Model 511

10 ppm Precision DC Source/ Calibrator

KROHN-HITE CORPORATION

Calibration Manual

Model 511

10 ppm Precision DC Source/ Calibrator

Calibration Manual

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Section 1
511 General Information

1-1 Introduction

This manual provides the user with the information needed to calibrate the Krohn-Hite Model 511. Section 2 is a procedure used to verify that the DC Calibrator is within the published specifications. This manual is intended for use by service trained personnel only. Operating personnel should refer to the Krohn-Hite Model 511 Operator's manual. Details for contacting Krohn-Hite and important safety information are also contained within this manual.

Note: If the Model 511 is still under warranty and it is outside its specified limits, contact Krohn-Hite or your distributor to establish the course of action.

1-2 Safety Information

The Model 511 has been designed, tested and supplied in a safe condition. The following general safety precautions must be observed during all phases of operation, service, and repair. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture and intended use of this instrument. Krohn-Hite assumes no liability for the customer's failure to comply with these requirements.

This manual contains information and warnings that must be observed to keep the instrument in a safe condition and ensure safe operation. Operation or service in conditions or in a manner other than specified could compromise safety. For the correct and safe use of this instrument, operating and service personnel must follow generally accepted safety procedures.

To avoid injury or fire hazard, do not switch on the instrument if it is damaged or suspected to be faulty. Do not use the instrument in damp, wet, condensing, dusty or explosive gas environments.

Whenever it is likely that safety protection has been impaired, make the instrument inoperative and secure against any unintended operation, and then inform qualified personnel. Safety protection is likely to be impaired if, for example, the instrument shows visible damage, or fails to operate normally.

Ground the Instrument

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. Any interruption of the protective ground conductor inside or outside the instrument is likely to make the instrument dangerous. Intentional interruption is prohibited.

Do Not Operate In an Explosive Atmosphere

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away From Live Circuits

Operating personnel must not remove instrument covers. Qualified maintenance personnel must make component replacement and internal adjustments. Under certain conditions, dangerous voltages may exist. To avoid injuries, always disconnect input voltages before removing the covers. Use caution when working with voltages above 30 Vac rms, 42 V peak, or 60 Vdc. These voltages pose a shock hazard. A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.

Do Not Substitute Parts or Modify Instrument

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modifications. Use only the replacement fuse(s) listed in this manual. Return the unit to the Krohn-Hite Service Department to modify or repair the instrument to ensure that safety features are maintained.

Do Not Operate a Damaged Instrument

Whenever it is possible that the safety protection features built into this instrument have been impaired, either through physical damage, excessive moisture, or any other reason, REMOVE the POWER and do not use the instrument until safe operation can be verified by service-trained personnel. If necessary, return the instrument to the Krohn-Hite Service Department for service and repair to ensure that the safety features are maintained.

1-3 Krohn-Hite Contact Information

To order parts, accessories, or obtain service call:
1-508-580-1660
Or, visit the Krohn-Hite Web site at www.krohn-hite.com

Section 2
Verification

2-1 Introduction

The following procedure should be used to verify that the Model 511 is operating properly. These checks may be used for incoming acceptance and periodic performance checks. Test should be made with the covers in place and after a minimum one hour warm-up.

----- Warning -----

The chassis of this instrument is connected to ground. For safety purposes, connect the line cord to a grounded 3-terminal ac outlet.

The information in this section is intended only for qualified service personnel Do not attempt these procedures unless you are qualified to do so.

----- Caution -----

Because of the potentially dangerous voltages that exist within the instrument, the covers of the Model 511 should not be removed when connected to an ac power source.

2-2 Recommended Test Equipment

The equipment listed below is required to perform the acceptance tests.

Digital Voltmeter: H-P Model 3458A or equivalent.
Power Load Resistor: CLAROSTAT Model 240-C or equivalent.
High gain differential preamplifier such as PREAMBLE Model DA1822A or equivalent.
True rms voltmeter having a 20mV range: Fluke Model 8920A or equivalent.

2-3 Warm-up Procedure

Perform your verification measurements in a test environment that has a stable ambient room temperature with a relative humidity of less than 70% unless noted otherwise. The Model 511 requires a power line voltage of 100V, 120V, 220V, 240V, ±10% with a line frequency of 50Hz to 400Hz

Allow the minimum warm up time for all test equipment. The Model 511 needs at least one hour to stabilize. Additional time will be needed if the instrument has been subjected to temperatures outside the 18-28°C range.

