TO 33K8-4-810-1

TECHNICAL MANUAL

CALIBRATION PROCEDURE
FOR

VOLTAGE CALIBRATOR
332B

(FLUKE)

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332B (FLUKE) VOLTAGE CALIBRATOR

1 CALIBRATION DESCRIPTION:

Table 1.

Test Instrument (TI) Characteristics	Performance Specifications	Test Method
Regulation	Line: ± 0.0002% of setting or 10 μV @ 105 to 125 VAC Load: ±0.0002% of setting or 10 μV for full load change	Voltage monitored while varying line and load
Ripple and Noise	10 V range: 20 μVRMS MAX 100 V range: 30 μVRMS MAX 1000 V range: 40 μVRMS MAX	Measured with a Distortion Analyzer @ Full Load
Output Voltage DC	Range: 0 to 1111.1110 VDC Accuracy: 10 V rng: ± (0.002% of setting + 10 μV) 100 V rng: ± (0.002% of setting + 20 μV) 1000 V rng: ± (0.002% of setting + 200 μV)	Compared to a Standard Cell with a DC Voltage Divider

2 EQUIPMENT REQUIREMENTS:

	Noun	Minimum Use Specifications	Calibration Equipment	Sub-Item
2.1	STANDARD CELL	Range: 1.0178 approximate Accuracy: ± 5 PPM	Guildline 9152R	
2.2	DC VOLTAGE DIVIDER	Range: 0 to 1.0000000 ratio Terminal Linearity: ±2 PPM with chart	Leeds & Northrup 4397M	
2.3	RESISTANCE STANDARD	Range: 1 k and 100 k ohm/ step Accuracy: N/A	Electro Scientific Industries SR1010 boxes	
2.4	POWER DECADE RESISTOR	Range: 8000 to 999,999 ohms Accuracy: N/A	Clarostat 240C	

	Noun	Minimum Use Specifications	Calibration Equipment	Sub-Item
2.5	DISTORTION ANALYZER	Function: Voltmeter sensitivity: 0.0003 Volt range Accuracy: ±2%	Hewlett Packard 334A	
2.6	AC VOLTMETER	Range: 0 to 150 Accuracy: ±1% of F.S.	Weston 433	
2.7	AUTO TRANSFORMER	Range: 60 Hz Accuracy: N/A	General Radio Variac	
2.8	DC NULL DETECTOR	Sensitivity: 10 μVDC F.S.	Fluke 845AB	

3 PRELIMINARY OPERATIONS:

3.1 Read the entire procedure before beginning calibration.

WARNING

Unless otherwise designated, and prior to beginning the Calibration Process, insure that all test equipment voltage and/or current outputs are set to zero (0) or turned off, where applicable. Insure that all equipment switches are set to the proper position before making connections or applying power.

3.2 Connect TI AC POWER cord and AC Voltmeter INPUT in parallel to the Variac OUTPUT.

3.3 Connect Variac INPUT and AC Voltmeter POWER cord to 115 V, 60 Hz power source. Adjust Variac for an 115 V indication on the AC Voltmeter.

3.4 Set TI VOLTAGE OUTPUT dials to 0.000000, POWER switch to OPR and allow a two(2) hour warm-up period.

3.5 Measure the Standard Cell temperature before and intercompare the Standard Cell EMF's before and after use IAW 33K8-4-1-1 Part A, Section 11.

3.6 The Resistance Standards must be filled with mineral oil.

3.7 Annotate AFTO Form 108 giving Temperature unit was calibrated at

4 CALIBRATION PROCESS:

NOTE

Unless otherwise specified, verify the results of each test and take corrective action whenever the test requirement is not met, before proceeding.

4.1 REGULATION & RIPPLE CALIBRATION:

4.1.1 Connect equipment as shown in Figure 1.

4.1.2 Move lead from B9 (leads that connect B9 to B0) on the SR1010-100 k ohm box to B10 on the SR1010-1 k ohm box.

4.1.3 Set Power Decade Resistor to 999,999 ohms.

4.1.4 Set TI VOLTAGE OUTPUT dials to (10)00.0000 and allow 5 minutes to stabilize.

4.1.5 While setting DC Null Detector SENSITIVITY switch to the 10 μV position with less then full scale deflection, adjust DC Voltage Divider for a null indication.

