AE-103

TECHNICAL MANUAL

INSTRUMENT CALIBRATION PROCEDURE

DC VOLTAGE STANDARD

FLUKE
332D

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LIST OF EFFECTIVE PAGES

The purpose of this list is to identify the pages in this document affected by any technical content changes made since the previous release of the document. Format changes are not identified.

NOTE: On a changed page, with the exception of the Title, List of Effective Pages, and the Table of Contents pages, the technical changes are indicated by a change bar in the outer right margin of the page.

Page No.	Chg / Rev[(1)]	Paragraph / Location	Summary
Title	C		
A	C		
i	C		
1	0		
2	C	Table 2	Removed models from items 2.1 and 2.8; Added 10 V ref to item 2.9
3, 4	0		
5	C	Figure 2	Added shorting line between SENSE (-) and OUTPUT (-)
6, 7	0		
8	C	4.3.3	Modified step to include 10 V ref
9 to 21	0		

[(1)] Zero (0) in this column indicates an original page; C indicates a changed page; R indicates a revision.

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ILLUSTRATIONS

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SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 This procedure describes the calibration of Fluke 332D DC Voltage Standard. The instrument being calibrated is referred to herein as the TI (Test Instrument).

1.2 All comments concerning this procedure should be directed to the Measurement Science Department, Corona Division, Naval Surface Warfare Center, P.O. Box 5000, Corona, CA 92878-5000.

1.3 This procedure includes tests of essential performance parameters only. Any malfunction noticed during calibration, whether specifically tested for or not, should be corrected.

Table 1. Calibration Description

TI Characteristics	Performance Specifications	Test Method
Load and line regulation	Tolerance: 0.0002% of setting or 10 μV for either a 10% line voltage change or a full load change.	The TI output voltage is monitored while the line voltage is changed or while the load is changed from full load to no load.
Voltage standard (Output voltage)	Output Voltage: 0 to 1111.1110 V dc Output Current: 0 to 50 mA Voltage Ranges: 10, 100 and 1000 V Resolution: 0.1 ppm of range Tolerance: 10 V Range: ±(0.001% iv + 10 μV) 100 V Range: ±(0.001% iv +0.00002% of range) 1000 V Range: ±(0.0015% iv +0.00002% of range)	The output of a standard-cell-referenced direct-voltage-measurement system is used for adjusting certain circuits, and for measuring the TI output voltages.

SECTION 2

EQUIPMENT REQUIREMENTS

NOTES

Minimum use specifications are the principal parameters required for performance of the calibration, and are included to assist in the selection of alternate equipment, which may be used at the discretion of the using laboratory. Satisfactory performance of alternate items shall be verified prior to use. All applicable equipment must bear evidence of current calibration.

The instruments utilized in this procedure were selected from those known to be available at Navy calibration facilities, and the listing by make or model number carries no implication of preference, recommendation, or approval for use by other agencies. It is recognized that equivalent equipment produced by other manufacturers may be capable of equally satisfactory performance in this procedure.

Table 2. Equipment Requirements

Item	Minimum Use Specifications	Calibration Equipment
2.1 Autotransformer	Input voltage: 115 V at 60 Hz Output voltage: variable from 105 to 125	GenRad W5MT3A
2.2 Voltmeter (VM)	Range: 105 to 125 V Uncertainty: ±2% iv (used to monitor line voltage)	Hewlett-Packard 34401A or Fluke 8840AFTOPT05
2.3 Load resistor	Values: 200 Ω, ±5%, 1.25 W 2000 Ω, ±5%, 12.5 W 20 kΩ, +5%, 125 W	Clarostat 240C is set to the required values.
2.4 Differential voltmeter (DIFF VM)	Range: 9 to 1100 V dc Uncertainty: ±0.0026% iv Null range: 100 μV	Fluke 895A
2.5 Null detector (2 required)	Null range: 3 μV to 30 mV Uncertainty: ±(3% end scale +0.1 μV)	Fluke 845AB or 845AR

NOTE

Calibration instructions, using only one null detector are provided in step 4.4.4 and subsection 4.5.

2.6 DV source	Output voltage: 10 μV to 1100 V dc Uncertainty: approx. ±0.002% iv; not as important as the stability rating in this procedure. Stability must be within: ±(0.001% of setting +20 μV)	Fluke 332B
2.7 Voltage divider	Ratio range: 0.0000010 to 1.1 Uncertainty: 1 ppm related to input	Fluke 720A
2.8 A-B switch (Pinch-type, reversing switch)	Two-position switch arbitrarily assigned positions A and B or simply A-B switch	Laboratory supply, such as: Leeds and Northrup 3294
2.9 DC transfer standard (ERS)	Output voltage: Std-cell magnitude (e.g., 1.018000), or 10 V Uncertainty: Traceable to Type 1 calibration laboratory through a certified output voltage called “Assigned Reference Output” or simply “V_{ref}” herein	Fluke 731B, 731A, 732A, or any STD CELL with known history
2.10 Reference divider	Range: Input voltage: 1100 Output Voltage Taps: 5, 10, 100, 500, 1000, and 1100 Uncertainty: ±1 ppm[(1)]	Fluke 750A
Required Component:		
2.10.1 Reference divider	Substitute for item 2.10 if item 2.9 is a Fluke 732A	Fluke 752A

[(1)] Fluke 750A must be adjusted to within ±1 ppm in accordance with NAVAIR 17-20AE-63 just prior to use.

SECTION 3

PRELIMINARY OPERATIONS

3.1 Ensure that all power switches are set to off, and set all auxiliary equipment controls as necessary to avoid damage to the equipment and so that dangerous voltages will not be present on output terminals when the power switches are turned on.

3.2 Set the TI controls as follows:

POWER switch to	OFF
METER switch to	CURRENT
VOLTAGE TRIP to 1000; VERNIER	fully clockwise
CURRENT LIMIT to	fully clockwise
VOLTAGE RANGE switch to	10
READOUT DIALS (Output-Voltage Controls) to	all zeros

3.3 Set the DV Source, item 2.6, controls as follows:

POWER switch to	OFF
METER switch to	CURRENT
VOLTAGE TRIP to 1000; VERNIER	fully clockwise
CURRENT LIMIT to	fully clockwise
VOLTAGE RANGE to	10

3.4 Adjustments Access: Certain adjustments are necessary during the calibration process while the TI is in operation. Remove the covers from the TI just far enough, as required, to gain access for: the Range-Zero-Output-, the Sample-String-, and the Range-Cal adjustments. Refer to Figure 1 for the location of adjustments.