2-4 DC Voltage Verification Test

After allowing sufficient warm up time, connect the DC voltmeter to the output terminals of the model 511. The front panel "SENSE" switch should be in the 2-wire position and the "LO" switch should be in the float positions. The chart below lists the 511 settings along with the test limits.

Uncertainty Check										
Range	**D.P. LED on**	**Polarity**	**Front Panel Decade Switch Setting**						**Low Limit**	**Upper Limit**
10V	V	+	10	0	0	0	0	0	+ 9.999858 V	+10.000142 V
		-	10	0	0	0	0	0	- 9.999858 V	-10.000142 V
		+ or -	0	0	0	0	0	0	± 42 μV	
1V	0.V	+	10	0	0	0	0	0	+ 0.999984 V	+ 1.000016 V
		-	10	0	0	0	0	0	- 0.999984 V	- 1.000016 V
		+ or -	0	0	0	0	0	0	± 6 μV	
100mV	mV	+	10	0	0	0	0	0	+ 99.997 mV	+ 100.003 mV
		-	10	0	0	0	0	0	- 99.997 mV	- 100.003 mV
		+ or -	0	0	0	0	0	0	± 2 μV	

Table 2.1 Output Uncertainty Check

2-5 Optional Tests

These procedures are used to ensure that the Model 511 passes both the 4-wire load regulation and the output noise tests.

2-6 DC Voltage Load Regulation Test

Connect the DC voltmeter to the sense and output junction on the Power Load Resistor box.[1] Set the 511 to 4-wire mode and connect the load box to the 511 with two 2-wire twisted pair cables. The 511 sense and output terminals must be connected at the load box. Refer to figure 2.1 for hookup details.

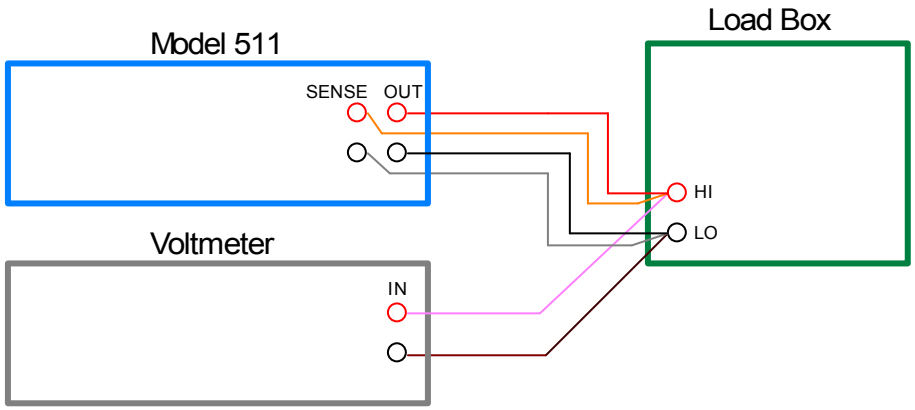

Figure 2-1 Load Regulation Setup

Set the 511 to output 10.00000 volts and set the load box to a few hundred thousand ohms (light load). After noting the voltmeters reading, reduce the load resistance to 100 ohms and record the voltmeter new reading. The change should be less than ± 1µV.

Change to the 1 V range and repeat the test using 10 ohms for the second setting. The change should be less than ± 1µV.

Change to the 100 mV range and repeat the test using 1 ohms for the second setting. The change should be less than ± 1µV.

[1] The voltmeter **must** be connected to the sense leads at the junction of where the 511's output and sense cables connect at the load.

2-7 Output Noise Test

KH uses the following procedure to measure the noise levels of the voltage calibrator. Techniques are employed to minimize external ground loops and radiation paths that may introduce improper data into the desired measurements. "Rule of Thumb": If the measurement indicates more than 1 millivolt p-p of noise on any KH instrument, the operator should recheck his equipment, cables and connections.

Noise may appear in many forms, therefore KH recommends the use of a true rms voltmeter with a 20mV range and a high gain (1000) differential pre-amplifier to make the noise measurements. The high gain differential pre-amplifier specified will increase the sensitivity of the true rms voltmeter, enabling it to resolve noise levels in the μV level.

The noise test should not be made simultaneously with regulation and voltage accuracy test. The "feedback" currents from some measuring devices will seriously disturb noise measurements.