4.1.6 Return DC Null Detector SENSITIVITY switch to 1000.

4.1.7 Record DC Voltage Divider indication.

4.1.8 Adjust Autotransformer for 105 V indication on the AC Voltmeter.

4.1.9 Repeat steps 4.1.5 thru 4.1.7.

4.1.10 Subtract the new DC Voltage Divider recorded indication from the first recorded indication in step 4.1.7.

4.1.11 The DC Voltage Divider must indicate within $\pm$.0000002 of the recorded indication in step 4.1.7.

4.1.12 Adjust Autotransformer for 125 V indication on the AC Voltmeter.

4.1.13 Repeat steps 4.1.5 thru 4.1.7, then 4.1.10.

4.1.14 Adjust Autotransformer for 115 V indication on the AC Voltmeter.

4.1.15 Set Power Decade Resistor to 20,000 ohms.

4.1.16 Repeat steps 4.1.5 thru 4.1.7, then 4.1.10 and 4.1.11.

4.1.17 Set all TI VOLTAGE OUTPUT dials to zero.

4.1.18 Disconnect all equipment, except Power Decade Resistor from TI.

4.1.19 Connect Distortion analyzer HI through a 10 K ohm resistor to the TI output HI, connect the LOW'S direct. Connect a .005MF capacitor across the Distortion Analyzer Input.

4.1.20 Set Power Decade Resistor to 8 000 ohms.

4.1.21 Set TI VOLTAGE OUTPUT dials to 400.0000.

4.1.22 The Distortion Analyzer must not indicate more than 40 μVRMS.

4.1.23 Set all TI VOLTAGE OUTPUT dials to zero.

4.1.24 Disconnect all equipment from TI.

4.2 VOLTAGE CALIBRATION:

4.2.1 Set TI RANGE switch to 10, VOLTAGE TRIP to 1000, VERNIER FULLY CW, CURRENT LIMIT to 60 and METER to VOLTAGE.

4.2.2 Connect TI +(POS) OUTPUT, +(POS) SENSE terminals together. Connect -(NEG) OUTPUT and -(NEG) SENSE terminals together.

4.2.3 Connect DC Null Detector to the TI VOLTAGE OUTPUT terminals, observing polarity.

4.2.4 Set DC Null Detector ZERO-OPR switch to ZERO and adjust ZERO control for zero indication.

4.2.5 Set DC Null Detector ZERO-OPR switch to OPR.

4.2.6 Set TI POWER switch to OPR.

4.2.7 Rotate DC Null Detector SENSITIVITY switch to the lowest RANGE with less than full scale deflection.

4.2.8 The DC Null Detector must indicate no more than $\pm$10 μV.

4.2.9 Return DC Null Detector SENSITIVITY switch to 1000 position.

4.2.10 Set TI RANGE switch to 100. Repeat step 4.2.7.

4.2.11 The DC Null Detector must indicate no more than ± 20 μV. Repeat step 4.2.9.

4.2.12 Set TI Range switch to 1000. Repeat step 4.2.7.

4.2.13 The DC Null Detector must indicate no more than ± 40 μV. Repeat step 4.2.9.

4.2.14 Set TI POWER switch to STDBY. Disconnect DC Null Detector.

4.2.15 Connect equipment as shown in Figure 1. Do not connect Standard Cell positive lead at this time.

4.2.16 Set Power Decade Resistor to 999,999 ohms.

4.2.17 Set DC Voltage Divider dials to .0900000.

4.2.18 Set TI VOLTAGE RANGE switch to 100.

4.2.19 Divide Standard Cell voltage by 0.09 and set the quotient obtained on the TI VOLTAGE OUTPUT dials.

4.2.20 Set TI POWER switch to OPR. Connect the Standard Cell positive lead.

4.2.21 While setting DC Null Detector SENSITIVITY switch to the 10 μV position with less than full scale deflection, adjust TI VOLTAGE OUTPUT dials for a null indication.