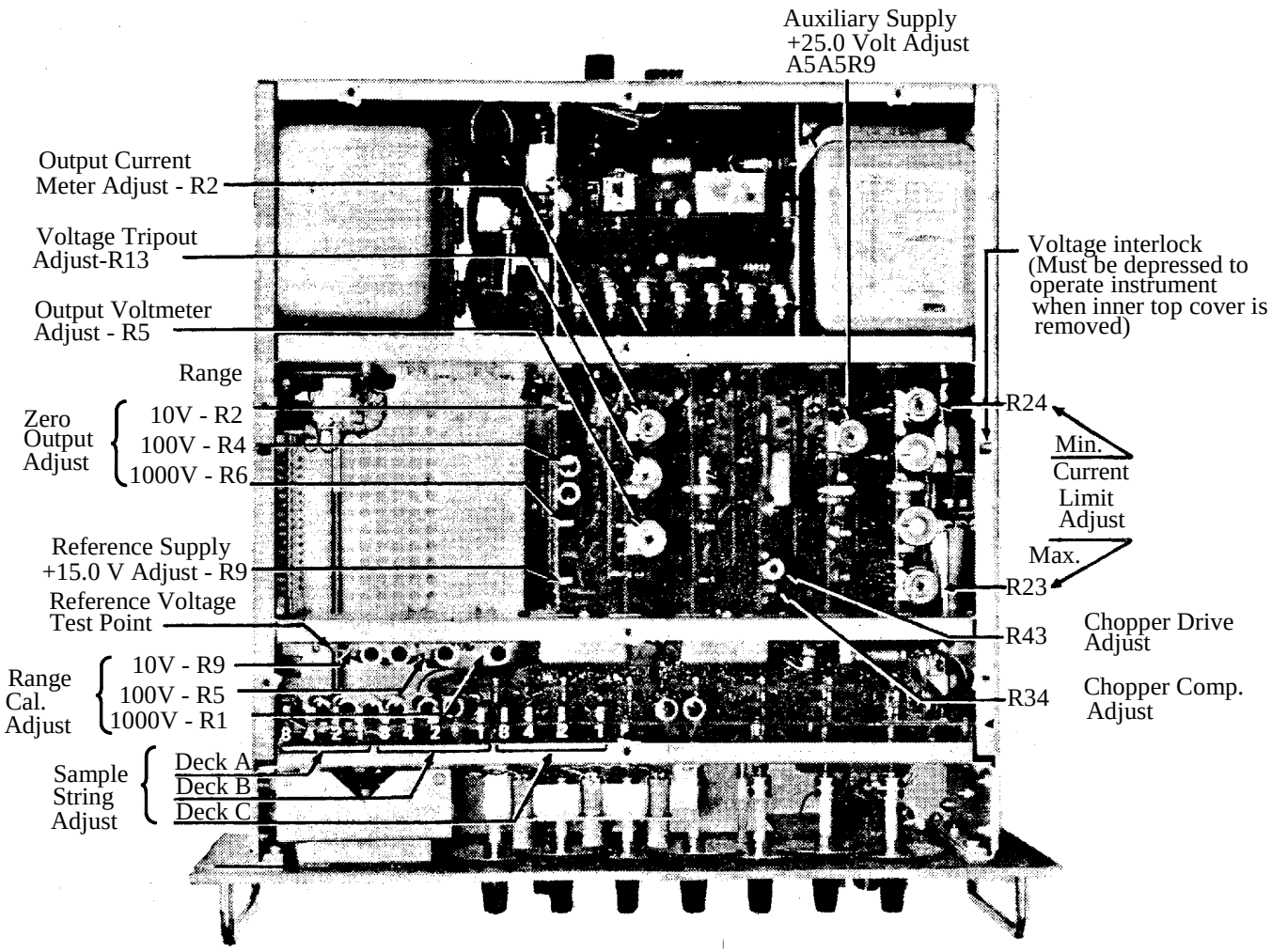


Figure 1. Location of Adjustments

3.5 Set all other equipment controls as necessary to avoid damage to the equipment, and so that dangerous voltages will not be present on the output terminals when the power switches are turned on.

3.6 Connect the TI and all line powered test equipment to the appropriate power source.

3.7 Turn all power switches on and allow one hour warm-up period prior to calibration.

3.8 Perform the self calibration procedure for the Fluke 720A voltage divider, if it has not been calibrated within the past few weeks.

SECTION 4

CALIBRATION PROCESS

WARNING

VOLTAGES HAZARDOUS TO LIFE MAY BE PRESENT. USE EXTREME CAUTION.

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 LINE AND LOAD REGULATION TEST

4.1.1 Connect the equipment as shown in Figure 2.

4.1.2 Adjust the autotransformer for 115 V output as monitored on the VM (item 2.2).

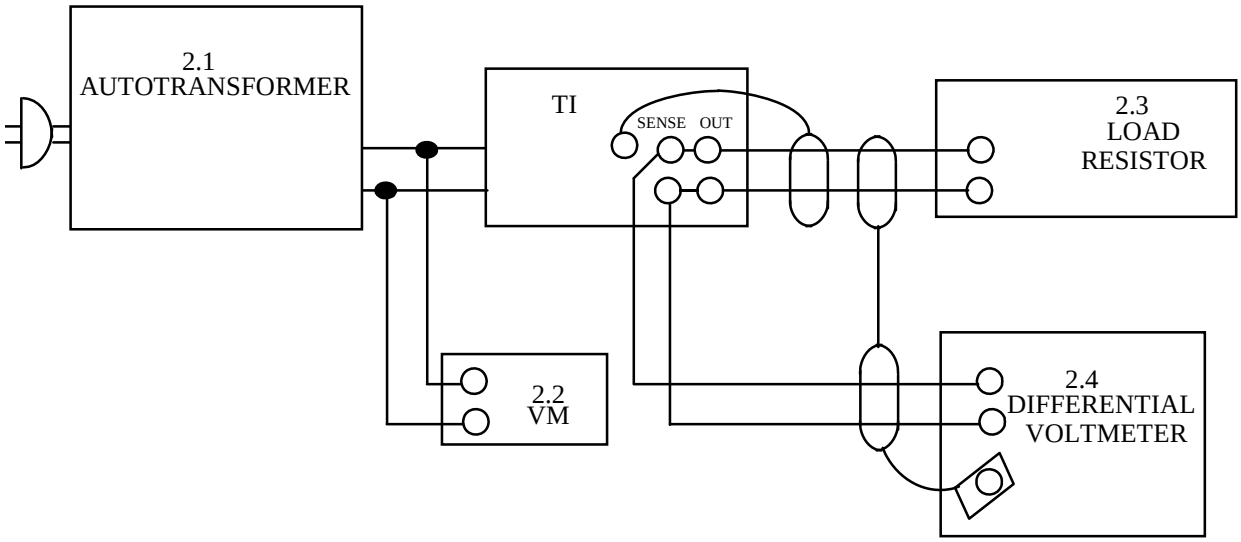


Figure 2. Line and Load Regulation Test Configuration

4.1.3 Set the TI front panel controls as follows:

POWER switch to	STANDBY
METER switch to	CURRENT
VOLTAGE RANGE switch to	10
Output-Voltage (READOUT) DIALS to	ALL ZEROS
VOLTAGE TRIP switch to	1000
VERNIER control to	fully clockwise
CURRENT LIMIT	fully clockwise (60)

4.1.4 Set the differential voltmeter controls as follows:

POLARITY switch to	PLUS
NULL switch to	TVM
RANGE switch to	10

4.1.5 Perform each of the measurements tabulated below as follows:

4.1.5.1 Set the equipment controls to obtain the settings listed for each measurement in the following table. (Note that the setting required for the Diff VM (item 2.4) voltage dials is always one significant digit less than the setting listed for the TI Output-Voltage dials).

