is a self-contained 9 range, 4 terminal shunt, for precision current measurements up to 300 A. The design optimizes a number of important factors such as the effects of self-heating, temperature coefficient, size, weight, ease of operation and total measuring range.

It provides 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 ºC to 30 ºC. Self-heating has only a small effect for a still wider range of ambient temperatures. The resistors are made of selected zeranin wire and are non-inductively wound, up to 1 ampere. The unit consists of nine (9) shunts, of the 4-terminal configuration. Each shunt provides a 100 mV drop at the nominal rated current. The maximum current rating is 140 % of nominal for all ranges except the 100 A and 300 A ranges, for which the maximum is 110 % of the nominal current rating.

Figure 3-1 : 9211B Current Terminal Connections

3.2 Operating Instructions

3.2.1 Maximum Current

Determine the maximum current that will be measured. If maximum current to be measured is unknown, good instrumentation practice would be to approximate it at a value that is certain not to be exceeded.

As an example, if the current is thought to be between 100 A and 120 A, then the connections should me made to the 300 A terminals for the measurement.

3.2.2 Current Input Terminals

The following terminals have the following rated currents. Note that all terminals should tighten uniformly when making measurements. Loose connections can cause faulty readings.

Figure 3-2 : 9211B Current Terminal Connections

3.2.3 Range Selector Plugs

Insert a pair of range selector plugs into the appropriate female receptacles on the front panel. One plug is inserted over the other (in a vertical line). For example, if the range selected is 0.01 A, insert the two plugs in the two receptacles directly over the engraved portion marked with the numeral 0.01 A for current and 10 Ω for resistance.

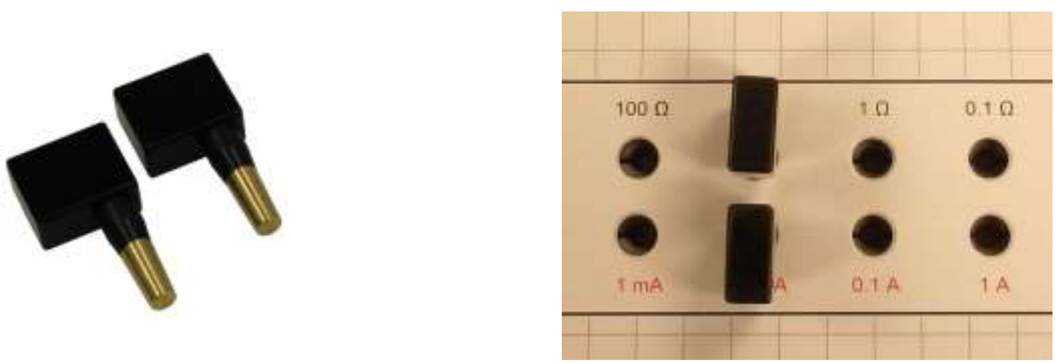

Figure 3-3 : Range Selector Plugs

3.2.4 Potential Terminals

Potential Terminals are used for DMM or other measurement device inputs to read the mV output produced at this terminal.. Use low thermals leads for best connections.

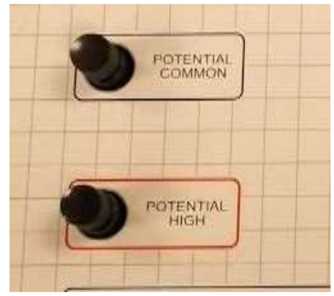

Figure 3-4 : Potential Terminals

3.2.4 10 Ampere Measurements and Below

For measurements up to and including 10 A, connect the shunt in series with the power source and the item under test. Note the polarity of the connections. If a DC ammeter is being calibrated make sure the meter deflects up scale. If not, reverse it's lead connections. Use leads of sufficient size to carry the rated current. Connect leads to the two binding posts labeled "INPUT COMMON" and "10 A MAX." Connect the milli-voltmeter being used as a readout instrument (DVM, DC potentiometer, etc., with a range of 0 to 100 mV) to the two binding posts engraved Potential in the space between them.

Note 1: ·Polarity from the source is unimportant insofar as the shunt is concerned as long as the potential and current connections agree, i.e., both "common" binding posts must be connected in the same polarity.

Note 2: If the readout device is a low resistance milli-voltmeter, inaccuracies can result proportional to the current drain. All potentiometers have a finite resistance so their use will result in some loss of accuracy due to circuit loading.

If a DVM is employed, its input impedance should be checked to see that it is sufficiently high. Using a DMM with 10 GΩ impedance could affect the verification of the 10 kΩ up to 10 µΩ/Ω. On lower ranges the impedance affect will be neglible. If using DVM with lower input impedance, careful consideration of the setup is highly recommended. Consideration also should be for thermal emf errors when using a less accurate DVM. This can be checked by checking the zero point and taking 2 readings with the current reversed for the second reading etc.

3.2.5 Measurements above 10 Ampere

For measurements above 10 A (up to and including 300 A), observe the same procedures as described in 3 (a) above, except connect one lead to the 100 A or 300 A binding post as required (instead of to the 10 A binding post). Be certain the range plugs are inserted into the correct range positions before application of the test current."