4.2.22 Return DC Null Detector SENSITIVITY switch to 1000. Disconnect the Standard Cell positive lead.

4.2.23 Record TI VOLTAGE OUTPUT dial setting, then set all dials to zero.

4.2.24 Remove the lead from B9 (the lead that connects B0 to B9) and connect to A0 (SR1010 - 100 k ohm box).

4.2.25 Set DC Voltage Divider dials to .9000000.

4.2.26 Set TI VOLTAGE OUTPUT dials to the recorded value of step 4.2.23. Connect the Standard Cell positive lead.

4.2.27 While setting DC Null Detector SENSITIVITY switch to the 10 μV position with less than full scale deflection, adjust DC Voltage Divider for a null indication.

4.2.28 Return DC Null Detector SENSITIVITY switch to 1000. Disconnect the Standard Cell positive lead.

4.2.29 Set TI VOLTAGE OUTPUT dials to all zeros.

4.2.30 Divide DC Voltage Divider indication into .0900000 and record the quotient as ratio "A".

4.2.31 Set DC Voltage Divider dials to 0.1 of the present setting.

4.2.32 Set TI VOLTAGE OUTPUT dials to the recorded value of step 4.2.23 and VOLTAGE RANGE switch to 1000. Connect the Standard Cell positive lead.

4.2.33 While setting DC Null Detector SENSITIVITY switch to the 10 μV position with less than full scale deflection, adjust TI VOLTAGE OUTPUT dials for a null indication.

4.2.34 Return DC Null Detector SENSITIVITY switch to 1000. Disconnect the Standard Cell positive lead.

4.2.35 Record TI VOLTAGE OUTPUT dial setting, then all dials to zero.

4.2.36 Move lead from A0 (on the SR1010 - 100 k ohm box) to B10 on the SR1010 - 1 k ohm box.

4.2.37 Set DC Voltage Divider dials to .9000000.

4.2.38 Set TI VOLTAGE OUTPUT dials to the recorded value of step 4.2.35. Connect the Standard Cell positive lead.

4.2.39 While setting DC Null Detector SENSITIVITY switch to the 10 μV position with less than full scale deflection, adjust DC Voltage Divider for a null indication.

4.2.40 Return DC Null Detector SENSITIVITY switch to 1000. Disconnect the Standard Cell positive lead.

4.2.41 Set all TI VOLTAGE OUTPUT dials to zero.

4.2.42 Divide DC Voltage Divider indication into .0090000 and record the quotient obtained as ratio "N".

4.2.43 Move the lead from B10 on the SR1010-1 k ohm box to B9 on the SR1010 - 100 k ohm box.

NOTE

The following symbols will be used in formuals throughout the procedure:

E IN = TI voltage

S = DC Voltage Divider setting

E SC = Standard Cell voltage

A = Ratio recorded in step 4.2.30

N = Ratio recorded in step 4.2.42

4.2.44 Calculate the approximate DC Voltage Divider setting using the following formula and set the DC Voltage Divider to the value calculated

$$S = \frac{E\,SC}{E\,IN}$$

4.2.45 Set TI VOLTAGE OUTPUT dials to 002.0000. Connect the Standard Cell positive lead.

4.2.46 While setting DC Null Detector SENSITIVITY switch to the 10 μV position with less than full deflection, adjust DC Voltage Divider for a null indication.

4.2.47 Return DC Null Detector SENSITIVITY switch to 1000. Disconnect the Standard Cell positive lead.

4.2.48 Set all TI VOLTAGE OUTPUT dials to zero.

4.2.49 Calculate TI voltage using the following formula:

$$E\,IN = \frac{E\,SC}{S}$$

4.2.50 The voltage calculated in step 4.2.49 must be within the corresponding limits listed in Table 2.

4.2.51 Repeat steps 4.2.44 thru 4.2.50 (except in step 4.2.45, set VOLTAGE OUTPUT dials to the next position) for each remaining TI dials setting listed in Table 2.