Diff VM and TI Settings			
Load Resistor (Ω)	Range (V)	Output-Voltage Dials (V)	Tolerance Limits
200	10	10.000000	±20 μV
2000	100	100.00000	±200 μV
20000	1000	1000.0000	±2.0 mV

4.1.5.2 Set the autotransformer for 115 V output. Adjust the Diff VM controls as necessary to establish a reference-null indication, increasing the null range sensitivity as required. Note the Diff VM indication as the 1st indication, for reference.

4.1.5.3 Adjust the autotransformer for a 105 volt output. Wait one minute; then, adjust the Diff VM controls as required to obtain a null indication. Verify that the difference between the 1st and the 2nd Diff VM indications is within the tolerance limits listed.

4.1.5.4 Adjust the autotransformer for a 115 volt output. Adjust the Diff VM controls as necessary to establish a reference-null indication, increasing the null range sensitivity as required; and note the Diff VM indication for reference.

4.1.5.5 Adjust the autotransformer for a 125 volt output. Wait one minute, and then adjust the Diff VM controls as required to obtain a null indication, increasing the null range sensitivity as required. Verify that the difference between the last two Diff. VM indications, required to establish a null, is within the tolerance limits listed.

4.1.5.6 Adjust the Diff VM controls as required to obtain the settings listed for the next measurement and set the null switch to TVM to avoid meter pegging.

4.1.6 Set the autotransformer for a 115 volt output.

4.1.7 Perform each of the load-regulation measurements (still using Figure 2 as the test setup) as follows:

4.1.7.1 Set the equipment controls as necessary to obtain the settings listed for each measurement in the following table.

Diff VM and TI Settings			
Load Resistor (Ω)	Range (V)	Output-Voltage Dials (V)	Tolerance Limits
20,000	1000	1000.0000	±2.0 μV
2000	100	100.00000	±200 μV
200	10	10.000000	±20 μV

4.1.7.2 With the load resistor connected as shown in Figure 2, adjust the Diff VM controls as required to establish a Diff VM null indication, increasing the null range sensitivity as required. Note the Diff VM indication as the 1st indication; and switch the Diff VM null switch to the TVM position.

4.1.7.3 Set the TI power switch to STDBY/RESET, disconnect the load resistor; and then, set the TI power switch to OPR.

4.1.7.4 Set the Diff VM null switch for differential-mode measurements and adjust the Diff VM controls as required to establish a null indication, increasing the null-range sensitivity as required. Verify that the difference between the two Diff VM indications is within the tolerance limits listed. Set the Diff VM switch to the TVM position to avoid meter pegging as a preparation for the next measurement.

4.1.8 Disconnect the test configuration, setting the equipment controls as required to safeguard the equipment.

4.2 ZERO OUTPUT ADJUSTMENTS

4.2.1 Set the null detector (item 2.5) OPR-ZERO switch to ZERO. Perform the mechanical or electrical zero adjustments for the null detector as required. Electrically zero adjusts the null detector up to its 3 μV position.

4.2.2 Set the TI output-voltage dials to indicate all zeroes, connect the equipment as shown in Figure 3; and set the TI power switch to OPR.

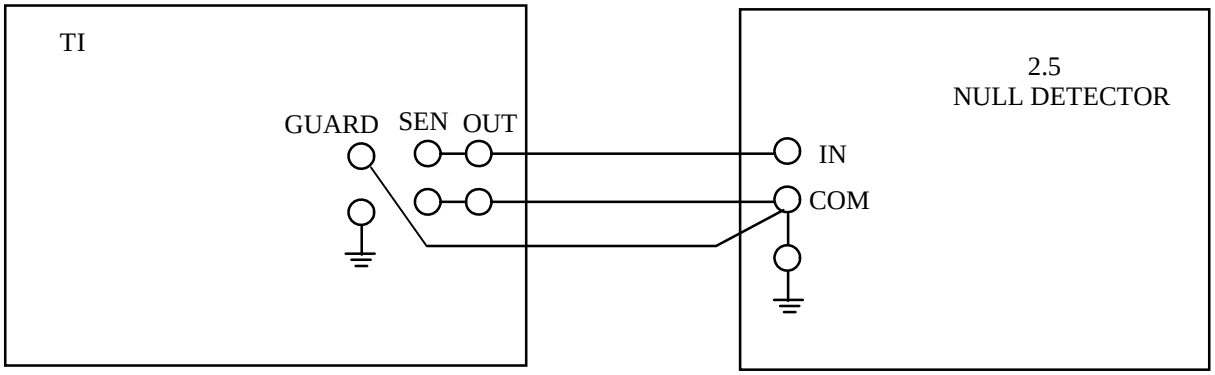


Figure 3. Zero Output Adjust Configuration

4.2.3 Set the null detector OPR-ZERO switch to OPR position.

4.2.4 Set the TI range switch to each of the TI voltage ranges. At each TI voltage-range position, adjust the TI corresponding ZERO-OUTPUT-ADJUST range control to establish a null indication within ±1 μV on the null detector. Use only insulated screwdrivers or plastic alignment tools when performing the adjustments. Refer to Figure 1 for location of the adjustments.

4.2.5 Set the null detector OPR-ZERO switch to ZERO, the TI power switch to STDBY/RESET; and disconnect the equipment setup.