3.2.6 mV Output

Each shunt has a 100 mV output with the application of the rated current. In actual measurement, it is this voltage or fraction thereof, which the readout instrument indicates. It's reading in mV is directly proportional to the current applied. For example, if connections are made to the 10 A shunt, a 100 mV reading indicates a 10 A flow within ±0.01 % (plus the accuracy of the readout instrument). A 90 mV reading indicates a 9 A flow, etc. Direct readings in amperes can he obtained for all ranges up to, and including, the 100 A range by arbitrarily fixing the decimal point of the readout instrument. When making measurements using the 300 A range, readings must be interpolated as follows:

Test Current (A)	Readout in mV
300 A	(100 ± 0.1) mV
270 A	(90 ± 0.09) mV
240 A	(80 ± 0.08) mV
210 A	(70 ± 0.07)mV
180 A	(60 ± 0.06) mV
150 A	(50 ± 0.05) mV
120 A	(40 ± 0.04) mV
90 A	(30 ± 0.03) mV
60 A	(20 ± 0.02) mV
30 A	(10 ± 0.01) mV

On the 300 A range, to obtain a reading in amperes, the indication of the milli-voltmeter is multiplied by 3 and the decimal point arbitrarily fixed.

3.2.7 Full Rated Accuracy

Each shunt can be used at rated nominal current to full accuracy with no duty cycle limitations. For the 100 A and 300 A ranges, 30 minutes to 1 h minimum should be allowed for the meter readings to settle to due to thermal dissipation effects. All other ranges should be stable within 15 min or less

> Note: If an overload has inadvertently been applied, for best accuracy allow the shunt to cool for approximately 1 h before using again. It is good instrumentation practice to reduce power to zero before disconnecting the shunt.

3.2.8 Minimum accuracy

Minimum accuracy that can be attained overall is the accuracy of the shunt resistor in use plus the accuracy of the readout instrument. This value is in "± % of full scale" and "± % of reading" depending on how the readout instrument is rated. As an example. using a DVM with ± 0.006 % of reading 0.001 % of range accuracy and the 10 A range of the shunt (0.01 %), overall DVM accuracy is ± 0.0061 %. If a DC potentiometer of ± 0.01 % accuracy of reading is employed instead of the DVM, accuracy is in % of reading. Additional uncertainty contributions should also be considered like temperature effects.

Note: Most readout instruments, have a residual error at the low end of their range which may be a significant accuracy factor. Examine the specifications of the milli-voltmeter used to determine what these errors are. For this reason it is good instrumentation practice to use that shunt range which will provide the highest millivolt output for a given current flow. As an example, if the 10 A range is being used for measurements of 1 A or below, change to the 1 A range. Higher accuracy can be achieved by using the deviation from nominal data provided on the certificate of calibration."

3.3 Additional Applications of the Model 9211B

Each shunt can be employed as a separate 4 terminal standard resistor for measurements of resistance. The operating procedure is identical to that described previously. The circuit would include a resistance in series with the "current" connections rather than an instrument under test (although it could include both if desired). By measuring the voltage drop separately across the resistance under test the two resistors can he compared.

Note: When comparing standard resistors as described above, accuracy of comparison is directly proportional to current stablity if using a single milli-voltmeter to measure the drop across each resistor and switching from the standard to the unit under test. If two milli-voltmeters are employed overall accuracy must include the accuracy of both readout instruments.

4.0 CALIBRATION AND PERFORMANCE VERIFICATION

4.1 Introduction

The following section describes the calibration and performance verification procedures for the 9211B Series of Multi-tap DC Current Shunts. It is recommended that DC Shunt be calibrated at the currents listed in Table 3 for each resistance values.

4.2 Calibration Overview

This calibration procedure covers the entire range of the 9211B Series of Multi-Tap DC Shunts. The 9211B Series has 9 shunt calibration resistance values with each reistance value requireing verification at various currents. This requires the ability to generate currents up to 100 A (optinal 300 A) and measurement resistance down to 0.333333 mΩ with uncertainties less than 20 μΩ/Ω.

The 9211B recommended calibration interval is 12 months or 1 There are two different methods of calibration that customers may use.

Most customers prefer to utilized the 9211B as standard whose ohmic values remain within the nonimal range. This means that the values listed for each resistance range will be within the 1 year specification. For example, the 1 Ω (0.1 A Range) will be within the 12 month tolerance of 0.01 % (100 ppm). If the value would exceed this limitation, the unit would be adjusted or repaired to return the unit back within the nominal range.

The second optional method is to use the actual calibrated value of each range and use this characterized value vs the nominal value of the standard. Using the same 1 Ω value (0.1 A range) above as an example. Say this value drifted at a upward rate of 15 μΩ/Ω per year. In approximately 7 years, this unit will have drifted 105 μΩ/Ω or 5 μΩ/Ω greater than the nominal tolerance of 100 μΩ/Ω. Rather than have this value adjusted back to within the nominal value of 1 Ω ± 0.01 %, the customer uses the value obtained each year and verifies that this value remains within 0.01 % of last calibration.

It is up to the individual customer to determine which method they will incorporate within their calibration procedure. The calibration process to determine the validity of the UUT measurement, regardless of the applicaton philopsy they will use, is exactly the same for either method.

The two calibration processes and tables are provided. Paragraph 4.6 and Table 4 are used if the nominal calibration process is used. Paragraph 4.7 and Table 5 are used if the customer is using the drift of the unit vs nominal value.