Table 2.

TI Dial Setting	Limits (Volts)
002.0000	1.99976 to 2.00024
002.1111	2.11086 to 2.11134
002.2222	2.22196 to 2.22244
002.3333	2.33305 to 2.33355
002.4444	2.44415 to 2.44465
002.5555	2.55525 to 2.55575
002.6666	2.66635 to 2.66685
002.7777	2.77744 to 2.77796
002.8888	2.88854 to 2.88906

Table 2. (Cont)

TI Dial Setting	Limits (Volts)
002.9999	2.99964 to 3.00016
001.9999	1.99966 to 2.00014
002.XXXX	3.11074 to 3.11136
003.0000	2.99974 to 3.00026
004.0000	3.99972 to 4.00028
005.0000	4.99970 to 5.00030
006.0000	5.99968 to 6.00032
007.0000	6.99966 to 7.00034
008.0000	7.99964 to 8.00036
009.0000	8.99962 to 9.00038
00X.0000	9.99960 to 10.00040
010.0000	9.99960 to 10.00040

4.2.52 Set TI VOLTAGE RANGE switch 10 and VOLTAGE OUTPUT dials to (10).000000.

4.2.53 Repeat steps 4.2.46 thru 4.2.49.

4.2.54 Calculated voltage (step 4.2.49) must be between 9.99979 and 10.00021 Volts.

4.2.55 Set all TI VOLTAGE OUTPUT dials to zero.

4.2.56 Remove the lead from B9 (the lead that connects B0 to B9) and connect to A0 (SR1010-100 k ohms box).

4.2.57 Set TI VOLTAGE RANGE switch to 1000.

4.2.58 Calculate approximate DC Voltage Divider setting using the following formula:

$$S = \frac{E\,SC}{AE\,IN}$$

4.2.59 Set TI VOLTAGE OUTPUT dials to 020.0000. Connect the Standard Cell positive lead.

4.2.60 While setting DC Null Detector SENSITVITY switch to the 10 μV position with less than full scale deflection, adjust DC Voltage Divider for a null indication.

4.2.61 Return DC Null Detector SENSITIVITY switch to 1000. Disconnect the Standard Cell positive lead.

4.2.62 Set all TI VOLTAGE OUTPUT dials to zero.

4.2.63 Calculate TI voltage using the following formula:

$$E\,IN = \frac{E\,SC}{AS}$$

4.2.64 The voltage calculated in step 4.2.63 must be within the corresponding limits listed in Table III.

4.2.65 Repeat steps 4.2.58 thru 4.2.64 (exception, step 4.2.59, set VOLTAGE OUTPUT dials to the next position) for each remaining TI dial setting listed in Table III.

Table 3.

TI Dial Setting	Limits (Volts)
020.0000	19.9994 to 20.0006
030.0000	29.9992 to 30.0008
040.0000	39.9990 to 40.0010
050.0000	49.9988 to 50.0012
060.0000	59.9986 to 60.0014
070.0000	69.9984 to 70.0016
080.0000	79.9982 to 80.0018
090.0000	89.9980 to 90.0020
0X0.0000	99.9978 to 100.0022
100.0000	99.9978 to 100.0022

4.2.66 Set TI VOLTAGE RANGE switch to 100 and VOLTAGE OUTPUT dials to (10)0.00000.

4.2.67 Repeat steps 4.2.60 thru 4.2.63.

4.2.68 The calculated voltage (step 4.2.63) must be between 99.99798 and 100.00202 Volts.

4.2.69 Move lead from A0 (on the SR1010 - 100 k ohm box) to B10 on the SR1010 - 1 k ohm box.

4.2.70 Set TI VOLTAGE RANGE switch to 1000.

4.2.71 Calculate approximate DC Voltage Divider setting using the following formula:

$$S = \frac{E\,SC}{NE\,IN}$$

4.2.72 Set TI VOLTAGE OUTPUT dials to 200.0000. Connect the Standard Cell positive lead.

4.2.73 While setting DC Null Detector SENSITIVITY switch to the 10 μV position with less than full scale deflection, adjust DC Voltage Divider for a null indication.