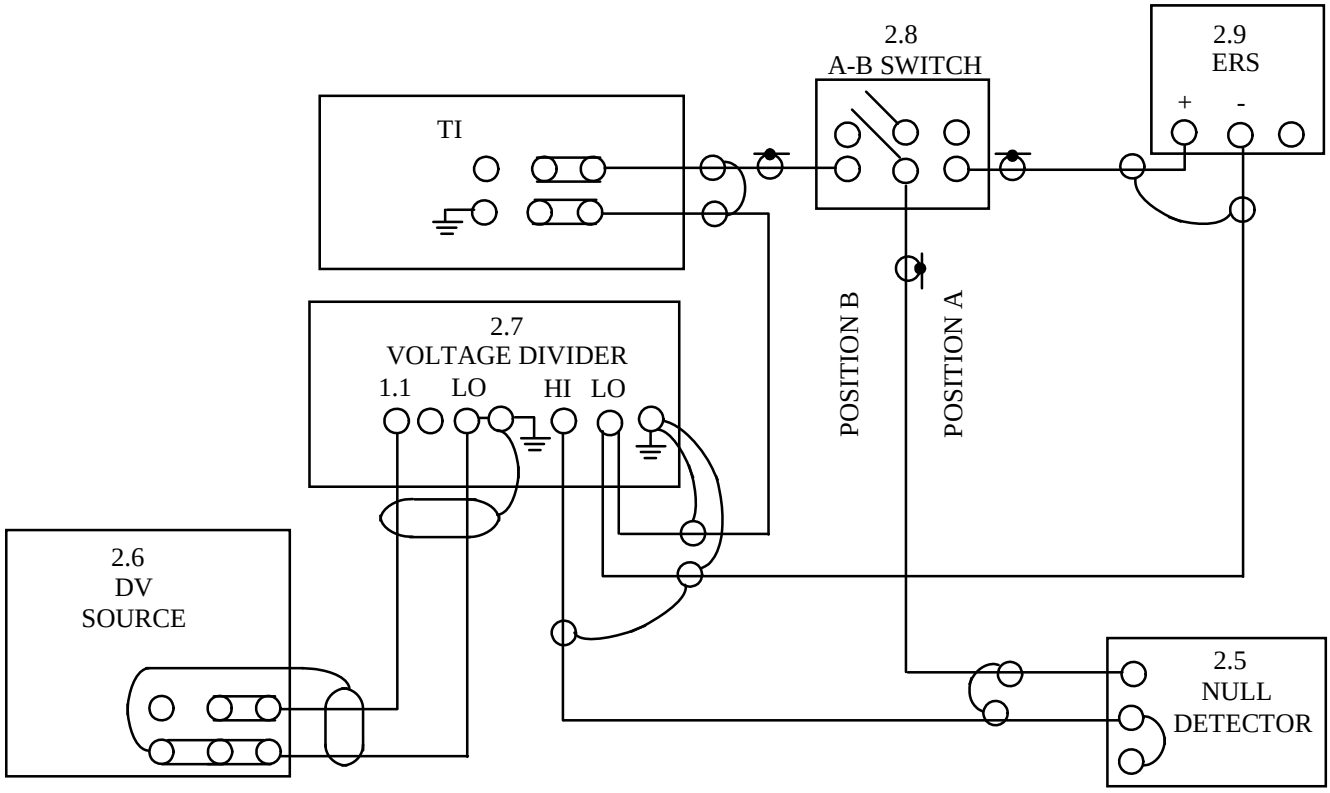
4.3 SAMPLE STRING LINEARIZATION

4.3.1 Connect the equipment as shown in Figure 4.

4.3.2 If applicable, set the ERS (item 2.9) range and ΔE controls, as necessary, for its Assigned-Reference-Output voltage and lock the ΔE dial of the ERS. If the 732A ERS is used, make the connections shown in Figure 4 to the Assigned-Reference-Output voltage terminals. For simplification, the ERS Assigned-Reference-Output voltage will be referred to herein simply as V_{ref}.

4.3.3 Set the voltage divider (item 2.7) controls to indicate a setting equal to 1/10th of V_{ref}. For example, if V_{ref} is equal to 1.018000, the divider controls would be set for a 0.101800 indication, (or if V_{ref} is equal to 10.000xx set the divider controls to 1.0000xx)

4.3.4 Set the A-B switch (item 2.8) to position A. Set the DV source range control to 10 V, and its output-voltage controls for l0.X00000, or 11 V, initially.



NOTE: USE PURE COPPER CONDUCTORS SHIELDED CABLE, NOT COATED OR PLATED WIRE NOR COAXIAL CABLE

Figure 4. Sample-String-Linearization Adjustment Setup

4.3.5 Set the null detector OPR-ZERO switch to OPR, and adjust the DV source output-voltage controls to establish a null indication to within ±1 μV on the null detector 10 μV range, adjusting the null detector null sensitivity control as required. Set the TI power switch to OPR.

4.3.6 Set the null detector OPR-ZERO switch to ZERO, and set the A-B switch to position B.

4.3.7 Perform each of the adjustments in the following table, using only insulated screwdrivers or plastic alignment tools as follows:

4.3.7.1 Set the null detector OPR-ZERO switch to ZERO to avoid meter pegging in preparation for the upcoming circuit changes.

4.3.7.2 Set the equipment controls to the settings listed for each required adjustment.

Voltage Divider (Dials)	TI		Required Adjustments	Tolerance Limits
	Range	Voltage Dials		
0000000	1000 V	000.0000	Detector(1)	±1 μV
.1000000	1000 V	000.X00	1000 V CAL	±1 μV
.1000000	1000 V	001.0000	DECK C – 1	±1 μV
.2000000	1000 V	002.0000	DECK C – 2	±1 μV
.4000000	1000 V	004.0000	DECK C – 4	±2 μV
.8000000	1000 V	008.0000	DECK C – 8	±4 μV
1.0000000	1000 V	00X.0000	Divider(2)	±5 μV
Retained setting	1000 V	010.0000	DECK B – 1	±5 μV
0000000	100 V	00.00000	Detector(1)	±1 μV
.1000000	100 V	01.00000	100 V CAL	±1 μV
.2000000	100 V	02.00000	DECK B – 2	±1 μV
.4000000	100 V	04.00000	DECK B – 4	±2 μV
.8000000	100 V	08.00000	DECK B – 8	±4 μV
1.0000000	100 V	0X.00000	Divider(2)	±5 μV
Retained setting	100 V	10.00000	DECK A –1	±5 μV
0000000	10 V	0.000000	Detector(1)	±1 μV
.1000000	10 V	1.000000	10 V CAL	±1 μV
.2000000	10 V	2.000000	DECK A – 2	±1 μV
.4000000	10 V	4.000000	DECK A – 4	±2 μV
.8000000	10 V	8.000000	DECK A – 8	±4 μV

(1) Adjust the null detector ZERO ADJ to obtain a system zero.
(2) Adjust the voltage divider readout dials for a null on the null detector. Retain this setting for the next measurement step marked “Retained setting”.

4.3.7.3 Set the null detector OPR-ZERO switch to OPR. Make the indicated adjustment to establish a detector null indication within the tolerance limits listed, increasing the detector null-range sensitivity as required. Refer to Figure 1 for the locations of the TI RANGE-CAL or the TI SIMPLE-STRING-ADJUST potentiometers.

4.3.8 Set the null detector OPR-ZERO switch to ZERO. Adjust the null detector zero control for a zero meter deflection on the 3 μV range; then, set the detector range switch to the 30 μV range position.

4.3.9 Set the TI range control to its 1000 V position, and set the TI output-voltage dials (READOUT DIALS) to 010.0000 volts.

4.3.10 Set the A-B switch (item 2.8) to position A, repeat steps 4.3.2 and 4.3.3; then, set the null detector OPR-ZERO switch to OPR.

4.3.11 Adjust the DV source output voltage controls as required to establish a null indication to within ±1 μV on the null detector 10 μV range while adjusting the null detector null sensitivity control as required.

4.3.12 Set the null detector OPR-ZERO switch to ZERO. Set the A-B switch to position B, and set the voltage divider controls to 1.0000000.

CAUTION

ALL TI ADJUSTMENTS MUST BE MADE ONLY WITH INSULATED SCREWDRIVERS OR PLASTIC ALIGNMENT TOOLS.

4.3.13 Set the null detector OPR-ZERO switch to OPR. Adjust the TI internal 1000 V CAL potentiometer to establish a null indication on the null detector to within ±5 μV while switching the null detector range sensitivity as required.

4.3.14 Set the null detector OPR-ZERO switch to ZERO. Set the TI voltage range selector to the 100 V position, and the voltage dials to 10.00000 V. Set the detector OPR-ZERO switch to OPR, and adjust the TI 100 V CAL potentiometer to establish a null indication to within ±5 μV.

4.3.15 Using the TI 10 V range setting and the TI 10 V CAL potentiometer, repeat step 4.3.14, with the TI voltage dials set for 10.000000 V.