4.3 Calibration Interval and Performance

It is recommended that the 9211B series be calibrated or verified at the manufacturer's recommended 1 year interval. As with all Standards that have resistance elements, it is highly recommended that past history be used to determine drift rates and allow user confidence that the unit will remain within calibration for the next calibration period.

Each 9211B is manufacturered to provide some of the best (i.e. lowest) uncertainies when compared to other commercially available Multi-tap DC Current Shunts. After recalibration the user should determine the Resistance Calibration Uncertainties by applying a 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 Resistance Calibration Services, both accredited and non-accredited, from its Smiths Falls Location. We can provide very good turn-around times with some of the lowest uncertainties available today. 9211B Users may find the use of Guildline Calibration Services an excellent convenience as well as a great alternative to maintaining their own calibration facilities to support these standards.

4.4 Equipment and Standards Required for Calibration

The following Resistance Standards and Test Equipment is required for calibration.

Standards and Equipment Required:

Complete 6625A Resistance Measurement System with 6623A-300A Range Extender Installed (See Below for Alternative Acceptable Equipment Models).

Or (Alternative Standards)

(a) Direct Current Comparator Resistance Bridge (Acceptable Models)

Guildline Instruments 6622A Series DCC Resistance Bridge
Guildline Instruments 6675 or 6675A Series DCC Resistance Bridge
Guildline Instruments Model 9975A

(b) Laboratory Grade Primary Resistance Standard (Acceptable Models)

Guildline Instruments 6634A-X Temperature Stabilized Resistance Standards
Guildline Instruments 9334A Series Air Resistance Standards
Guildline Instruments 9330 Series Oil Resistance Standards

(c) Low Thermal Lead Sets or Low Thermal Wire (Acceptable Models) (for Rs) and Appropriately rated leads for Current Leads (150 mA to 300 A)

Guildine 6622A : Precision Lead Set For Resistance Bridge
SCW-30:18AWG : 18 Guage Low Thermal Wire
92303 Lead Set (300 A, 1.5 m)
92321 Lead Set (150 A, 1.5 m)
92301 Lead Set (20 A, 1.5 m)

4.5 Routine Calibration

This routine calibration procedure describes the calibration currents required for the 9211B Multi-Tap Current Shunt. 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 Resistance Measurements and full understanding of the DCC Bridge operation's and will take precautions to avoid introducing errors from sources such as guard errors, thermal emfs, temperature and or EMI errors and others. The procedure assumes operators will make adequate allowance for equipment stabilization and measurement settling times.

For the best uncertainties with least operational influence on the measurements, it is recommended that customers use automation technologies such as Bridgeworks-R or Bridgeworks-C Software, IEEE control and 6664X Series Low Thermal Scanners (can be used for automation of measurements up to 2 A).

Calibration Notes

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 for damage and cleanliness. If the UUT is not in suitable condition for calibration, please clean or repair before proceeding.

Leads can have an impact on overall measurements. Ensure that the leads selected are Metrology Grade leads. While 300 A leads are called out for the 300 A range, Guildline uses 500 A leads for this measurement to avoid temperature affects on measurements. Your measurement may or may not be affected depending on the quality of the leads.

Table 4-1 : List of Recommended Test Currents or Voltages For Resistance Values

Ampere Input	Range Resistance	Recommended Test Currents	Foot Notes	Comments
300	0.333 333 mΩ	30 Adc 100 Adc 300 Adc[4]	1, 4	6623A-300 Range Extender required . Calibrate in order (minimum current to maximum current)
100	1 mΩ	10 Adc 100 Adc	1,2	6623A Range Extender required Calibrate in order (minimum current to maximum current)
10	10 mΩ	1.0 Adc 10 Adc	1	6623A Range Extender required Calibrate in order (minimum current to maximum current)
1	100 mΩ	0.1 Adc 1 Adc	2	6623A Range Extender required Calibrate in order (minimum current to maximum current)
0.1	1 Ω	0.01 Adc 0.1 Adc	3	Calibrate in order (minimum current to maximum current)
0.01	10 Ω	0.001 Adc 0.01 Adc	3	Only 6622A Bridge Required (No Range Extender needed) for Remaining Tests. Calibrate in order (minimum current to maximum current)
0.001	100 Ω	0.000 1 Adc 0.001 Adc	3	Only 6622A Bridge Required (No Range Extender needed) for Remaining Tests. Calibrate in order (minimum current to maximum current)
0.000 1	1000 Ω	0.000 1 Adc	3	Only 6622A Bridge Required (No Range Extender needed) for Remaining Tests.
0.000 01	10 kΩ	0.000 1 Adc	3	Only 6622A Bridge Required (No Range Extender needed) for Remaining Tests.

1 – Requires 6623A Series Range Extender
2 – Requires either 6623A Series Range Extender or 6623A-2 (With Built in Supply)
3 – Can use any of the recommended Bridges
4 – Optional Calibration Points can be used in place of Standard Point or added to standard points for calibraiton.

4.6 Nominal Value Calibration Procedure

4.6.1 Record the UUT Information on Table 4.

(b) Allow the 9211B to stabilize at Calibration environment for a 24 hour period. Ensure that the room is properly ventilated to dissipate heat up to 30 W of power for the calibration process.

(c) Setup DCC Bridge and Range Extender and other standards used for appropriate measurement (refer to Standards Manuals used).