4.2.74 Return DC Null Detector SENSITIVITY switch to 1000. Disconnect the Standard Cell positive lead.

4.2.75 Set all TI VOLTAGE OUTPUT dials to zero.

4.2.76 Calculate TI voltage using the following formula:

$$E\,IN = \frac{E\,SC}{NS}$$

4.2.77 The voltage calculated in step 4.2.76 must be within the corresponding limits listed in Table IV.

4.2.78 Repeat steps 4.2.71 thru 4.2.77 (except in step 4.2.72, set VOLTAGE OUTPUT dials to the next position) for each remaining TI dial setting listed in Table IV.

Table 4.

TI Dial Setting	Limits (Volts)
200.0000	199.9958 to 200.0042
300.0000	299.9938 to 300.0062
400.0000	399.9918 to 400.0082
500.0000	499.9898 to 500.0102
600.0000	599.9878 to 600.0122
700.0000	699.9858 to 700.0142
800.0000	799.9838 to 800.0162
900.0000	899.9818 to 900.0182
(10)00.0000	999.9798 to 1000.0202

4.2.79 Set all TI VOLTAGE OUTPUT dials to zero.

4.2.80 Disconnect and secure all equipment.

CALIBRATION PERFORMANCE TABLE

REGULATION CALIBRATION:

Range	Applied	Limits (Volts)
0 to 1111.1110	1000 V @ 105-125 Volts	999.998 to 1000.002
	1000 V @ no load to full load	999.998 to 1000.002

RIPPLE CALIBRATION:

Range	Applied	Limits
0 to 1111.1110	400 V @ full load	40 μVAC MAX.

DC VOLTAGE CALIBRATION:

Range	Applied (Volts)	Limits (Volts)
0 to 1111.1110	0.0000	± 0.000040
	2.0000	1.99976 to 2.00024
	2.1111	2.11086 to 2.11134
	2.2222	2.22196 to 2.22244
	2.3333	2.33305 to 2.33355
	2.4444	2.44415 to 2.44465
	2.5555	2.55525 to 2.55575
	2.6666	2.66635 to 2.66685

Range	Applied (Volts)	Limits (Volts)
	2.7777	2.77744 to 2.77796
	2.8888	2.88854 to 2.88906

Range	Applied (Volts)	Limits (Volts)
	2.9999	2.99964 to 3.00016
	1.9999	1.99966 to 2.00014
	2.XXXX	3.11074 to 3.11136
	3.0000	2.99974 to 3.00026
	4.0000	3.99972 to 4.00028
	5.0000	4.99970 to 5.00030
	6.0000	5.99968 to 6.00032
	7.0000	6.99966 to 7.00034
	8.0000	7.99964 to 8.00036
	9.0000	8.99962 to 9.00038
	X.0000	9.99960 to 10.00040
	10.0000	9.99960 to 10.00040
	20.0000	19.9994 to 20.0006
	30.0000	29.9992 to 30.0008
	40.0000	39.9990 to 40.0010
	50.0000	49.9988 to 50.0012
	60.0000	59.9986 to 60.0014
	70.0000	69.9984 to 70.0016
	80.0000	79.9982 to 80.0018
	90.0000	89.9980 to 90.0020
	X0.0000	99.9978 to 100.0022
	100.0000	99.9978 to 100.0022
	200.0000	199.9958 to 200.0042
	300.0000	299.9938 to 300.0062
	2.9999	2.99964 to 3.00016
	1.9999	1.99966 to 2.00014
	2.XXXX	3.11074 to 3.11126
	3.0000	2.99974 to 3.00026
	4.0000	3.99972 to 4.00028
	5.0000	4.99970 to 5.00030
	6.0000	5.99968 to 6.00032
	7.0000	6.99966 to 7.00034
	8.0000	7.99964 to 8.00036