Differential input measurements are the most reliable. They will cancel out common mode, due to slight errors in cable connections.

The pre-amplifier, true rms voltmeter and the KH Calibrator under test should be connected to adjacent power outlets on the same phase. A three wire ground is required. In the event the line does not have a ground, the pre-amplifier and unit under test should have a separate, heavy wire chassis-to-chassis connection separate from the shield of the differential input leads. The lead used between the pre-amplifier input and the source output should be a shield, twisted pair with the shield connected to the frame of the pre-amplifier, and to the chassis ground terminal adjacent to the output terminals of the KH source. Do not use the shield of the input cable as the chassis-to-chassis connection in place of line system ground. Use additional separate heavy wire. Refer to Figure 2.2 on the next page for correct connections.

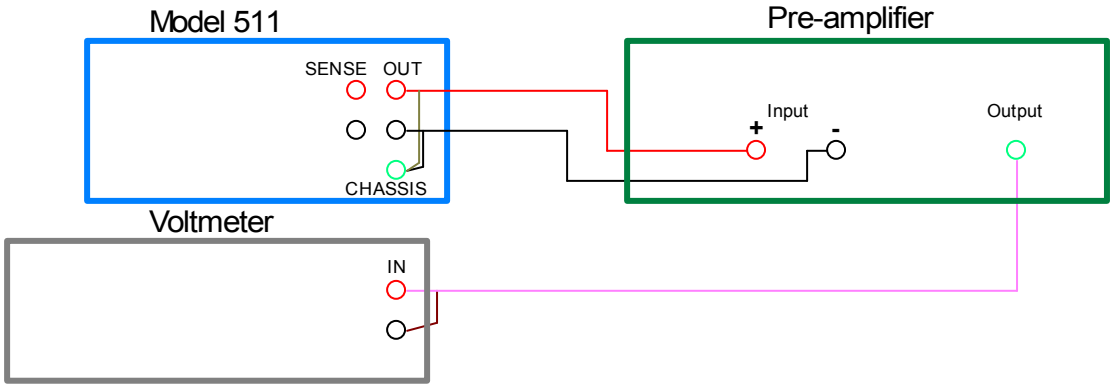

Figure 2.2 Noise Check Setup

Set the differential pre-amplifier upper frequency cutoff to100kHz and the lower cutoff to 0.1Hz. Set the model 511 “sense” switch to the “2-Wire” position and the output to zero. Connect the output of the pre-amplifier to the input of the true rms voltmeter. Observe that ripple and noise does not exceed specifications on each of the ranges. The limit is 5µV rms on both the 100mV and 1V range; and 10µV rms on the 10V range.

NOTE: The "DC" mode on the preamp in use usually results in more accurate "noise" measurements. Be aware of the specifications for your preamp if this test is made at voltage levels other than zero, and AC input is used.

Notes:

Section 3

Calibration

3-1 Introduction

This section provides the user with a procedure to calibrate the Model 511 DC Calibrator.

Note: If the Model 511 is still under warranty and it is outside its specified limits, contact Krohn-Hite or your distributor to establish the course of action.

----- Warning -----

The chassis of this instrument is connected to ground. For safety purposes, connect the line cord to a grounded 3-terminal ac outlet.

The information in this section is intended only for qualified service personnel Do not attempt these procedures unless you are qualified to do so.

----- Caution -----

Because of the potentially dangerous voltages that exist within the instrument, the covers of the Model 511 should not be removed when connected to an ac power source.

3-2 Accessing the Fuse

The fuse is accessible from the rear panel. The 511 will operate on 100, 120, 220 or 240 Vac line voltage. The following explain how to change the voltage settings and the fuse. The cover of the Power Entry Module shows four possible voltage settings (100V, 120V, 220V or 240V). Notice that a pin will be in one of these holes, indicating the present voltage setting for the 511. If this setting does not match the voltage available at your site, then it must be changed before powering on the Model 511. Figure 3.1 shows an example setting for 120 Vac operation

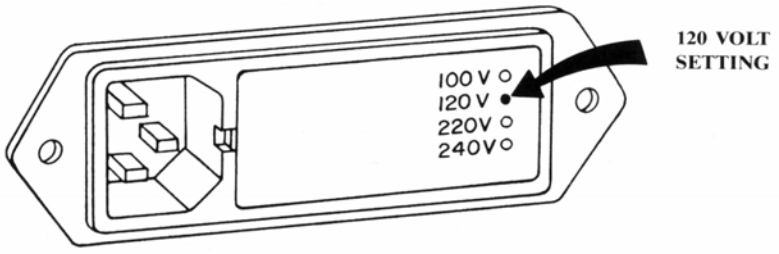

Figure 3.1
120 Volt Line Setting Example

Follow the steps below to change a fuse or convert the operating voltage of the Model 511.