4.3.16 Set the detector OPR-ZERO switch to ZERO, set all voltage-source equipment for minimum output, and disconnect the equipment setup.

4.3.17 If the output voltage measurements test is to be made using a reference divider item 2.10, proceed to step 4.4. If item 2.10.1 is to be used, skip to step 4.6.

4.4 OUTPUT VOLTAGE MEASUREMENTS: USING THE 750A REFERENCE DIVIDER

4.4.1 Connect the null detector across the TI output terminals and set the TI power switch to OPR.

4.4.2 For each of the measurements in the following table, perform a test as follows:

4.4.2.1 Set the TI controls to obtain the settings indicated in the following table, and set the null detector OPR-ZERO switch to OPR.

Range	Voltage Dials	Tolerance Limits
10 V	0.000000	±10 μV
100 V	00.00000	±20 μV
1000 V	000.0000	±200 μV

4.4.2.2 Adjust the null detector controls to measure the TI output voltage, changing the null detector null-range sensitivity as required. Verify that the null detector indication is within the tolerance limits listed.

4.4.2.3 Set the null detector OPR-ZERO switch to ZERO and set the detector null range control to a range position that would prevent meter pegging for the next measurement.

4.4.3 Disconnect the null detector from the TI, and set the TI power switch to STDBY/RESET.

4.4.4 Ensure that the following equipment controls are set as follows:

Reference Divider; item 2.10:

STD CELL CIRCUIT switch to — OPEN

STD CELL VOLTAGE switches to — V_{ref} (of ERS below)

INPUT VOLTAGE switch to — 1100

OUTPUT VOLTAGE switch to — 5

ERS; item 2.9:

Voltage-Output controls to V_{ref} (Assigned-Reference-Output voltage), if applicable

Null Detectors:

OPR-ZERO switch to	ZERO
RANGE switch to	300 μV (to be changed as required later)

TI

VOLTAGE RANGE switch to	10 V
Output Voltage (READOUT DIALS) controls to	5.000000

DV Source; item 2.6:

POWER switch to	STDBY/RESET
VOLTAGE RANGE switch to	1000
VOLTAGE TRIP vernier to	fully cw
METER switch to	VOLTAGE

CURRENT LIMIT control to approximately $^1/_4$ of fully cw position (about 15 mA)

NOTE

The following described calibration measurements require two null detectors. For output voltage measurements using only one null detector, skip to subsection 4.5.

4.4.5 Connect the equipment as shown in Figure 5.

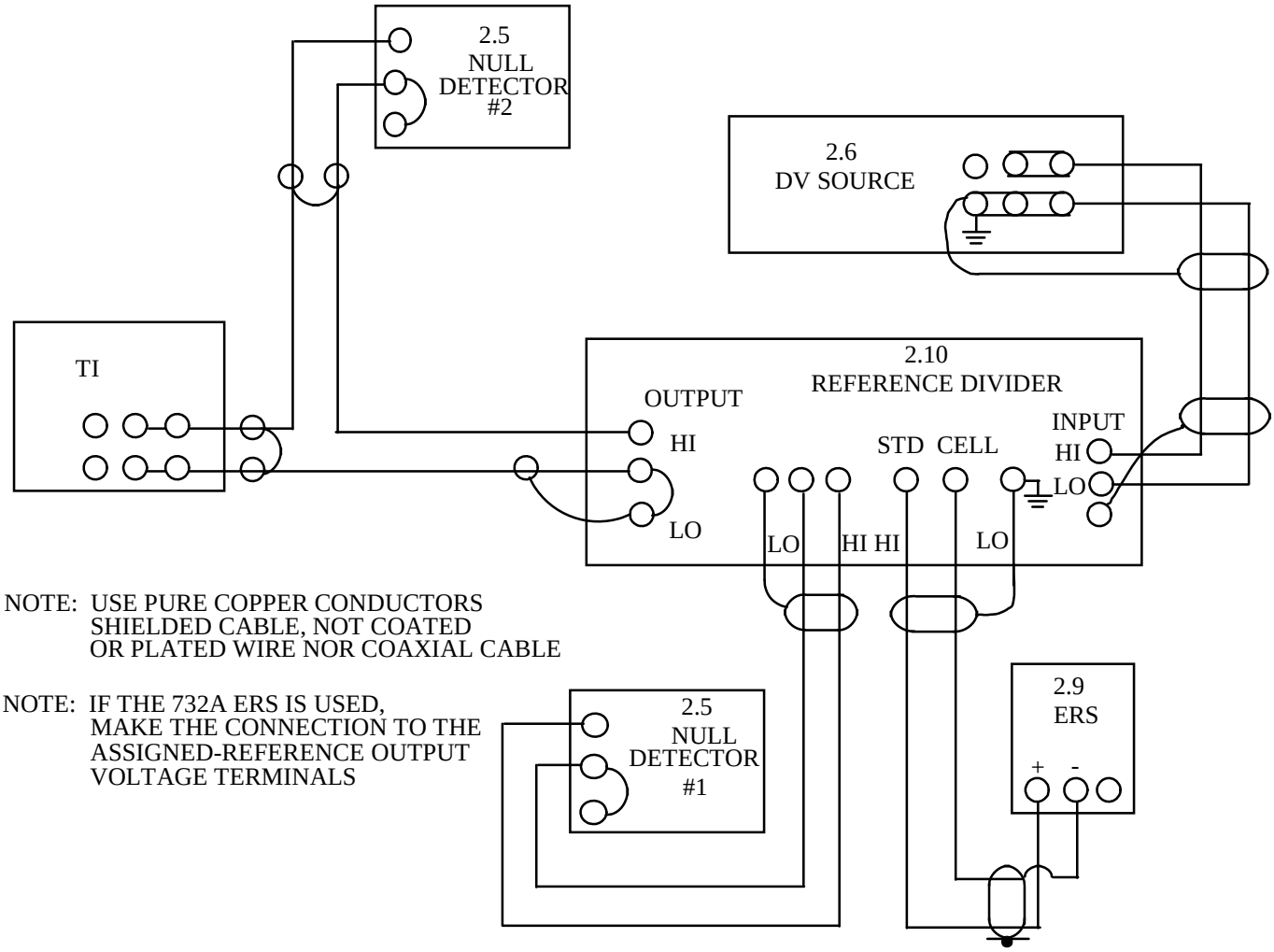


Figure 5. Output Voltage Test Configuration (Using Two Null Detectors)

4.4.6 Set the null detectors #1 and #2 OPR-ZERO switch to OPR, and set the DV source and the TI to the operate mode.

4.4.7 Set the reference divider STD-CELL switch to MOMENTARY long enough to establish a reference-null indication within ±5 μV on the null detector #1 by adjusting the DV source output voltage controls as required. Increase the null-range sensitivity of the null detector #1, as necessary, during the adjustment for the reference null. (The DV source output indication at null should be approximately 1100 V).

4.4.8 Set the reference divider STD-CELL switch to LOCKED and adjust the DV source output voltage controls to establish a reference null within ±1 μV on the null detector #1.

4.4.9 Perform each of the measurements tabulated as follows:

4.4.9.1 Set the null detectors #1 and #2 OPR-ZERO switch to ZERO and set the TI power switch to STDBY/RESET.

4.4.9.2 Set the equipment controls to obtain the settings listed in the following table for each measurement; then, set the TI power switch to OPR.

Ref Divider Output Setting	Test Instrument		Tolerance Limits
	Range	Output-Voltage Dials	
5	10 V	5.000000	±60 μV
10	10 V	10.000000	±110 μV
5	100 V	05.00000	±70 μV
10	100 V	10.00000	±120 μV
50	100 V	50.00000	±520 μV
100	100 V	100.00000	±1.020 mV
5	1000 V	005.0000	±275 μV
10	1000 V	010.0000	±350 μV
50	1000 V	050.0000	±950 μV
100	1000 V	100.0000	±1.700 mV
500	1000 V	500.0000	±7.7 mV
1000	1000 V	1000.0000	±15.2 mV
1100	1000 V	100X0.0000	±16.7 mV
1100	1000 V	1099.999X	±16.7 mV

4.4.9.3 Set both null detectors OPR-ZERO switch to OPR, increasing the detector null range sensitivity as required to avoid meter pegging.

4.4.9.4 Adjust the DV source output voltage controls as required to maintain the reference-null indication within ±1 μV on the meter of null detector #1.

4.4.9.5 Verify that the indication of the null detector #2 is within the tolerance limits listed.

4.4.10 Set the null detectors OPR-ZERO switch to ZERO, and set the reference divider STD-CELL-CIRCUIT switch to OPEN.

4.4.11 Set the TI power switch to STDBY/RESET and the DV source to the standby mode.

4.4.12 Unless other measurements are to be performed, set all equipment controls as required to avoid damage to the equipment and injury to personnel; then disconnect the test configuration.

4.5 OUTPUT VOLTAGE MEASUREMENTS: USING THE 750A REFERENCE DIVIDER AND ONE NULL DETECTOR

NOTE

If two null detectors (item 2.5) are available, perform the output voltage measurements as described in Section 4.4, starting with steps 4.4.4 and 4.4.5.

4.5.1 Set the reference divider INPUT-VOLTAGE switch to RESET, and connect the equipment as shown in Figure 6.

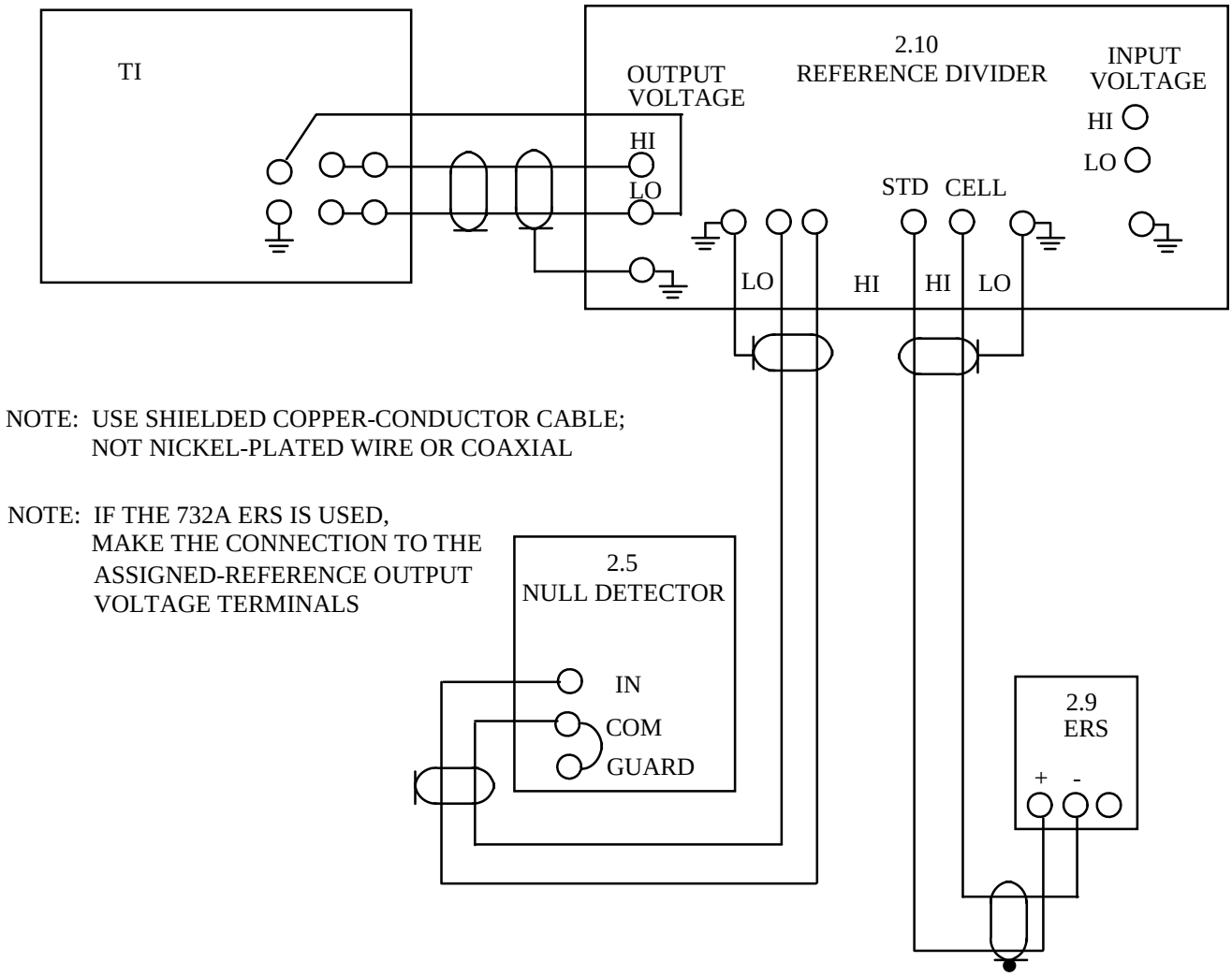


Figure 6. One-Detector Output-Voltage Measurements Setup

4.5.2 Perform each of the measurements as follows:

4.5.2.1 Set the reference divider STD-CELL switch to OPEN, the TI power switch to STDBY/RESET, and the null detector OPR-ZERO switch to ZERO. Adjust the null detector ZERO control to obtain a null indication on the null detector 10 μV range, switching null range control to a lower range as required.

4.5.2.2 Set the equipment controls as required to obtain the settings listed in the following table for each measurement; then set the TI power switch to OPR.

TI Initial Settings		Ref Divider Output Switch	Tolerance Limits (V)
Range (V)	Output-Voltage Dials (V)		
10	5.000000	5	4.999940 to 5.000060
10	10.000000	10	9.999890 to 10.000110
100	05.00000	5	04.99993 to 05.00007
100	10.00000	10	9.99988 to 10.00012
100	50.00000	50	49.99948 to 50.00052
100	100.00000	100	99.99898 to 100.00102
1000	005.0000	5	004.9997 to 005.0003
1000	010.0000	10	09.9996 to 010.0004
1000	050.0000	50	049.9990 to 050.0010
1000	100.0000	100	99.9983 to 100.0017
1000	500.0000	500	499.9923 to 500.0077
1000	1000.0000	1000	999.9848 to 1000.0152
1000	10X0.0000	1100	1099.9833 to 1100.0167
1000	1099.999X	1100	1099.9833 to 1100.0167

4.5.2.3 Set the null detector OPR-ZERO switch to OPR, selecting a null range sensitivity setting to avoid meter pegging and switching the reference divider STD-CELL switch to MOMENTARY, as required.

4.5.2.4 While holding the reference divider STD-CELL switch to MOMENTARY, adjust the TI output voltage dials to establish a reference null indication on the null detector.

4.5.2.5 Set the reference divider STD-CELL switch to LOCK. Obtain a reference null indication on the null detector 10 μV range by progressively increasing the detector null-range sensitivity and adjusting the TI output voltage controls as required.

4.5.2.6 Verify that the TI output voltage indication is within the tolerance limits listed. Arbitrarily set the null detector null range switch to a higher range (say, 300 μV).

4.5.3 Unless other measurements are to be performed, set all equipment controls as required to avoid damage to the equipment and injury to personnel; then, disconnect the test configuration.

4.6 OUTPUT VOLTAGE MEASUREMENTS: USING THE 752A REFERENCE DIVIDER

4.6.1 Prior to using the 752A reference divider, perform the self calibration procedure in accordance with the manufacturer's manual.

4.6.2 Connect the equipment as shown in Figure 7.

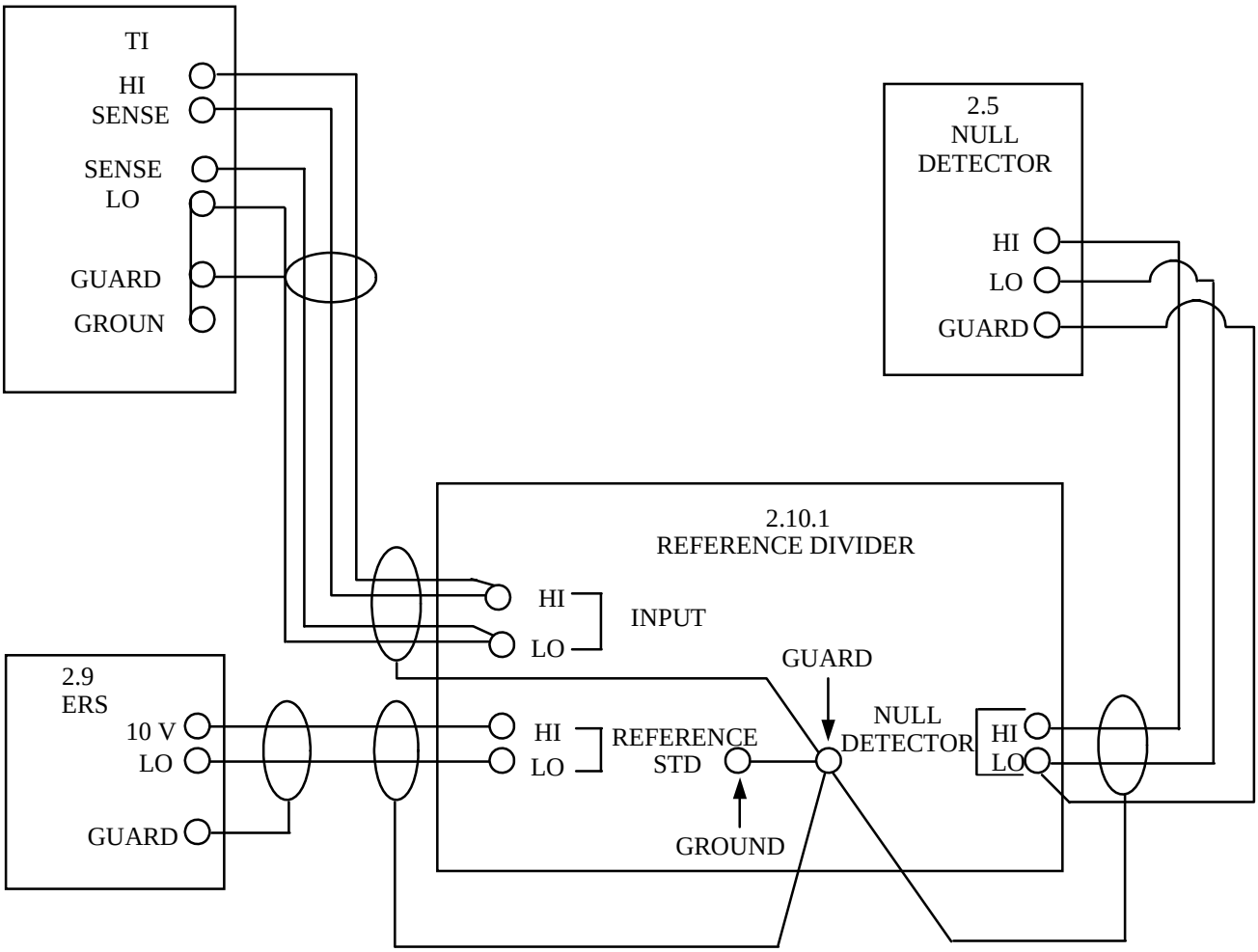


Figure 7. Output Voltage Test Configuration Using the 752A Reference Divider

4.6.3 Set the TI POWER switch to STDBY/RESET and the null detector OPR-ZERO switch to ZERO.

4.6.4 Adjust the null detector ZERO control to obtain a null detector null indication, progressively increasing the null detector sensitivity to the 10 μV range.

4.6.5 Set the reference divider CALIBRATE switch to operate and MODE switch to 10.

4.6.6 Set the TI RANGE switch to 10 and Output Voltage dials to 10.000000.

4.6.7 Select a null detector sensitivity setting to avoid meter pegging and set the OPR-ZERO switch to OPR.

4.6.8 Set the TI POWER switch to OPR and Output Voltage dials for a null detector null indication, progressively increasing the null detector sensitivity to the 10 μV range.

4.6.9 Verify that the TI Output Voltage dial setting is equal to the Ref voltage on the report of calibration ±0.00011.

4.6.10 Set the null detector range switch to avoid meter pegging and OPR-ZERO switch to ZERO. Set the TI RANGE switch to STDBY/RESET.

4.6.11 Using the methods described in steps 4.6.4 through 4.6.10, repeat the measurement for each of the following TI and reference divider settings. At each setting, verify that the TI Output Voltage dial setting is within the tolerance limits listed in the following table.

Reference Divider Mode Switch Setting	TI Initial Settings		TI Output Voltage Dial Tolerance Limits	
	Range	Output Voltage Dials		
10	100	10.00000	Ref Voltage	±0.00012
100	100	100.00000	Ref Voltage X10	±0.00102
10	1000	010.0000	Ref Voltage	±0.0004
100	1000	100.0000	Ref Voltage X10	±0.0017
1000	1000	1000.0000	Ref Voltage X100	±0.0152

4.6.12 Unless other measurements are to be performed, set all equipment controls as required to avoid damage to the equipment and injury to personnel; then disconnect the test configuration.

CALIBRATION CHECKLIST

TEST INST (S) Fluke 332D DC Voltage Standard

MFR	MODEL		SER. NO.			DATE
PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.1	Line and Load Regulation Test					
	10 V-Range Test (Line Regulation)					
	Load Line					
4.1.5.2	200 Ω 115 V	--	(μV)			Ref:
4.1.5.3	200 Ω 105 V	--				±20 μV
4.1.5.4	200 Ω 115 V	--	(μV)			Ref:
4.1.5.5	200 Ω 125 V	--				±20 μV
	100 V-Range Test					
	Load Line					
4.1.5.2	2000 Ω 115 V	--	(μV)			Ref:
4.1.5.3	2000 Ω 105 V	--				±200 μV
4.1.5.4	2000 Ω 115 V	--	(μV)			Ref:
4.1.5.5	2000 Ω 125 V	--				±200 μV
	1000 V-Range Test					
4.1.5.2	20000 Ω 115 V	--	(mV)			Ref:
4.1.5.3	20000 Ω 105 V	--				±2.0 mV
4.1.5.4	20000 Ω 115 V	--	(mV)			Ref:
4.1.5.5	20000 Ω 125 V	--				±2.0 mV
	Load Regulation Tests					
	TI Range Load					
4.1.7.2	1000 V 20000 Ω	--	(mV)			1st indication (ref):
4.1.7.4	1000 V None	--				±2.0 mV
4.1.7.2	100 V 2000 Ω	--	(μV)			Ref:
4.1.7.4	100 V None	--				±200 μV
4.1.7.2	10 V 200 Ω	--	(μV)			Ref:
4.1.7.4	10 V None	--				±20 μV

CALIBRATION CHECKLIST

TEST INST (S) Fluke 332D DC Voltage Standard

MFR	MODEL		SER. NO.			DATE
PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.2	Zero Output Adjustments					
	Range Adjust	(μV)				
4.2.4	10 V 10 V-zero pot	0	ck ( )			±1 μV
”	100 V 100 ”	0	ck ( )			±1 μV
”	1000 V 1000 ”	0	ck ( )			±1 μV
4.3	Sample String Linearization					
	Required Adjustments	(μV)	(μV)			
4.3.7.3	Null-Detector ZERO adj	0	ck ( )			±1 μV
”	1000 V CAL	0	ck ( )			±1 μV
”	DECK C-1	0	ck ( )			±1 μV
”	” C-2	0	ck ( )			±1 μV
”	” C-4	0	ck ( )			±2 μV
”	” C-8	0	ck ( )			±4 μV
”	Voltage-Divider dials	0	ck ( )			±5 μV
”	DECK B-1	0	ck ( )			±5 μV
”	Null-Detector ZERO adj	0	ck ( )			±1 μV
”	100 V CAL	0	ck ( )			±1 μV
”	DECK B-2	0	ck ( )			±1 μV
”	” B-4	0	ck ( )			±2 μV
”	” B-8	0	ck ( )			±4 μV
”	Voltage-Divider dials	0	ck ( )			±5 μV
”	DECK A-1	0	ck ( )			±5 μV
”	Null-Detector ZERO adj	0	ck ( )			±1 μV
”	10 V CAL	0	ck ( )			±1 μV
”	DECK A-2	0	ck ( )			±1 μV
”	” A-4	0	ck ( )			±2 μV
”	” A-8	0	ck ( )			±4 μV
4.3.13	1000 V CAL adjust	0	ck ( )			±5 μV
4.3.14	100 V CAL adjust	0	ck ( )			±5 μV
4.3.15	10 V CAL adjust	0	ck ( )			±5 μV

CALIBRATION CHECKLIST

TEST INST (S) Fluke 332D DC Voltage Standard

MFR	MODEL		SER. NO.			DATE
PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
4.4	Output Voltage Measurements: Using The 750A Reference Divider					
	Range Voltage Dials	(μV)	(μV)			
4.4.2.2	10 V 0.000000	0				±10 μV
”	100 V 00.00000	0				±20 μV
”	1000 V 000.0000	0				±200 μV
	Range Voltage Dials					
4.4.9.5	10 V 5.000000	0				±60 μV
”	10 V 10.000000	0				±110 μV
”	100 V 05.00000	0				±70 μV
”	100 V 10.00000	0				±120 μV
”	100 V 50.00000	0				±520 μV
”	100 V 100.00000	0				±1.020 mV
”	1000 V 005.0000	0				±275 μV
”	1000 V 010.0000	0				±350 μV
”	1000 V 050.0000	0				±950 μV
”	1000 V 100.0000	0				±1.700 mV
”	1000 V 500.0000	0				±7.7 mV
”	1000 V 1000.0000	0				±15.2 mV
”	1000 V 10X0.0000	0				±16.7 mV
”	1000 V 1099.999X	0				±16.7 mV
4.5	Output Voltage Measurements: Using The 750A Reference Divider and One Null Detector					
	Range Voltage Dials					
	(V) (V)	(V)	(V)			(V)
4.5.2.6	10 5.000000	5.000000				4.999940 to 5.000060
”	10 10.000000	10.000000				9.999890 to 10.000110
”	100 05.00000	05.00000				04.99993 to 05.00007
”	100 10.00000	10.00000				9.99988 to 10.00012
”	100 50.00000	50.00000				49.99948 to 50.00052
”	100 100.00000	00.00000				99.99898 to 100.00102
”	1000 005.00000	05.00000				04.9997 to 005.0003
”	1000 010.0000	10.0000				09.9996 to 010.0004

CALIBRATION CHECKLIST

TEST INST (S) Fluke 332D DC Voltage Standard

MFR	MODEL		SER. NO.			DATE
PROCEDURE STEP NO. (1)	FUNCTION TESTED (2)	NOMINAL (3)	MEASURED VALUES FIRST RUN (4)	MEASURED VALUES SECOND RUN (5)	OUT OF TOL (6)	CALIBRATION TOLERANCES (7)
	Range Voltage Dials					
	(V) (V)	(V)				(V)
4.5.2.6	1000 050.0000	050.0000				049.9990 to 050.0010
”	1000 100.0000	100.0000				99.9983 to 100.0017
”	1000 500.0000	500.0000				499.9923 to 500.0077
”	1000 1000.0000	1000.0000				999.9848 to 1000.0152
”	1000 10X0.0000	1100.0000				1099.9833 to 1100.0167
”	1000 1099.999X	1100.0000				1099.9833 to 1100.0167
4.6	Output Voltage Measurements: Using the 752A Reference Divider					
4.6.9	Range Voltage Dials					
	(V) (V)	(V)				(V)
”	10 Ref Voltage	--				±0.00011
4.6.11	100 10.00000	--				Ref Voltage ±0.00012
”	100 100.00000	--				Ref Voltage X10 ±0.00102
”	1000 010.0000	--				Ref Voltage ±0.0004
”	1000 100.0000	--				Ref Voltage X10 ±0.0017
”	1000 1000.0000	--				Ref Voltage X100 ±0.0152