Range	Applied (Volts)	Limits (Volts)
	9.0000	8.99962 to 9.00038
	X.0000	9.99960 to 10.00040
	10.0000	9.99960 to 10.00040
	20.0000	19.9994 to 20.0006
	30.0000	29.9992 to 30.0008
	40.0000	39.9990 to 40.0010
	50.0000	49.9988 to 50.0012
	60.0000	59.9986 to 60.0014
	70.0000	69.9984 to 70.0016
	80.0000	79.9982 to 80.0018
	90.0000	89.9980 to 90.0020
	X0.0000	99.9978 to 100.0022
	100.0000	99.9979 to 100.0022
	200.0000	199.9958 to 200.0042
	300.0000	299.9938 to 300.0062
	400.0000	399.9918 to 400.0082
	500.0000	499.9898 to 500.0102
	600.0000	599.9878 to 600.0122
	700.0000	699.9858 to 700.0142
	800.0000	799.9838 to 800.0162
	900.0000	899.9818 to 900.0182
	1000.0000	999.9798 to 1000.0202
0 to 111.11110	0.00000	±0.000020
	X0.0000	99.99798 to 100.0020
0 to 11.111110	0.000000	±0.000010
	X.0000	9.99979 to 10.00021

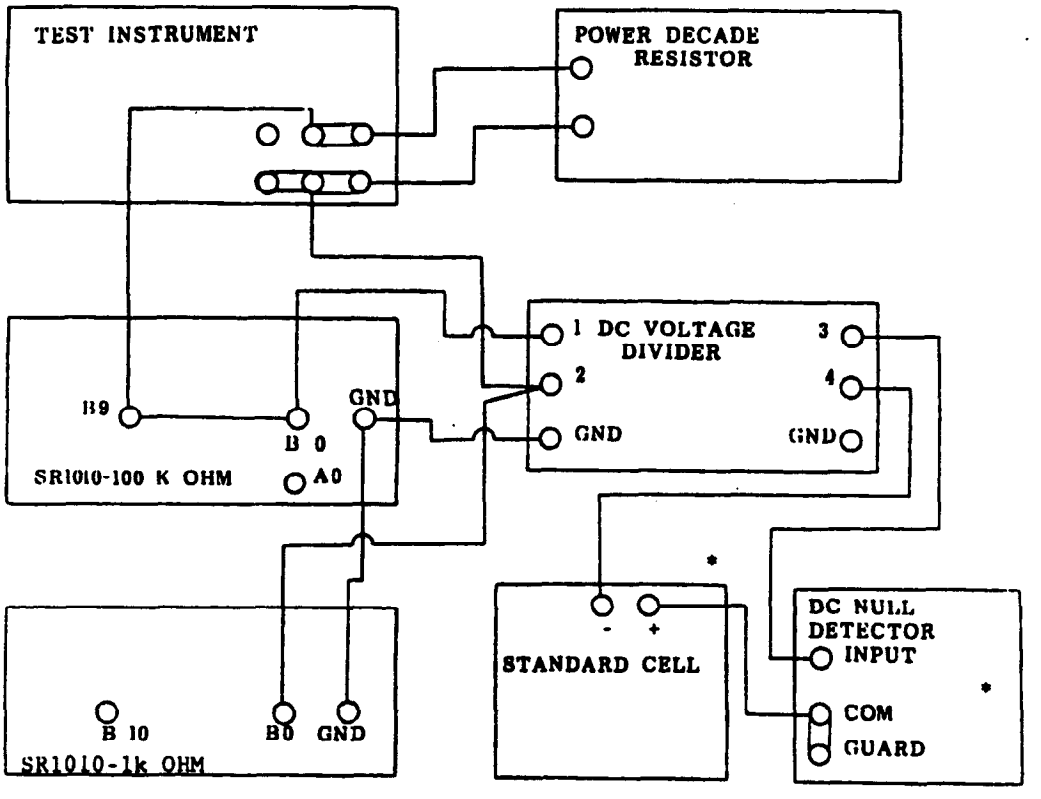

FIGURE 1

* UNPLUG FROM AC USE BATTERY OPERATION

* Connect and disconnect positive lead.