Set the 511 power switch to OFF. Unplug the power cord from the ac wall outlet and from the power cord receptacle on the power entry module. See Figure 3.2 on the next page.

Using a small flat blade screwdriver or similar tool inserted into the slot at the left edge of the cover, carefully pry the cover off the fuse cavity. To change the voltage setting, grasp the white plastic voltage select board pin and pull straight outward until the voltage select board unseats from the power entry module. Hold the board so that you can read the four voltage selection labels (100, 120, 220 and 240) imprinted on the board. Move the voltage indicator pin to the opposite side of the board from the desired voltage label. Be sure to seat the pin in the notch provided on the board's edge. Install the voltage select board so that it is fully seated in the voltage select cavity (the label side toward the fuse cavity).

To change the fuse (s), remove the fuse (s) from the fuse carrier on the back of the cover. For 100 or 120 Vac operation, the fuse rating is 1/8 Amp, Slow-Blow. For 220 or 240 Vac operation, the fuse rating is 1/16 Amp, Slow-Blow. Be sure to use the correct rating for your voltage selection. For installation, insert the fuse(s) of the proper rating into the fuse carrier. To change the fuse arrangement to match that used in your country, remove the screw from the fuse carrier, remove the fuse carrier, turn the fuse carrier so that the desired fuse arrangement (single fuse or dual fuses) is facing outward, install the fuse carrier, and install the screw. For United States type power operation, use a single standard AGC or 3AG 0.25 inch x 1.25 inches fuse of the correct rating. For European type power operation, use two standard 5.2 mm x 20 mm fuses of the correct rating. For European use, is important to note that if your local electrical code does not allow a dual fuse arrangement, then a dummy fuse must be installed in the lower fuse carrier. Otherwise, the 511 will not operate. Place the cover on the power entry module and press inward until it snaps into place. Verify that the desired operating voltage is indicated with the voltage select board pin on the cover label. Connect the power cord to the power entry module and wall outlet.