4.6.2 Calibration of 0.01 mA (10 kΩ) Ranges to 1 A (0.1 Ω Ranges)

(a) Connect the the 6622A Series Bridge directly (C1 and C2) to the Common and Potential terminals on the 9211B.

Note: The cables will remain connected in this configuration for the remainder of the calibration.

(b) Move the two Range Plugs to 0.01 mA. Allow the UUT to stablize 10 minutes prior to starting the measurements

(c) Output the first current (starting with lowest current) for the 0.01 mA range and after proper bridge measurement cycle (refer to user manuals for bridge, record the UUT value under MEASURED VALUE on the worksheet.

(d) Unit value should be between the minimum and maximum values. If not, unit will require repair.

(e) Repeat for all currents listed for each test point. Always start with lowest current (minimum heat dissipation) and work to highest current.

(f) Repeat Steps b through d for remaining values.

4.6.3 Calibration of 1 A (100 mΩ) Range

(a) Disconnect the current (C1 and C2) lead sets and connect a cable capable of handling 1 A to the UUT's 1 A Terminal and Input Common Terminals. Connect the other end to the 6623A Range Extenders 2 A Input Common cable connection to the high and low terminals. Potential Cables should remain connected as before.

(b) Move the two Range Plugs to 1 A. Allow the UUT to stablize 10 minutes prior to starting the measurements

(c) Output the first current (starting with lowest current) for the 1 A and after proper bridge measurement cycle (refer to user manuals for bridge),), record the UUT value under MEASURED VALUE on the worksheet.

(d) Unit value should be between the minimum and maximum values. If not, unit will require repair.

(e) Repeat for all currents listed for each test point. Always start with lowest current (minimum heat dissipation) and work to highest current.

4.6.4 Calibration of 10 A (10 mΩ) Range

(a) Disconnect the 1 A Current Cables Cable and connect a cable capable of handling 10 A to the UUT's 10 A and Input Common Terminals. On the 6623A Range Extender, move the Input Common cable connection to the appropriate range extender 15 A output high and low. Potential Cables should remain connected as before.

(b) Move the two Range Plugs to 10 A. Allow the UUT to stablize 10 minutes prior to starting the measurements

(c) Output the first current (starting with lowest current) for the 10 A and after proper bridge measurement cycle (refer to user manuals for bridge), record the UUT value under MEASURED VALUE on the worksheet.

(d) Unit value should be between the minimum and maximum values. If not, unit will require repair.

(e) Repeat for all currents listed for each test point. Always start with lowest current (minimum heat dissipation) and work to highest current.

4.6.5 Calibration of 100 A (1 mΩ) Range

(a) Common and Potential Cables should remain connected as before. Disconnect the 10 A Current Cables and connect a cable capable of handling 300 A to the UUT's 100 A and Input Common (Right side) and to the 6623A-300 Range Extender 300 A output. Potential Cables should remain connected as before.

(b) Move the two Range Plugs to 100 A. Allow the UUT to stablize 10 minutes prior to starting the measurements

(c) Output the first current (starting with lowest current) for the 100 A and after proper bridge measurement cycle (refer to user manuals for bridge), record the UUT value under MEASURED VALUE on the worksheet.

(d) Unit value should be between the minimum and maximum values. If not, unit will require repair.

(e) Repeat for all currents listed for each test point. Always start with lowest current (minimum heat dissiapation) and work to highest current.

4.6.6 Calibration of 300 A (0.333 333 mΩ) Range

(a) Connect leads capable of handling 300 A to the 9211B Input Common (Right side) and the 300 A Terminals to the 6623A-300 Range Extender output high and low.

(b) Connect the Bridge Rx terminals to the UUT Common and Potential Terminals on the left side (4 to 2 wire connection).

(c) Set the two range plugs to the 300 A terminals.

(d) Output the first current (starting with lowest current first) for the 300 A and after proper bridge measurement cycle (refer to user manuals for bridge), record the UUT value under MEASURED VALUE on the worksheet.

(e) Unit value should be between the minimum and maximum values. If not, unit will require repair.

(f) Repeat for all currents listed for each 300 A test point. Always start with lowest current (minimum heat dissapation) and work to highest current.

Note: Measurement Tips.

Consider the following when setting up the measurement

Verify that the max voltage or current applied in the measurement will not exceed the specs for the UUT or the STD.

For the 100 A and 300A range, permit a stbilization time of 30 minutes for the lower currents and minimum 1h for test currents 100A and higher!

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 PC, verify that the number of samples and logging delay are appropriate.

If using a PC set the environmental parameters in BridgeWorks .

Verify guard and ground connections (see 6622A Manual).

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

Table 4-2 : 9211B Nominal Calibration Data Worksheet

UUT Serial Number	Calibration Temperature	Calibration Date	Last Calibration Date

0.000 01 Ampere Output	Nominal Value: 10, 000 Ω		12 Month Tolerance: ±100 ppm
CALIBRATION CURRENT (ADC)	Lower Value Limit	Measured Value	Upper Value Limit
0.000 1	9 999.000 Ω		10 001.000 Ω

0.0001 Ampere Output	Nominal Value: 1000 Ω		12 Month Tolerance: ±100 ppm
CALIBRATION CURRENT (ADC)	Lower Value Limit	Measured Value	Upper Value Limit
0.000 1	999.900 0 Ω		1000.100 0 Ω

0.001 Ampere Output	Nominal Value: 100 Ω		12 Month Tolerance: ±100 ppm
CALIBRATION CURRENT (ADC)	Lower Value Limit	Measured Value	Upper Value Limit
0.0001	99.990 00 Ω		100.010 00 Ω
0.001	99.990 00 Ω		100.010 00 Ω

0.01 Ampere Output	Nominal Value: 10 Ω		12 Month Tolerance: ±100 ppm
CALIBRATION CURRENT (ADC)	Lower Value Limit	Measured Value	Upper Value Limit
0.001	9.999 000 Ω		10.001 000 Ω
0.01	9.999 000 Ω		10.001 000 Ω

0.1 Ampere Output	Nominal Value: 1.0 Ω		12 Month Tolerance: ±100 ppm
CALIBRATION CURRENT (ADC)	Lower Value Limit	Measured Value	Upper Value Limit
0.01	0.999 900 0 Ω		1.000 100 0 Ω
0.1	0.999 900 0 Ω		1.000 100 0 Ω

9211B Nominal Calibration Data Worksheet (Continued)

UUT Serial Number	Calibration Temperature	Calibration Date	Last Calibration Date

1 Ampere Output	Nominal Value: 0.1 Ω		12 Month Tolerance: ±100 ppm
Calibration Current (Adc)	Lower Value Limit	Measured Value	Upper Value Limit
0.1	0.099 990 0 Ω		0.100 010 0 Ω
1.0	0.099 990 0 Ω		0.100 010 0 Ω

10 Ampere Output	Nominal Value: 0.01 Ω		12 Month Tolerance: ±100 ppm
Calibration Current (Adc)	Lower Value Limit	Measured Value	Upper Value Limit
1	0.009 999 0 Ω		0.01 000 10 Ω
10	0.009 999 0 Ω		0.01 000 10 Ω

100 Ampere Output	Nominal Value: 0.001 Ω		12 Month Tolerance: ±500 ppm
Calibration Current (Adc)	Lower Value Limit	Measured Value	Upper Value Limit
10	0.000 999 50 Ω		0.001 000 50 Ω
100	0.000 999 50 Ω		0.001 000 50 Ω

300 Ampere Output	Nominal Value: 0.000 333 333 Ω		12 Month Tolerance: ±1000 ppm
Calibration Current (Adc)	Lower Value Limit	Measured Value	Upper Value Limit
30	0.000 333 000 Ω		0.000 333 666 Ω
100	0.000 333 000 Ω		0.000 333 666 Ω
300*	0.000 333 000 Ω		0.000 333 666 Ω

* Optional Current Point

4.7 Optional Calibration Procedure (Drift Verification)

4.7.1 Calibration of 300 A (0.333 333 mΩ) Range

(a) Record the last calibration date and previous values for each range on Table 5. The last calibration date is used to determine if the unit has met 1 year specifications.

(b) Allow the 9211B to stabilize at Calibration environment for a 24 hour period. Ensure that the room is properly ventilated to dissipate heat up to 30 W of power for the calibration process.

(c) Setup DCC Bridge and Range Extender and other standards used for appropriate measurement (refer to Standards Manuals used).

(d) Connect leads capable of handling 300 A to the 9211B Input Common (Right side) and the 300 A Terminals to the range extender output high and low.

(e) Connect the Bridge Rx terminals to the UUT Common and Potential Terminals on the left side (4 to 2 wire connection).

(f) Set the two range plugs to the 300 A terminals.

(g) Output the first current (starting with lowest current first) for the 300 A and after proper bridge measurement cycle (refer to user manuals for bridge), record the measured value under column "C" on the worksheet.

(h) Calculate Actual Deviation and compare to Maximum Deviation. Unit should be within maximum deviation values. If not, unit will require repair.

(i) Repeat for all currents listed for each 300 A test point. Always start with lowest current (minimum heat dissapation) and work to highest current.

4.7.2 Calibration of 100 A (1 mΩ) Range

(a) Common and Potential Cables should remain connected as before. Disconnect the 300 A Red Cable and connect a cable capable of handling 100 A to the UUT's Input Common (Right side) and 100 A Terminals and to the range extender output high and low.

(b) Move the two Range Plugs to 100 A. Allow the UUT to stablize 10 minutes prior to starting the measurements

(c) Output the first current (starting with lowest current) for the 100 A and after proper bridge measurement cycle (refer to user manuals for bridge), record the measured value under column "C".

(d) Calculate Actual Deviation and compare to Maximum Deviation. Unit should be within maximum deviation values. If not, unit will require repair.

(e) Repeat for all currents listed for each test point. Always start with lowest current (minimum heat dissiapation) and work to highest current.

4.7.3 Calibration of 10 A (10 mΩ) Range

(a) Disconnect the 100 A Red Cable and connect a cable capable of handling 10 A to the 9211B 10 A Terminal and range Extender current output. Move the Input Common cable connection to the appropriate range extender output low. Common and Potential Cables should remain connected as before.

(b) Move the two Range Plugs to 10 A. Allow the UUT to stablize 10 minutes prior to starting the measurements

(c) Output the first current (starting with lowest current) for the 10 A and after proper bridge measurement cycle (refer to user manuals for bridge), record the measured value under column "C".

(d) Calculate Actual Deviation and compare to Maximum Deviation. Unit should be within maximum deviation values. If not, unit will require repair.

(e) Repeat for all currents listed for each test point. Always start with lowest current (minimum heat dissipation) and work to highest current.

4.7.4 Calibration of 1 A (100 mΩ) Range

(a) Disconnect the 10 A Red Cable and connect a cable capable of handling 1 A to the 9211B 1 A Terminal and and range Extender current output. Move the Input Common cable connection to the appropriate range extender output low. Common and Potential Cables should remain connected as before.

(b) Move the two Range Plugs to 1 A. Allow the UUT to stablize 10 minutes prior to starting the measurements

(c) Output the first current (starting with lowest current) for the 1 A and after proper bridge measurement cycle (refer to user manuals for bridge), record the measured value under column "C".

(d) Calculate Actual Deviation and compare to Maximum Deviation. Unit should be within maximum deviation values. If not, unit will require repair.

(e) Repeat for all currents listed for each test point. Always start with lowest current (minimum heat dissipation) and work to highest current.

4.7.5 Calibration of 0.1 A and below (1 Ω) Ranges

(a) Remove the Range Extender cable and connect leads from the 10A to the Bridge directly.

(b) Move the two Range Plugs to 0.1 A. Allow the UUT to stablize 10 minutes prior to starting the measurements

(c) Output the first current (starting with lowest current) for the 0.1 A and after proper bridge measurement cycle (refer to user manuals for bridge), record the measured value under column "C".

(d) Calculate Actual Deviation and compare to Maximum Deviation. Unit should be within maximum deviation values. If not, unit will require repair.

(e) Repeat for all currents listed for each test point. Always start with lowest current (minimum heat dissipation) and work to highest current.

(f) Repeat Steps b through d for remaining values.

Note: Measurement Tips.

Consider the following when setting up the measurement

Verify that the max voltage or current applied in the measurement will not exceed the specs for the UUT or the STD.

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 PC, verify that the number of samples and logging delay are appropriate.

If using a PC set the environmental parameters in BridgeWorks .

Verify guard and ground connections (see 6622A Manual).

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

Table 4-3 : 9211B Optional Calibration Data Worksheet

UUT Serial Number	Calibration Temperature	Calibration Date	Last Calibration Date

300 Ampere Output		Nominal Ohmic Value:	0.000 333 333 Ω	
		12 Month Tolerance [1]	±1000 ppm	
A	B	C	D	E
Calibration Current (ADC)	Ohmic Value Last Calibration	Ohmic Value Current Calibration	Actual Deviation (Ω) [2]	Maximum Deviation (Ω) [3]
30				
100*				
300				

* Optional

100 Ampere Output		Nominal Ohmic Value:	0.001 Ω	
		12 Month Tolerance [1]	±500 ppm	
A	B	C	D	E
Calibration Current (ADC)	Ohmic Value Last Calibration	Ohmic Value Current Calibration	Actual Deviation (Ω) [2]	Maximum Deviation (Ω) [3]
10				
100				

10 Ampere Output		Nominal Ohmic Value:	0.01 Ω	
		12 Month Tolerance [1]	±100 ppm	
A	B	C	D	E
Calibration Current (ADC)	Ohmic Value Last Calibration	Ohmic Value Current Calibration	Actual Deviation (Ω) [2]	Maximum Deviation (Ω) [3]
1				
10				

9211B Optional Calibration Data Worksheet (Continued)

UUT Serial Number	Calibration Temperature	Calibration Date	Last Calibration Date

1 Ampere Output		Nominal Ohmic Value:	0.1 Ω	
		12 Month Tolerance [1]	±100 ppm	
A	B	C	D	E
Calibration Current (Adc)	Ohmic Value Last Calibration	Ohmic Value Current Calibration	Actual Deviation (Ω) [2]	Maximum Deviation (Ω) [3]
0.1				
1				

0.1 Ampere Output		Nominal Ohmic Value:	1.0 Ω	
		12 Month Tolerance [1]	±100 ppm	
A	B	C	D	E
Calibration Current (Adc)	Ohmic Value Last Calibration	Ohmic Value Current Calibration	Actual Deviation (Ω) [2]	Maximum Deviation (Ω) [3]
0.01				
0.1				

0.01 Ampere Output		Nominal Ohmic Value:	10.0 Ω	
		12 Month Tolerance [1]	±100 ppm	
A	B	C	D	E
Calibration Current (Adc)	Ohmic Value Last Calibration	Ohmic Value Current Calibration	Actual Deviation (Ω) [2]	Maximum Deviation (Ω) [3]
0.001				
0.01				

9211B Optional Calibration Data Worksheet (Continued)

UUT Serial Number	Calibration Temperature	Calibration Date	Last Calibration Date

0.001 Ampere Output		Nominal Ohmic Value: 100 Ω		
		12 Month Tolerance [1] ±100 ppm		
A	B	C	D	E
CALIBRATION CURRENT (ADC)	OHMIC VALUE LAST CALIBRATION	OHMIC VALUE CURRENT CALIBRATION	ACTUAL DEVIATION (Ω) [2]	MAXIMUM DEVIATION (Ω) [3]
0.000 1				
0.00 1				

0.000 1 Ampere Output		Nominal Ohmic Value: 1000 Ω		
		12 Month Tolerance [1] ±100 ppm		
A	B	C	D	E
CALIBRATION CURRENT (ADC)	OHMIC VALUE LAST CALIBRATION	OHMIC VALUE CURRENT CALIBRATION	ACTUAL DEVIATION (Ω) [2]	MAXIMUM DEVIATION (Ω) [3]
0.000 1				

0.000 01 Ampere Output		Nominal Ohmic Value: 10000 Ω		
		12 Month Tolerance [1] ±100 ppm		
A	B	C	D	E
CALIBRATION CURRENT (ADC)	OHMIC VALUE LAST CALIBRATION	OHMIC VALUE CURRENT CALIBRATION	ACTUAL DEVIATION (Ω) [2]	MAXIMUM DEVIATION (Ω) [3]
0.000 1				

Note 1 – 12 Month Specification is a drift spefication. This is the maximum drift per year allowed. If UUT has not been calibrated in last 12 months, this specification will increase by the actual time since the last calibration.

Note 2 – To Calculate Actual Deviation (in Ohms) use the following formula:

Actual Deviation = Current Calibration Ohmic Value – Last Calibration Ohmic Value

Note 3 – To Calculate Maximum Deviation (in Ohms) use the following formula:

Maximum Deviation = Last Calibration Ohmic Value x 12 Month Tolerance

5.0 MAINTENANCE

Maintenance of the resistor consists only of routinely inspecting the unit for physical damage and cleanliness. Cleanliness is especially important on the high value resistors (1 MΩ and greater). These should be cleaned with isopropanol and a soft brush or cloth. Special care should be taken to ensure that the terminal connectors are clean.

5.1 Maintenance, Inspection and Cleaning

5.1.1 Inspection

Inspect the shunt panel before operation. It should be free from physical damage with no broken or bent binding posts.

5.1.2 Cleaning

Front panel by wiping with a dryt lint-free cloth. Male plugs and receptacles can be wiped with a crocus cloth if they appear discolored. Do not use sand paper. Avoid using a cleanser since many leave a film.

Caution

Do not remove rear cover to clean inside of shunt box. Physical movement of shunts can cause mounting stress and changes in resistance values.

5.2 Troubleshooting

5.2.1 Steps for Trouble Shooting the 9211B

5.2.1.1 A visual inspection is most important. Check to see if rear cover or panel is warped or distorted. If it is, the entire unit should be re-calibrated at once.

5.2.1.2 If the binding post heads on the front panel are broken, they should be replaced.

5.2.1.3 If an electrical overload has been applied beyond the rating of each resistor, the entire unit should be re-calibrated at once. (Note: A burned shunt will have a distinct charred odor).

5.2.1.4 If an open or intermittent circuit is found in the instrument, (no reading or varying reading on millivoltmeter), check per 5.2.1.5 to 5.2.1.8.

5.2.1.5 All lead connections to binding posts must be tight. Leads should be checked for continuity using a circuit tester. See that plugs are firmly inserted in female receptacles.

5.2.1.6 Lead connectors, plugs and receptacles should be checked for clean surfaces. Clean, if required, using a crocus cloth.

5.2.1.7 Readout instrument should indicate and be stable when tested in another circuit in accordance with the manufacturer's instructions.

5.2.1.8 Power source should be tested for output. If no output, troubleshoot in accordance with manufacturer's instructions.

Note: A skipping or variable rheostat in the circuit can cause results similar to a broken lead or bad connnection.

5.2.2 Short Circuit Troubleshooting

If a short circuit is found in the instrument, check as follows:

5.2.2.1 Verify proper connection of all leads

5.2.2.2 Physical condition of vented rear cover. If cover indented badly, it could short circuit two or more resistors by touching them. Remove the cover from the rear panel taking care not to put pressure on any resistors. Straighten the cover. Examine the internal circuit visually for possible snorting of components. Reinstall the cover observing the same precautions.

5.2.2.3 Compare each resistor to a standard resistor

5.2.2.4 If tests above are negative, the problem may be in the internal wiring or resistors in the shunt. Each shunt can be tested separately for continuity without removing the rear vented cover, by inserting the two plugs in the paired female receptacles for each range and using an ohmmeter between the "10 A MAX." or "100 A MAX" or "300 A MAX" binding post and the "Input Common" binding post. If a defective shunt or internal connection is found (or suspected), the entire unit should be returned for possible repair. (See Warranty information in front of this manual for instructions).

5.3 Replaceable Parts

The following tables list the replaceable parts. **Note that once a part has been replaced, the unit will require 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

9211B Spare Parts Listing

Part Number:	12294-01-01			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	9711A/9211B Taper Plug Assembly for Range Selection - Precision Machined, Sold in Set (2 Plugs as shown)			
Dimensions:	(each Plug) 0.94" Tall, 1.0" Wide and 0.5" Thick			
Weight:	(Each Plug) 0.60 oz. (17 g)			

Part Number:	30559-02-17			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	Knob Assembly (3/8-16) (300 A, and Common Terminals)			
Dimensions:	1.8" length, 1.9" diameter			
Weight:	1.8 oz, 51 g			

Part Number:	30559-01-17			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	Knob Assembly (1/4-20) (100 A Terminal)			
Dimensions:	1.5" length, 1.4" diameter			
Weight:	0.72 oz, 21 g			

Part Number:	17749.01.12			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	Small Binding Post Head			
Dimensions:	⅝" length, ⅝" diameter			
Weight:	0.32 oz, 9g			

NOTE: The 100 and 300 Ampere Shunt Resistors are only factory replaceable. The following shunt resistors are replaceable, but must be trimmed in by the repair facility as insertion and repair techniques to include type of solder used will change the value once put into the unit.

Part Number:	17798.01.02			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	Precisiouesn 1 Ω Range Resistor (0.1 A Current Range)			
Dimensions:	4″ lenght, 2¾" width, ¾ diameter			
Weight:	1.8 oz, 51g			

Part Number:	17798.02.02			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	Pecision 10 Ω Range Resistor (0.01 A Current Range)			
Dimensions:	4″ length, 3" width, ¾ diameter			
Weight:	1.62 oz, 46g			

Part Number:	17798.03.02			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	Precision 100 Ω Range Resistor (0.001 A Current Range)			
Dimensions:	5¼″ length, 1⅛″ width, ¾″ diameter			
Weight:	1.45 oz, 41g			

Part Number:	17798.04.02			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	Precision 1 kΩ Range Resistor (0.0001 A Current Range)			
Dimensions:	5⅛″ length, ⅞″ width, ¾″ diameter			
Weight:	1.31 oz, 37g			

Part Number:	17798.05.02			
Manufacturer:	Guildline Instruments		Cage Code:	35939
Description:	Precision 10 kΩ Range Resistor (0.000 01 A Current Range)			
Dimensions:	5⅜″ length, ⅞″ width, ¾″ diameter			
Weight:	1.23oz, 35g			

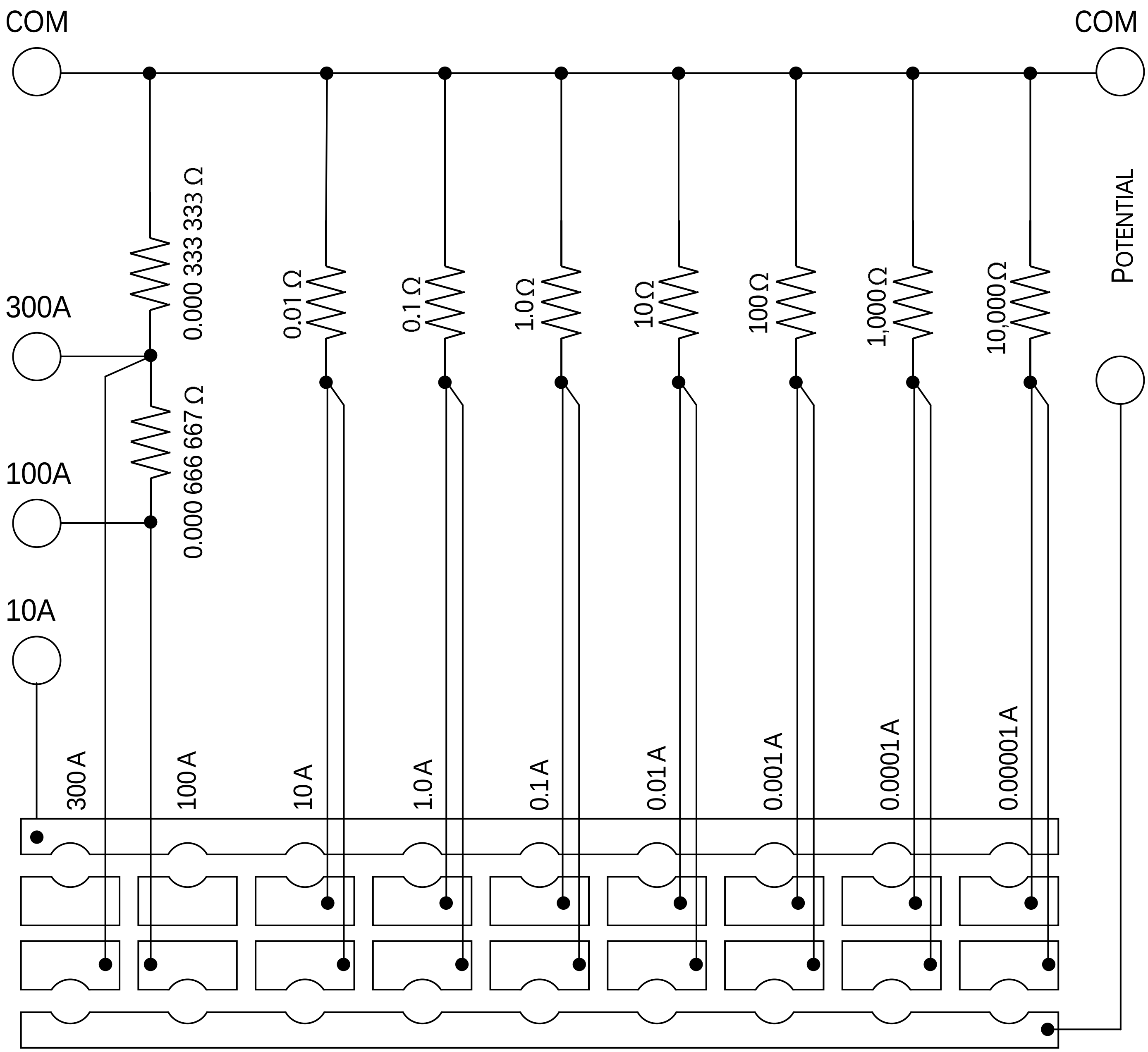

Figure 5-1 : 9211B Schemtic Overview