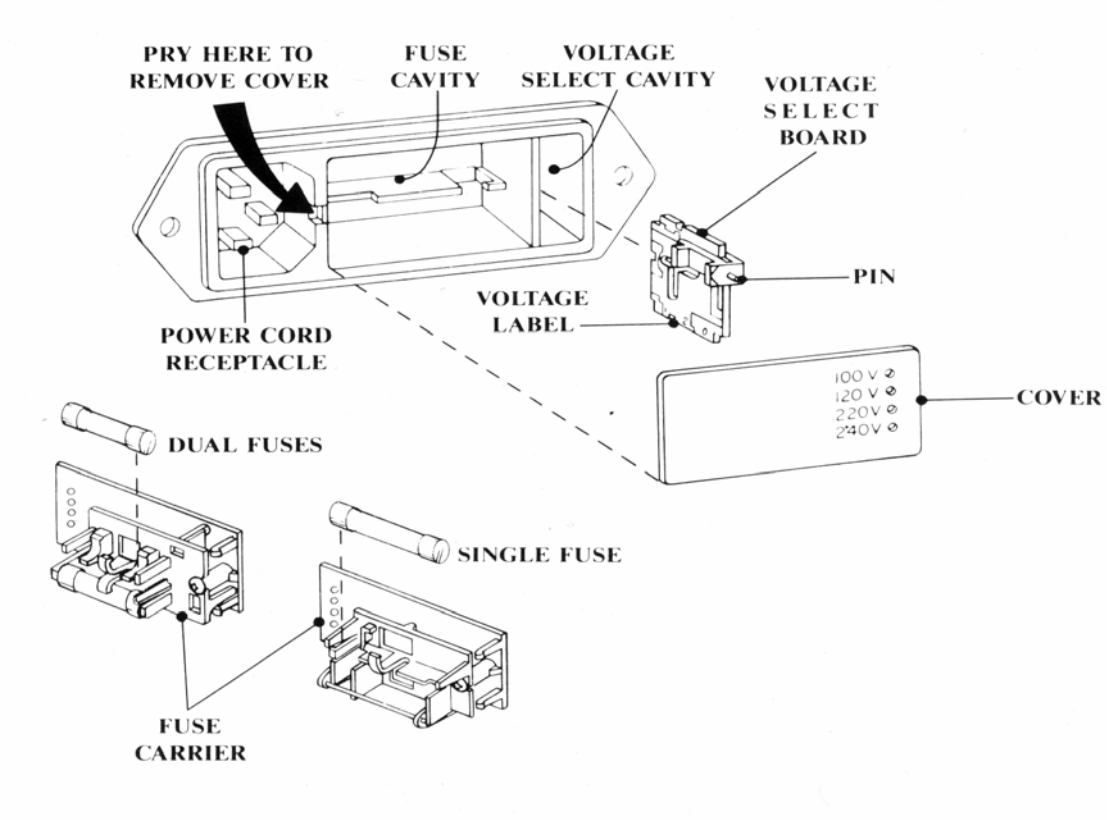

Figure 3.2
Power Entry Module

The Model 511 is now ready to be operated on the selected ac line voltage.

3-3 Exterior Cleaning

----- Warning -----
To avoid personal injury or damage to the Calibrator, use only the specified replacement parts and do not allow water into the case. *The information in this section is intended only for qualified service personnel Do not attempt these procedures unless you are qualified to do so.*

To keep the calibrator looking like new, clean the case, and front panel using a soft cloth slightly dampened with either water or a non-abrasive mild cleaning solution that is not harmful to plastics.

----- Caution -----
Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They can damage the plastic materials used in the calibrator.

3-4 Testing and Calibration

This procedure should be used to calibrate the Model 511. Calibration adjustments should be made with a calibration cover in place and after a minimum warm-up time of one hour under standard reference conditions of 23ºC ± 1ºC and <70% relative humidity. The front panel "SENSE" switch should be in the 2-wire position and the "LO" switch should be in the float positions.

3-5 Recommended Test Equipment

The equipment required to calibrate the Model 511.

1. Digital System Multimeter: H-P Model 3458A or equivalent.

3-6 Warn-up Procedure

Perform your verification measurements in a test environment that has a stable ambient room temperature with a relative humidity of less than 70% unless noted otherwise. The Model 511 requires a power line voltage of 100V, 120V, 220V, 240V, ±10% with a line frequency of 50Hz to 400Hz

Allow the minimum warm up time for all test equipment. The Model 511 needs at least one hour to stabilize. Additional time will be needed if the instrument has been subjected to temperatures outside the 18-28°C range.

3-7 Power Supplies Testing

Measure the following dc supply voltages at their test points.
Use ground test point TP102 (DAC GND) for the ± 15V and +7.5V readings, and ground test point TP105 (PG) for the ± 17V readings.

Voltage	Test Point	Reading Range
+15V	TP103	+14.5V to +15.5V
-15V	TP104	- 14.5V to -15.5V
+7.5V	TP302	+7.2V to +7.8V
+17V	TP107	+16.5V to +17.5V
-17V	TP106	+16.5V to +17.5V

Table 3-1 Power Supply Voltage Readings

3-8 Adjustment Procedures

Reference Adjustment
Connect the meter leads between TP301 and TP305. Allow the readings to settle before any calibration is preformed. Adjust trim R356 for 5.03V ± 2µV. Move the meter leads to the front output terminals for the rest of the calibration. Set the 511 to output zero volts on the ten volt range

Offset Adjustments
Center trim pot R355. Note the meter reading and switch to negative polarity. Adjust trim pot R360 so that the meter reads the same number ± 1µV.

Switch to 100mV range and adjust trim pot R404 to zero ±1µV. Switch to 1V range and adjust trim pot R429 to zero ±1µV. Switch to 10V range and adjust trim pot R421 to zero ±1µV. Recheck 1V range zero and adjust if needed as R421 and R429 interact.

Set the output to positive 10V on the 10V range and note the reading. Alternately switch between - and + polarity and adjust trim pot R455 for equal readings ±1µV.

DAC Adjustments

The chart below lists the Model 511 settings along with the adjustment points.

DAC Adjustment Chart										
Range	D.P. LED on	Polarity	Front Panel Decade Switch Setting						Adjustment	Test Value
10V	V	+	1	0	0	0	0	0	R319	1V ± 1μV
			2	0	0	0	0	0	R318	2V ± 1μV
			3	0	0	0	0	0	R317	3V ± 1μV
			4	0	0	0	0	0	R316	4V ± 1μV
			5	0	0	0	0	0	R315	5V ± 2μV
			6	0	0	0	0	0	R314	6V ± 4μV
			7	0	0	0	0	0	R313	7V ± 6μV
			8	0	0	0	0	0	R312	8V ± 8μV
			9	0	0	0	0	0	R311	9V ± 10μV
			10	0	0	0	0	0	R310	10V ± 10μV
			0	10	0	0	0	0	R347	1V ± 1μV
			0	0	10	0	0	0	R349	100mV ± 1μV
			0	0	0	10	0	0	R350	10mV ± 1μV
1V	0.V		10	0	0	0	0	0	R452	1 V ± 1μV
100mV	mV		10	0	0	0	0	0	R433	100mV ± 1μV

Table 3-2 DAC Adjustments

Section 4

Specifications

4-1 Introduction

When manufactured, all 511's are aged, calibrated and thoroughly verified with test equipment and calibration standards that are traceable to the U.S. National Bureau of Standards. Included with each shipment is a certificate of calibration.

Krohn-Hite Corporation recommends that the Model 511 be calibrated yearly at Krohn-Hite's service center to sustain factory new performance. All calibrators returned to the factory for calibration have pre and post calibration data recorded. This allows a performance history file to be complied for each unit. Minor updates are installed (if any are available) during recalibration

4-2 Specifications

Prior to shipment, the Model 511 calibrators are calibrated and data is recorded to guarantee that the unit is operating with-in specifications. Output Specifications listed below are absolute accuracies and are traceability to N.I.S.T.

4-3 Output Specifications

The output uncertainty specifications apply after a one hour warm-up under standard reference conditions of 23ºC ± 1ºC and <70% relative humidity.

Range	Full Scale	Resolution (1ppm)	Absolute Accuracy (1 year)
100mV	±111.1110 mV	100 nV	±(10ppm of setting + 2μV)
1V	±1.111110 V	1 μV	±(10ppm of setting + 6μV)
10V	±11.11110 V	10 μV	±(10ppm of setting + 42μV)

Table 4-1 Output Specifications

Note: The specifications listed above are ***valid for one year*** calibration cycle.

4-4 Secondary Performance Specifications

Stability:[2]
24 hrs, ± (2ppm of setting +1μV)

Temperature Coefficient:
0º C to 10º C, ± (3ppm of setting +2μV)/ºC
10º C to 40º C, ± (2ppm of setting +1μV)/ºC, typ ± 1ppm/ºC

Noise and Ripple (0.1Hz to 100kHz):
100mV and 1V range, 5μV rms; typ < 3μV rms
10V range, 10μV rms; typ < 5μV rms

Low Frequency Noise (0.1Hz to 10Hz):
2μV p-p.

Maximum Load:
100mA all ranges.

Output Impedance:
10 μΩ.

Line Regulation:
± (1ppm of range +1 μV) for a ± 10 % line fluctuation.

Load Regulation:
± 1μV no load to full load.

Settling Time:
< than 100ms to settle to within 5ppm of final value.

[2]Stability specifications apply after initial stabilization of one hour, constant ambient temperature ± 1ºC , constant line and load.

4-5 General Specifications

Calibration Interval:
1 year for 10ppm accuracy.

Warm-up Time:
1 hour to rated accuracy.

Output Isolation:
Output may be floated 500V from chassis

Power Requirements:
105-125 or 210-250 Volts ac, single phase, 50-400 Hz, 20 watts max.

Temperature:
Calibration Temperature: 23ºC ±1ºC
Operating Limit: 0ºC to 50ºC [3]
Storage Temperature: -40ºC to 85ºC

Dimension:
3.5"(9cm) high, 14"(36cm) wide, 12.5"(32.1cm) deep.

Weight:
12 lbs(5.4kg) net; 14 lbs(6.3kg) shipping.

Certification:
A Certificate of Compliance is issued with each new instrument to certify the calibration traceable to the National Institute of Standards and Technology (N.I.S.T.).

Warranty:
Full one year warranty on parts and labor and a full one year warranty on specifications and performance.

Extended warranty:
Part No. EW511 provides an additional one year to the standard warranty

[3]Accuracy is derated above 40º C due to loss of oven control.

Notes: