

TB 9-4931-383-50

Change 4

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR VOLTAGE STANDARAD, JOHN FLUKE, MODELS 332A, 332B, AND 332B/AF

Headquarters, Department of the Army, Washington, DC
9 March 1988

TB 9-4931-383-50, 26 July 1976, is changed as follows:

1. Remove old pages and insert new pages as indicated below. New or changed material is indicated by a vertical bar in the margin of the page.

Remove pages

3 through 8
11 and 12

Insert pages

3 through 8
11 and 12

2. File this change sheet in front of the publication for reference purposes.

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Chief of Staff

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Headquarters, Department of the Army, Washington, DC
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By Order of the Secretary of the Army:

E. C. MEYER
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Major General, United States Army
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CALIBRATION PROCEDURE FOR VOLTAGE STANDARD, JOHN FLUKE MODELS 332A, 332B, AND 332B/AF

Headquarters, Department of the Army, Washington, DC
26 July 1976

REPORTING OF ERRORS

You can help improve this publication by calling attention to errors and by recommending improvements and stating your reasons for the recommendations. Your letter or DA Form 2028, Recommended Changes to Publications, should be mailed directly to Commander, U.S. Army Aviation and Missile Command, ATTN: AMSAM-TMD-EP, Redstone Arsenal, A1 35898-5400. You may also contact this office electronically. E-mail address is tmde-e@redstone.army.mil. FAX to DSN 788-2313 (commercial 256-842-2313). A reply will be furnished directly to you.

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*This bulletin supersedes TB 9-4931-383-50, 31 January 75, including all changes.

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**SECTION I
IDENTIFICATION AND DESCRIPTION**

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Voltage Standard, John Fluke Models 332A, 332B, and 332B/AF. The manufacturers instruction manuals were used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the "TI" (test instrument) throughout this bulletin.

a. Model Variations. On model 332A with serial numbers 123 through 332, the X position of voltage dials 2 through 7 is labeled 10.

b. Time and Technique. The time required for this calibration is approximately 4 hours, using the dc and low frequency technique.

2. Calibration Data Card, DA Form 2416

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TM 38-750. DA Form 2416 must be annotated in accordance with TM 38-750 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) will follow the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test Instrument Parameters	Performance Specifications ¹
Voltage range	10-v range; 0 to 11.111110 v (1- μ v steps) 100-v range; 0 to 111.11110 v (10- μ v steps) 1000-v range; 0 to 1111.1110 v (100- μ v steps)
Resolution Accuracy	0.1 ppm of range (1 μ v max) 10-v range; \pm (0.003% of setting +10 μ v) 100-v range; \pm (0.003% of setting +20 μ v) 1000-v range; \pm (0.003% of setting +40 μ v)
Over-voltage protection	Automatically disables output voltage if level exceeds selected value (10 to 110% of selected range).
Output current	0 to 50 ma (any voltage setting)
Over-current protection	Automatically limits output current to present level; between 1 and 60 ma.
Line and load regulation	0.0005% of setting or 25 μ v for 10% change in line voltage from nominal.

¹The specifications for models 332B and 332B/AF have been derated to the same as model 332A which are, reflected in this calibration description.

**SECTION II
EQUIPMENT REQUIREMENTS**

4. Equipment Required. Table 2 identifies the specific equipment used in this calibration procedure. This equipment is issued with secondary reference standards calibration set NSN 4931-00-621-7878, and is to be used in performing this procedure. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. When accuracies listed in table 2 provide a four-to-one accuracy ratio between the standard and TI. Where the four-to-one ratio cannot be met, the accuracy of the equipment selected is shown in parenthesis.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are to be used in this calibration procedure. When necessary, these items may be substituted by equivalent items unless specifically prohibited.

Table 2. Minimum Specifications of Equipment Required

Item	Common Name	Minimum Use Specifications	Manufacturer, Model, and Part Number
A1	AUTOTRANSFORMER	Range: 105 to 125 vac Accuracy: \pm 1%	General Radio, Model WI0MT3AS3 (7910809)
A2	DC TRANSFER STANDARD	Range: 1 and 10 vdc Accuracy: \pm 0.0005% when transferred from saturated cells	John Fluke, Model 730A/AB (MIS-10358, type 2)
A3	DECADE RESISTOR	Range: 20 to 200 ohms Accuracy: \pm 1	Biddle-Gray, Model 601147-1 (7910328)
A4	NULL DETECTOR	Range: 0 to 1000 vdc Accuracy: N/A	John Fluke, Model 845AB (8205517)

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Table 2. Minimum Specifications of Equipment Required - Continued.

Item	Common name	Minimum use specifications	Manufacturer, Model, and Part Number
A5	OPERATING VOLTAGE SOURCE.	Range: 999 to 1000 vdc Stability: 0.0015% of setting +20 μ v	John Fluke, Model 332A (7911393) or 332B/AF (6625-150-6994)
A6	STANDARD CELL	Test report specifications	Guildline, Model 9154B (MIS-10364)
A7	VOLTAGE DIVIDER	Range: 0 to 1.000000 Accuracy: \pm 0.25 ppm FS	ESI, Model RV726 (MIS-10295)
A8	VOLTAGE REGULATOR	Range: 115 vac Accuracy: \pm 0.75%	Superior Electric Co., Model EM 4102 (8616523)
A9	VOLTMETER	Range: 6 to 16 vdc Accuracy: \pm 0.0025%	John Fluke, Model 887 ABAN (P/O MIS-10216)

Table 3. Accessories Required

Item	Common Name	Description And Part Number
B1	SENSITIVITY SWITCH	Sensitivity and reversing switch; galvanometer key (7913207)
B2	WIRE	Shielded pair, No. 18 AWG, solid copper conductor (MIS-10312)
B3	ADAPTER	Power cord adapter, T210 (7912356)
B4	LEAD ¹	18-in., spade lug terminations (black) (7911292-13)

¹Four required.

SECTION III CALIBRATION PROCESS FOR MODEL 332A

6. Preliminary Instructions

a. The instructions outlined in this paragraph are preliminary to the calibration process. Personnel should become familiar with the applicable sections before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2 and for prefix B, see table 3.

WARNING

HIGH VOLTAGE is used during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions.

NOTE

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

NOTE

Unless otherwise specified, all controls and control settings refer to the TI.

c. When indications specified in paragraph 10 are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraph 10. Do not perform power supply check if all other parameters are within tolerance.

d. Position TI controls as listed in (1) through (5) below:

- (1) VOLTAGE RANGE switch to 10.
- (2) Voltage dials to 1.000000.
- (3) METER switch to VOLTAGE.
- (4) VOLTAGE TRIP control fully clockwise.
- (5) CURRENT LIMIT control fully clockwise.

e. Connect TI to autotransformer (A1) and leave connected throughout procedure.

NOTE

The sensitivity switch (B1) has been included in equipment setup for safety and to allow reversal of connections to null detector (A4). Detailed operation of the switch is not included in step-by-step procedure.

f. Connect autotransformer to a 115-volt ac source and adjust for a 115-volt output.

g. Turn POWER switch to STANDBY/RESET and allow at least 1 hour for warm-up.

h. Connect operating voltage source (A5) to voltage regulator (A8), set its POWER switch to STANDBY/ RESET, and allow to warm-up until called for.

i. It is necessary to know actual value of $1.018 + \Delta E$ output of dc transfer standard (A2) to complete this calibration. If calibration of dc transfer standard is no more than 10 days old, the value recorded at time of calibration is sufficient. If calibration is more than 10 days old, determine the value by performing (1) through (11) below:

- (1) Connect equipment as shown in figure 1.

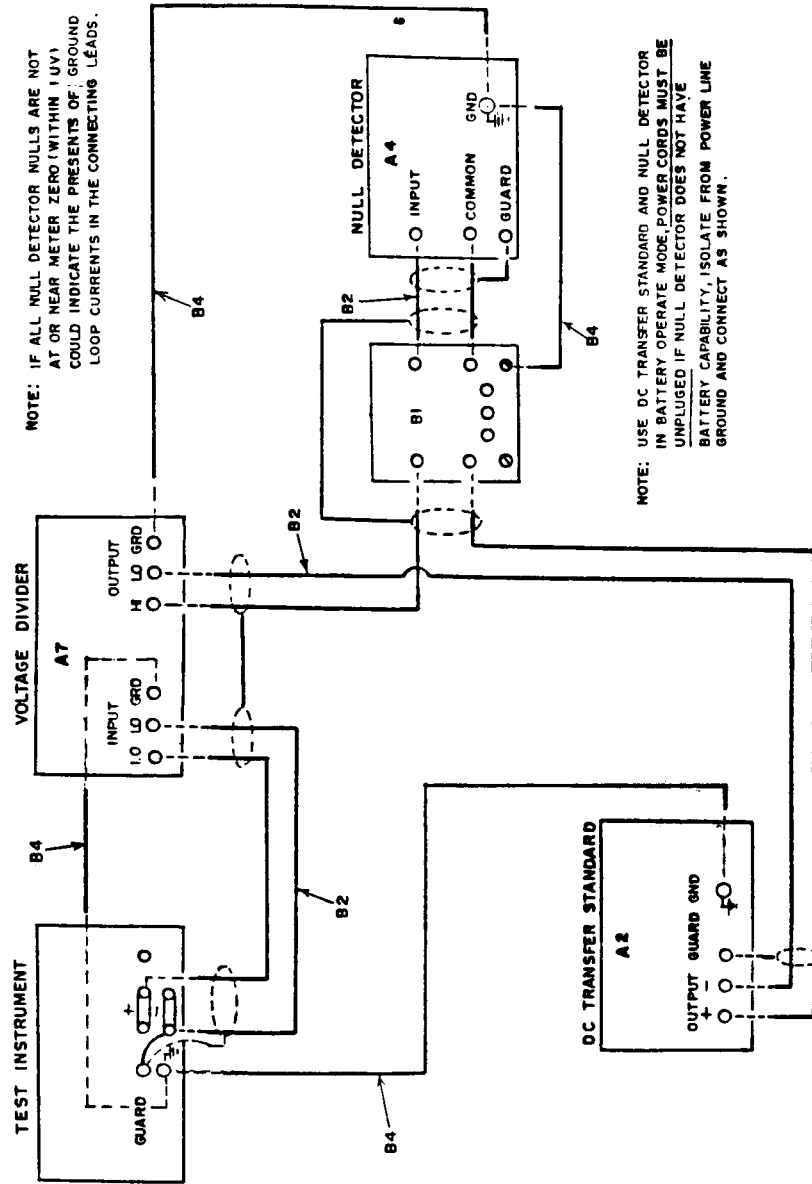


Figure 1. Measurement of $1.018 + \Delta E$ output of dc transfer standard - equipment setup.

NOTE

When adjusting for a null indication on null detector, always start on highest range of null detector and proceed down range to required sensitivity. When reading is complete, return null detector to high range.

- (2) Adjust dc transfer standard (A2) for $1.018 + \Delta E$ mean output and set ΔE dials to last three digits of standard cell (A6) certificate value.

- (3) Set voltage divider (A7) to one-tenth of value of dc transfer standard setting.
- (4) Adjust TI for a nominal 10-volt output and set its POWER switch to ON.
- (5) Adjust TI voltage dials for a null indication on null detector (A4). Do not change TI voltage dials until instructed.
- (6) Set TI POWER switch to STANDBY/RESET.
- (7) Replace dc transfer standard with standard cell in equipment setup.
- (8) Set TI POWER switch to ON.
- (9) Adjust voltage divider for a null indication on null detector. Record the voltage divider indication.
- (10) Set TI POWER switch to STANDBY/RESET.
- (11) Compute the actual value of the dc transfer standard output as follows. If in step (9) above the voltage divider setting was increased, subtract the amount of change multiplied by 10 from the standard cell value. If the setting was decrease add the amount of change multiplied by 10 to the standard cell value. Record the value for future use.

7. Regulation

a. Performance Check

- (1) Connect equipment as shown in figure 2.
- (2) Set decade resistor (A3) to 20 ohms.
- (3) Set voltage divider (A7) to .999999X.
- (4) Adjust dc transfer standard (A2) for a 1-volt mean output.
- (5) Adjust TI voltage dials for a nominal 1-volt output and turn POWER switch to ON.
- (6) Adjust TI voltage dials for a null indication on null detector (A4). Record voltage dial indication.
- (7) Adjust autotransformer (A1) output to 105 volts and wait 1 minute.
- (8) Adjust TI voltage dials for a null indication on null detector.

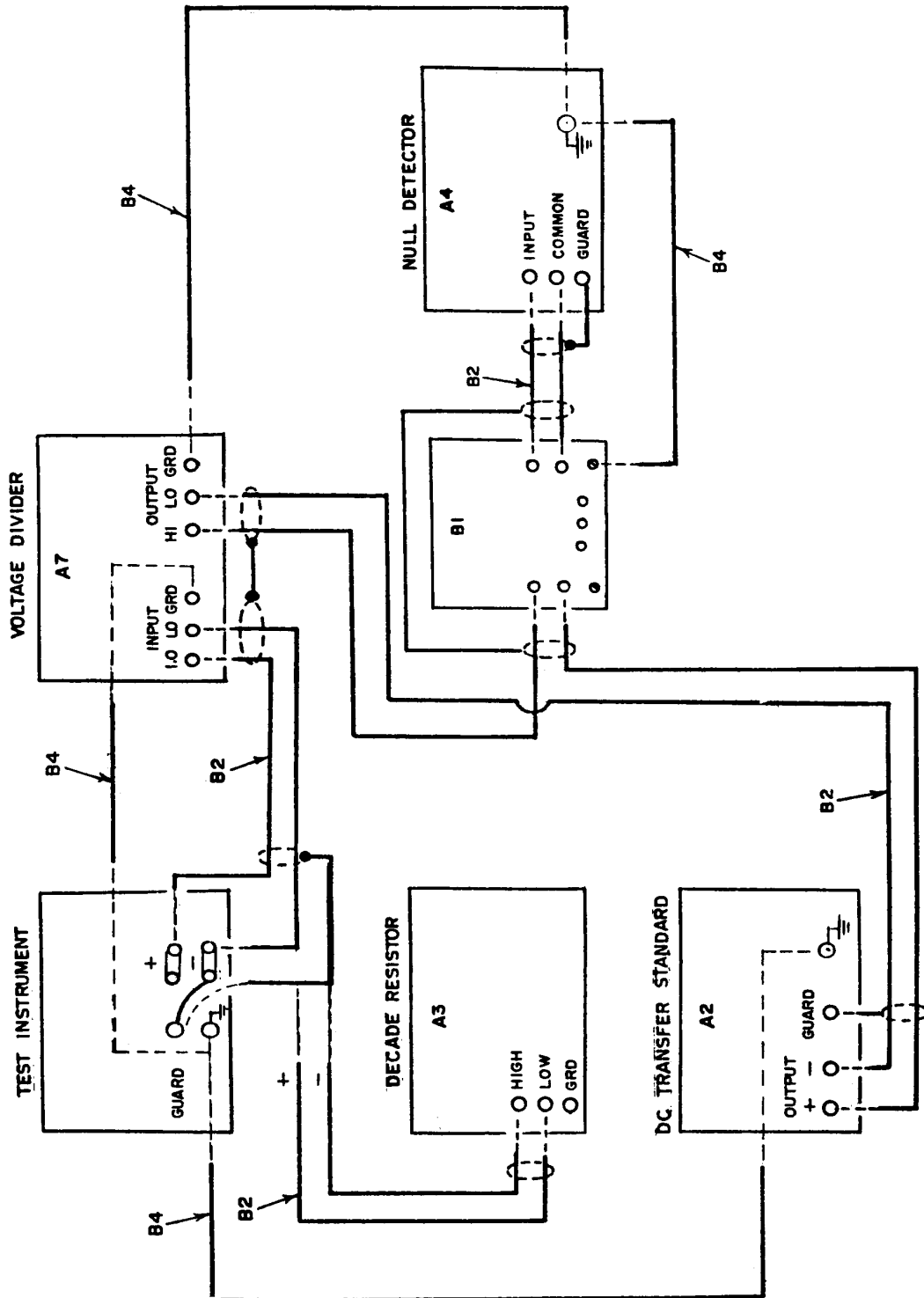


Figure 2. Regulation - equipment setup.

- (9) TI voltage dials will indicate within ± 25 microvolts of value recorded in (6) above.
- (10) Adjust autotransformer output to 125 volts and wait 1 minute.
- (11) Adjust TI voltage dials for a null indication on null detector.
- (12) TI voltage dials will indicate within ± 25 microvolts of value recorded in (6) above.
- (13) Adjust autotransformer output to 115 volts.
- (14) Remove decade resistor from equipment setup and wait 1 minute.
- (15) Adjust TI voltage dials for a null indication on null detector.
- (16) TI voltage dials will indicate within ± 25 microvolts of value recorded in (6) above.
- (17) Turn POWER switch to STANDBY/RESET.

b. Adjustments. No adjustments can be made.

8. Zero Voltage

a. Performance Check

- (1) Set dc transfer standard (A2) for (supply number 1) ΔE output and ΔE control to 000.
- (2) Position TI controls as listed in (a) through (c) below:
 - (a) VOLTAGE RANGE switch to 1000.
 - (b) Voltage dials to 0000000.
 - (c) POWER switch to ON.
- (3) Adjust ΔE control of dc transfer standard for a null indication on null detector (A4).
- (4) If ΔE control of dc transfer standard does not indicate 0 ± 40 microvolts, perform **b(1)** below.

NOTE

If reading is negative, reverse leads at OUTPUT of dc transfer standard.

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(5) Set VOLTAGE RANGE switch to 100.

(6) Repeat (3) above.

(7) If ΔE control of dc transfer standard does not indicate, 0 ± 20 microvolts, perform **b(2)** below.

(8) Set VOLTAGE RANGE switch to 10.

(9) Repeat (3) above.

(10) If ΔE control of dc transfer standard does not indicate 0 ± 10 microvolts, perform **b(3)** below.

(11) Set POWER switch to STANDBY/RESET.

b. Adjustments

WARNING

Dangerous potentials exist between chassis and ground.
Exercise extreme caution.

(1) Set ΔE control of dc transfer standard to 000 and adjust R112 (fig. 3) for a null indication on null detector (R).

(2) Set ΔE control of dc transfer standard to 000 and adjust R110 (fig. 3) for a null indication on null detector (R).

(3) Set ΔE control of dc transfer standard to 000 and adjust R108 (fig. 3) for a null indication on null detector (R).

9. Linearity

a. Performance Check

(1) Set voltage divider (A7) to .1000000.

(2) Set dc transfer standard (A2) for a 1-volt mean output.

(3) Position TI controls as listed in (a) through (c) below:

(a) VOLTAGE RANGE switch to 1000.

(b) Voltage dials to 00X.0000.

(c) POWER switch to ON.

(4) Adjust voltage divider for a null indication on null detector (A4) (within ± 10 microvolts). Record null detector indication.

(5) Set TI voltage dials to 010.0000.

(6) If null detector indication is not within ± 1 microvolt of value recorded in (4) above, perform **b**(1) and (2) below.

(7) Repeat the technique of (1) through (6) above, using settings, indications, and adjustments listed in table 4.

Table 4. Linearity

Voltage Range	Test Instrument Switch Settings.		Voltage Divider Initial Setting.	Dc Transfer Standard Output.	Maximum Difference Allowed (μV) ¹	Adjustments (fig. 3) ²
	Voltage Dial					
	Step (3) (B)	Step (5)				
1000	01X.0000	020.0000	.5000000	10-volt mean	10	R908 (R)
1000	03X.0000	040.0000	.2500000	10-volt mean	10	R909 (R)
1000	05X.0000	060.0000	.1666666	10-volt mean	20	R910 (R)
1000	07X.0000	080.0000	.1250000	10-volt mean	20	R911 (R)
1000	09X.0000	0X0.0000	.1000000	1-volt mean	20	R912 (R)
100	0X.00000	10.00000	.1000000	10-volt mean	1	R901 (R) ³
100	1X.00000	20.00000	.5000000	10-volt mean	10	R902 (R)
100	3X.00000	40.00000	.2500000	10-volt mean	10	R903 (R)
100	5X.00000	60.00000	.1666666	10-volt mean	20	R904 (R)
100	7X.00000	80.00000	.1250000	10-volt mean	20	R905 (R)
100	9X.00000	100.00000	.1000000	10-volt mean	20	R906 (R)

¹If difference exceeds this value, perform adjustment.

²Report adjustments only if difference is greater than 100 microvolts.

³Report this adjustment if difference is greater than 30 microvolts.

(8) Set POWER switch to STANDBY/RESET.

b. Adjustments

WARNING

Dangerous potentials exist between chassis and ground.
Exercise extreme caution.

(1) Adjust R907 (fig. 3) for same indication on null detector (R). (Report only if difference is greater than 30 microvolts.)

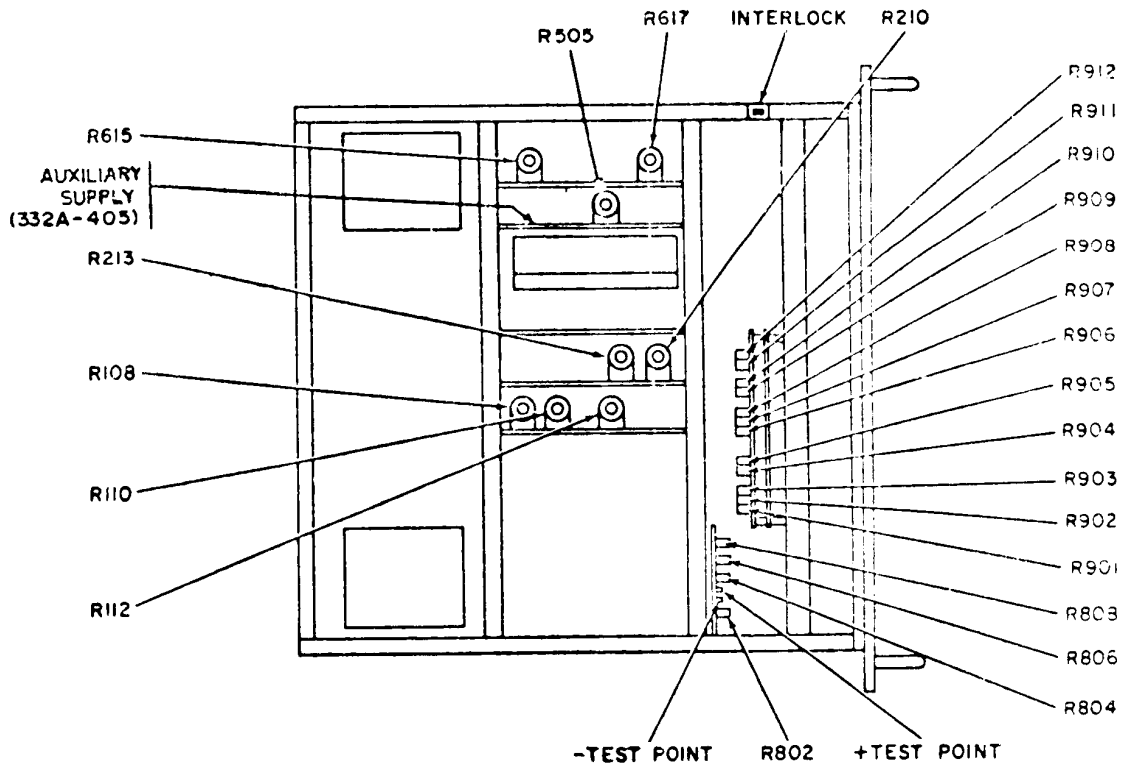


Figure 3. Model 332A top view - adjustment locations.

- (2) Repeat **a** above until no further adjustments are required.

10. Output Accuracy and Tracking

a. Performance Check

(1) Set voltage divider (A7) to one-tenth of actual value of dc transfer standard (A2) output determined in paragraph **6i** above.

(2) Set dc transfer standard for $1.018 + \Delta E$, mean output and set ΔE dials to last three digits of standard cell value.

(3) Position TI controls as listed in **(a)** through **(c)** below:

(a) VOLTAGE RANGE switch to 10.

(b) Voltage dials to 10.000000.

(c) POWER switch to ON.

(4) Adjust TI voltage dials for a null indication on null detector (A4).

- (5) If TI voltage dials do not indicate between 9.999690 and 10.000310, perform **b(1)** and (2) below.
- (6) If TI voltage dials are within tolerance but not exactly 10.000000, perform **b(3)** below.
- (7) Set dc transfer standard for a 10-volt mean output.
- (8) Set voltage divider to .999999X.
- (9) Adjust TI voltage dials for a null indication on null detector.
- (10) Record TI dial indication for future use. This is the actual value of 10-volt output of dc transfer standard.
- (11) Set dc transfer standard for $1.018 + \Delta E$, mean output and sets ΔE dial to 000.
- (12) Set TI voltage dials to 8.888888.
- (13) Adjust voltage divider for a null indication on null detector.
- (14) Voltage divider will indicate between .1145215 and .1145286.
- (15) Repeat technique of (12) through (14) above, using settings and indications listed in table 5. Set TI POWER switch to STANDBY/RESET.

Table 5. Tracking

Test Instrument Voltage Dial Settings	Voltage Divider Initial Settings	Voltage Divider Indications	
		Min	Max
6.666666	.1527000	.1526952	.1527048
5.555555	.1832400	.1832342	.1832459
4.444444	.2290500	.2290427	.2290574
2.222222	.4581000	.4580842	.4581159

- (16) Set voltage divider to one-hundredth of value recorded in (10) above.
- (17) Set dc transfer standard for a 10-volt mean output.
- (18) Position TI controls as listed in **(a)** through **(c)** below:
 - (a) VOLTAGE RANGE to 100.
 - (b) Voltage dials to 100.000000.
 - (c) POWER switch to ON.
- (19) Adjust TI voltage dials for a null indication on null detector.

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(20) If TI voltage dials do not indicate between 99.99698 and 100.00302, perform **b(4)** and (5) below.

(21) If TI voltage dials are within tolerance but not exactly 100.00000, perform **b(6)** below:

(22) Set TI POWER switch to STANDBY/RESET.

(23) Connect equipment as shown in figure 4.

(24) Set voltage divider to .1000000.

(25) Set operating voltage source (A5) VOLTAGE RANGE switch to 1000 and voltage dials to 1000.0000.

(26) Set TI and operating voltage source POWER switches to ON.

(27) Adjust operating voltage source voltage dials for a null indication on null detector.

(28) Set TI and operating voltage source POWER switches to STANDBY/RESET.

(29) Set voltage divider to .999999X.

(30) Set TI VOLTAGE RANGE switch to 1000 and voltage dials to 1000.0000.

(31) Set TI and operating voltage source POWER switches to ON.

(32) Adjust TI voltage dials for a null indication on null detector.

(33) If TI voltage dials do not indicate between 999.9699 and 1000.0300, perform **b(1)** and (8) below.

(34) Set TI and operating voltage source POWER switches to STANDBY/RESET.

b. Adjustments

WARNING

Dangerous potentials exist between chassis and ground.
Exercise extreme caution.

NOTE

Due to interaction of RANGE adjustments, adjustment of one range will require checking and, if necessary, readjustment of other ranges.

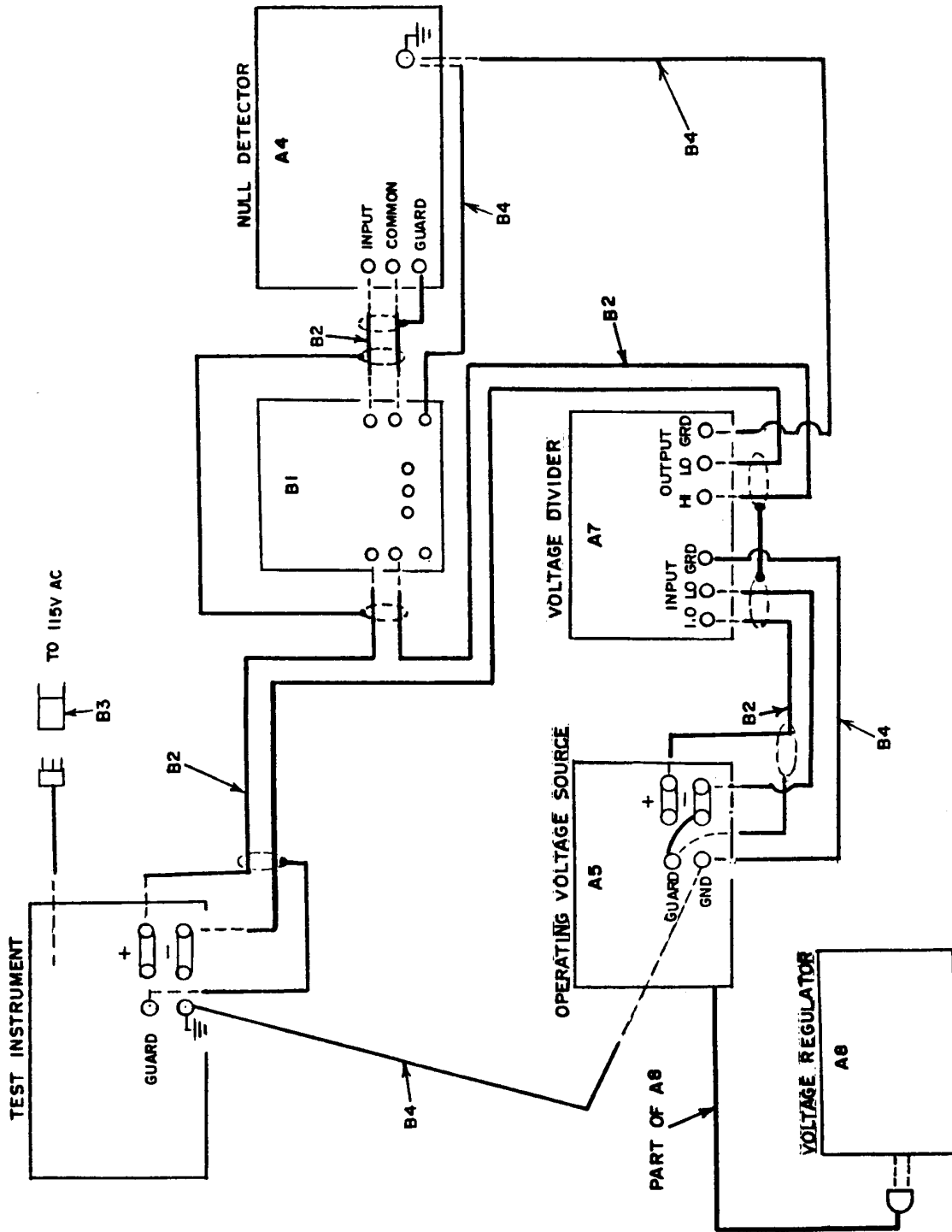


Figure 4. High voltage - equipment setup.

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- (1) Set TI voltage dials to 10.000000.
- (2) Adjust R804 (fig. 3) for a null indication on null detector (R).
- (3) Perform (1) and (2) above, but do not report adjustments.
- (4) TI voltage dials to 100.000000.
- (5) Adjust R806 (fig. 3) for a null indication on null detector (R).
- (6) Perform (4) and (5) above, but do not report adjustment.
- (7) Set TI voltage dials to 1000.0000.
- (8) Adjust R808 (fig. 3) for a null indication on null detector (r).

11. Panel Meter, Voltage Trip, and Current Limit

a. Performance Check

- (1) Disconnect TI from equipment setup.
- (2) Set VOLTAGE RANGE switch to 10, POWER switch to ON, and voltage dials for indication of 10 on 0-to-12 scale of panel meter.
- (3) If voltage dials do not indicate between 9.700000 and 10.300000, perform **b(1)** and (2) below.
- (4) Set voltage dials to 6.000000.
- (5) Slowly turn VOLTAGE TRIP control counter clockwise until voltage trip circuit actuates. If the VOLTAGE TRIP control is not an approximately midrange, perform **b(3)** through (7) below.
- (6) Set POWER switch to STANDBY/RESET.
- (7) Connect decade resistor (A3) to OUTPUT terminals and adjust to 100 ohms.
- (8) Position TI controls as listed in (a) through (d) below:
 - (a) METER switch to CURRENT.
 - (b) Voltage dials to 0000000.
 - (c) VOLTAGE TRIP control fully clockwise.
 - (d) POWER switch to ON.

(9) Adjust voltage dials for indication of 60 milliamperes on panel meter.

(10) If voltage dials do not indicate between 5.820000 and 6.180000, perform **b(8)** through (11) below.

(11) Set POWER switch to STANDBY/RESET.

b. Adjustments

WARNING

Dangerous potentials exist between chassis and ground.
Exercise extreme caution.

(1) Set voltage dials to 10.000000.

(2) Adjust R210 (fig. 3) for null indication on null detector (R).

(3) Set VOLTAGE TRIP control fully clockwise.

(4) Set POWER switch to STANDBY/RESET and back to ON.

(5) Adjust R213 (fig. 3) fully counterclockwise.

(6) Set VOLTAGE TRIP control to midrange.

(7) Slowly adjust R213 clockwise until voltage trip circuit actuates (R).

(8) Set voltage dials to 6.000000.

(9) Adjust R617 (fig. 3) fully counterclockwise then clockwise until LIMIT ON lamp comes on. Panel meter should indicate 60 milliamperes (R).

(10) Turn CURRENT LIMIT control to 0 (zero).

(11) Adjust R615 (fig. 3) for indication of 1 milliampere on panel meter (R).

12. Power Supply

a. Performance Check

NOTE

Do not perform power supply checks if all other parameters are within tolerance.

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WARNING

Dangerous potentials exist between chassis and ground.
Exercise extreme caution.

- (1) Connect voltmeter (A9) to -TEST POINT and +TEST POINT (fig. 3).
- (2) Position TI controls as listed in (a) through (g) below:
 - (a) METER switch to VOLTAGE.
 - (b) VOLTAGE RANGE switch to 1000.
 - (c) Voltage dials to 00X.0000.
 - (d) VOLTAGE TRIP switch to 1000.
 - (e) VERNIER control fully clockwise.
 - (f) CURRENT LIMIT control fully clockwise.
 - (g) POWER switch to OPR.
- (3) If voltmeter does indicate between 6.01999 and 6.02001 volts dc perform **b** below.
 - b. Adjustments.** Adjust R802 (fig. 3) for an indication of 6.02000 volts dc on voltmeter.

13. Final Procedure

- a.** Deenergize and disconnect all equipment.
- b.** In accordance with TM 38-750, annotate and affix DA label 80 (US Army Calibration System). When TI cannot be adjusted within tolerance, annotate and affix DA Form 2417 (Unserviceable or Limited Use) tag.

SECTION IV CALIBRATION PROCESS FOR MODELS 332B AND 332B/AF

14. Preliminary Instructions

- a.** The instructions outlined in this paragraph are preparatory to the calibration process. Personnel should become familiar with the applicable sections before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

WARNING

HIGH VOLTAGE is used during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions.

NOTE

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

NOTE

Unless otherwise specified, all controls and control settings refer to the TI.

c. When indications specified in paragraph 19 are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraph 19. Do not perform power supply check if all other parameters are within tolerance.

d. Position TI controls as listed in (1) through (5) below:

- (1) VOLTAGE RANGE switch to 10.
- (2) Voltage dials to 1.000000.
- (3) METER switch to VOLTAGE.
- (4) VOLTAGE TRIP control fully clockwise.
- (5) CURRENT LIMIT control fully clockwise.

e. Connect TI to autotransformer (A1) and leave connected throughout procedure.

NOTE

The sensitivity switch (B1) has been included in equipment setups for safety and to allow reversal of connections to null detector. Detailed operation of the switch is not included in step-by-step procedure.

f. Connect autotransformer to 115-volt source and adjust for 115-volt output.

g. Turn POWER switch to STDBY/RESET and allow at least 1 hour for warm-up.

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h. Connect operating voltage source (A5) to voltage regulator (A8), set its POWER switch to STDBY/ RESET, and allow to warm up until called for.

i. It is necessary to know actual value of $1.018 + \Delta E$ output of dc transfer standard (A2) to complete this calibration. If calibration of dc transfer standard is no more than 10 days old, the value recorded at time of calibration is sufficient. If calibration is more than 10 days old, determine the value by performing (1) through (11) below:

NOTE

When adjusting for a null indication on null detector (A4), always start on highest range of null detector and proceed down range to required sensitivity. When reading is complete, return null detector to high range.

- (1) Connect equipment as shown if figure 1.
- (2) Adjust dc transfer standard (A2) for $1.018 + \Delta E$ mean output and set ΔE dials to last three digits of standard cell (A6) certificate value.
- (3) Set voltage divider (A7) to one-tenth of value of dc transfer standard setting.
- (4) Adjust TI for a nominal 10-volt output and set its POWER switch to OPR.
- (5) Adjust TI voltage dials for a null indication on null detector (A4). Do not change TI voltage dials until instructed.
- (6) Set TI POWER switch to STDBY/RESET.
- (7) Replace dc transfer standard with standard cell in equipment setup.
- (8) Set TI POWER switch to OPR.
- (9) Adjust voltage divider for a null indication on null detector. Record voltage divider indication.
- (10) Set TI POWER switch to STDBY/RESET.
- (11) Compute the actual value of the dc transfer standard output as follows. If in step (9) above the voltage divider setting was increased, subtract the amount of change multiplied by 10 from the standard cell value. If the setting was decreased, add the amount of change multiplied by 10 to the standard cell value. Record the value for future use.

15. Regulation

a. Performance Check

- (1) Connect equipment as shown in figure 2.
- (2) Set decade resistor (A3) to 20 ohms.
- (3) Set voltage divider (A7) to .999999X.
- (4) Adjust dc transfer standard (A2) for a 1-volt mean output.
- (5) Adjust TI voltage dials for a nominal 1-volt output and turn POWER switch to OPR.
- (6) Adjust TI voltage dials for a null indication on null detector (A4) . Record voltage dial indication.
- (7) Adjust autotransformer (A1) output to 105 volts and wait 1 minute.
- (8) Adjust TI voltage dials for a null indication on null detector.
- (9) TI voltage dials will indicate within ± 25 microvolts of value recorded in (6) above.
- (10) Adjust autotransformer output to 125 volts and wait 1 minute.
- (11) Adjust TI voltage dials for a null indication on null detector.
- (12) TI voltage dials will indicate within ± 25 microvolts of value recorded in (6) above.
- (13) Adjust autotransformer output to 115 volts.
- (14) Remove decade resistor from equipment setup and wait 1 minute.
- (15) Adjust TI voltage dials for a null indication on null detector.
- (16) TI voltage dials will indicate within ± 25 microvolts of value recorded in (6) above.
- (17) Turn POWER switch to STDBY/RESET.

b. Adjustments. No adjustments can be made.

16. Zero Voltage

a. Performance Check

- (1) Set dc transfer standard (A2) for (supply number 1) ΔE output and set ΔE control to 000.
- (2) Position TI controls as listed in (a) through (c) below:
 - (a) VOLTAGE RANGE switch to 1000.
 - (b) Voltage dials to 0000000.
 - (c) POWER switch to OPR.
- (3) Adjust ΔE control of dc transfer standard for a null indication on null detector (A4).
- (4) If ΔE control of dc transfer standard does not indicate 0 ± 40 microvolts, perform **b(1)** below.

NOTE

If reading is negative, reverse leads at OUTPUT of dc transfer standard.

- (5) Set VOLTAGE RANGE switch to 100.
- (6) Repeat (3) above.
- (7) If ΔE control of dc transfer standard does not indicate 0 ± 20 microvolts, perform **b(2)** below.
- (8) Set VOLTAGE RANGE switch to 10.
- (9) Repeat (3) above.
- (10) If ΔE control of dc transfer standard does not indicate 0 ± 10 microvolts, perform **b(3)** below.
- (11) Set POWER switch to STDBY/RESET.

b. Adjustments

WARNING

Dangerous potential exists between chassis and ground.
Exercise extreme caution.

(1) Set ΔE control of dc transfer standard to 000 and adjust R6, 1000V ZERO OUTPUT ADJUST (fig. 5 or 6) for a null indication on null detector (R).

(2) Set ΔE control of dc transfer standard to 000 and adjust R4, 100V ZERO OUTPUT ADJUST (fig. 5 or 6) for a null indication on null detector (R).

(3) Set ΔE control of dc transfer standard to 000 and adjust R2, 10V ZERO OUTPUT ADJUST (fig. 5 or 6) for a null indication on null detector (R).

17. Linearity (Model 332B)

a. Performance Check

(1) Set voltage divider (A7) to .1000000.

(2) Set dc transfer standard (A2) for a 1-volt mean output.

(3) Position TI controls as listed in (a) through (c) below:

(a) VOLTAGE RANGE switch to 1000.

(b) Voltage dials to 00X.0000.

(c) POWER switch to OPR.

(4) Adjust voltage divider for a null indication on null detector (A4) (within ± 10 microvolts). Record null detector indication.

(5) Set TI voltage dials to 010.0000.

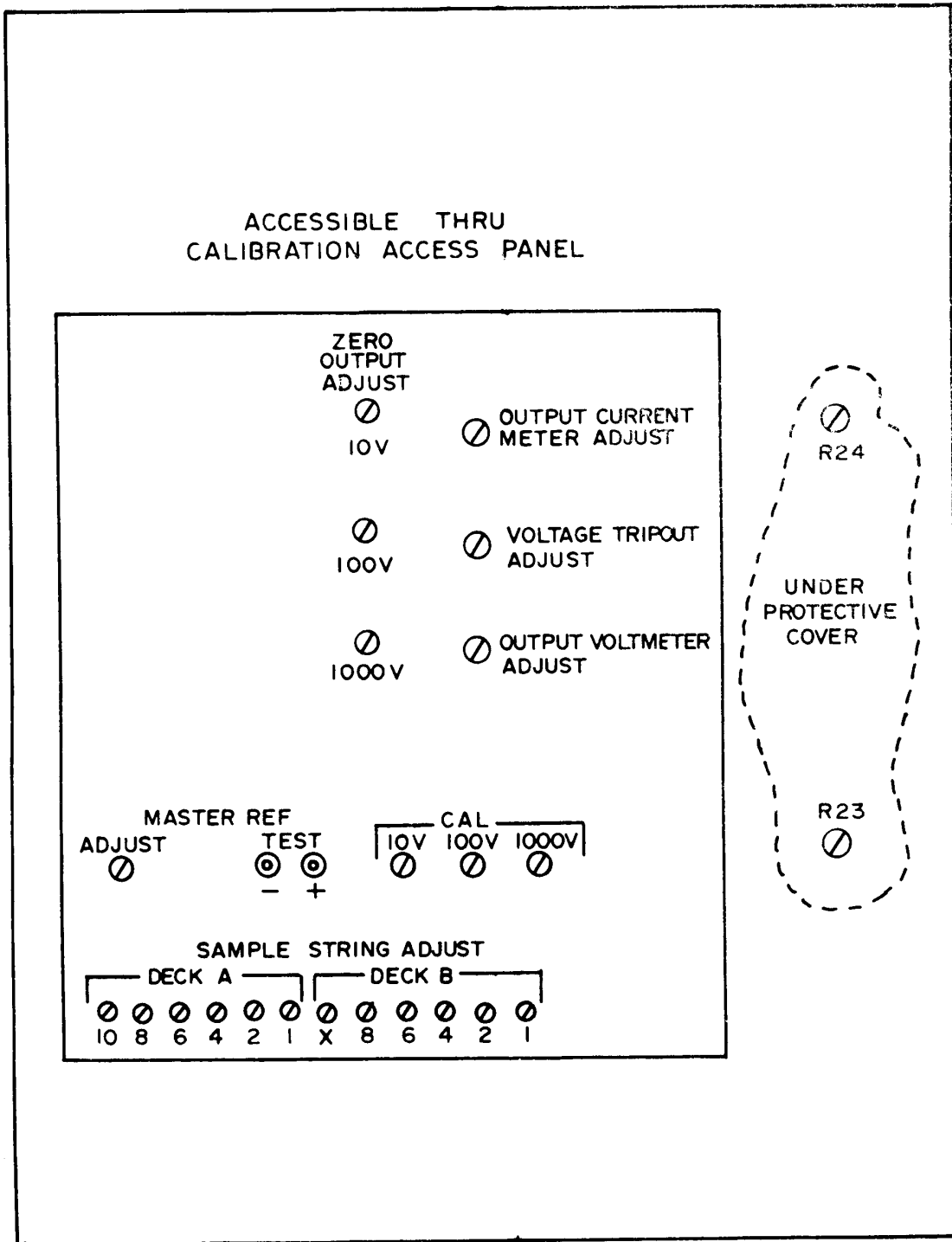
(6) If null detector indication is not within ± 1 microvolt of value recorded in (4) above, perform **b**(1) and (2) below.

(7) Repeat the technique of (1) through (6) above, using settings, indications, and adjustments listed in table 6.

(8) Set POWER switch to STDBY/RESET.

NOTE

Dangerous potentials exist between chassis and ground.
Exercise extreme caution.



FRONT

Figure 5. Model 332B, top view - adjustment location.

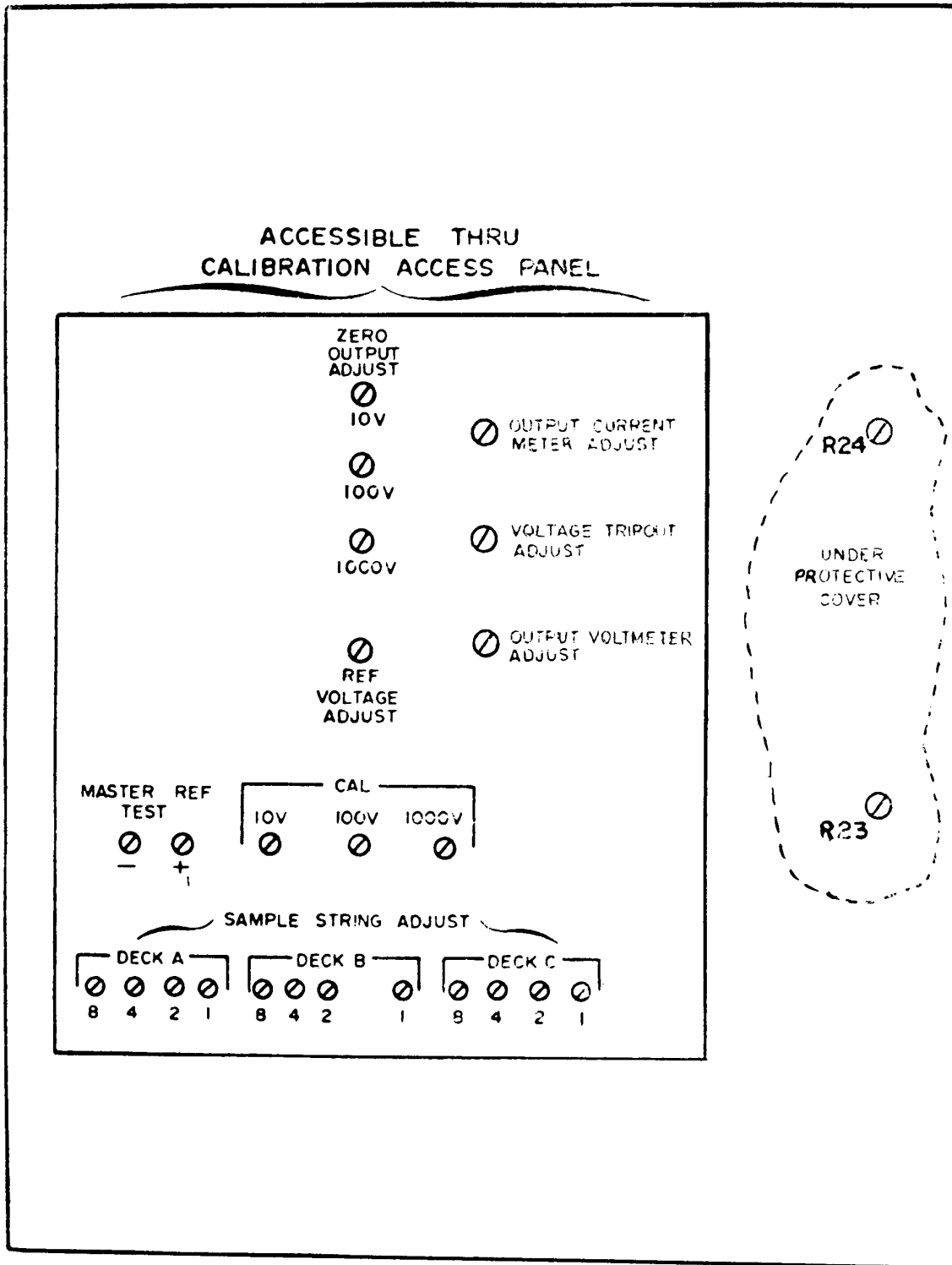


Figure 6. Model 332B/AF, top view - adjustment location.

Table 6. Linearity

VOLTAGE RANGE	Test Instrument Switch Settings. Voltage Dial		Voltage Divider Initial Setting	Dc Transfer Standard Output.	Maximum Difference Allowed (μ V) ¹	Adjustments (fig. 5) ²
	Step (3)(B)	Step (5)				
1000	01X.0000	020.0000	.5000000	10-volt mean	10	B2 (R)
1000	03X.0000	040.0000	.2500000	10-volt mean	10	B4 (R)
1000	05X.0000	060.0000	.1666666	10-volt mean	20	B6 (R)
1000	07X.0000	080.0000	.1250000	10-volt mean	20	B8 (R)
1000	09X.0000	0X0.0000	.1000000	10-volt mean	20	BX (R)
100	0X.00000	10.00000	.1000000	1-volt mean	1	A1 (R) ³
100	1X.00000	20.00000	.5000000	10-volt mean	10	A2 (R)
100	3X.00000	40.00000	.2500000	10-volt mean	10	A4 (R)
100	5X.00000	60.00000	.1666666	10-volt mean	20	A6 (R)
100	7X.00000	80.00000	.1250000	10-volt mean	20	A8 (R)
100	9X.00000	100.00000	.1000000	10-volt mean	20	A10 (R)

¹If difference exceeds this value, perform adjustment.

²Report adjustments only if difference is greater than 100 microvolts.

³Report this adjustment if difference is greater than 30 microvolts.

(1) Adjust DECK B adjustment 1 (fig. 5) for same indication on null detector (R). (Report only if difference is greater than 30 microvolts.)

(2) Repeat *a* above until no further adjustments required.

18. Linearity (Model 332B/AF)

a. Performance Check

- (1) Set voltage divider (A7) to .999999X.
- (2) Set dc transfer standard (A2) for a 1-volt mean output.
- (3) Position TI controls as listed in **(a)** through **(c)** below:
 - (a) VOLTAGE RANGE switch to 1000.
 - (b) Voltage dials to 000.X000.
 - (c) POWER switch to OPR.

NOTE

If null indication cannot be obtained at a 000.X000 dial setting, adjust R1, CAL 1000V (fig. 6) to obtain a null indication.

(4) Adjust voltage divider for a null indication on null detector (A4) (within \pm 10 microvolts). Record null detector indication.

(5) Set voltage dials to 001.0000.

(6) If null detector indication is not within ± 10 microvolts of value recorded in (4) above, perform **b**(1) and (2) below.

(7) Repeat the technique of (1) through (6) above using settings, indications, and adjustments listed in table 7.

Table 7. Linearity

VOLTAGE RANGE	Test Instrument Switch Setting Voltage Dials		Voltage Divider Initial Settings.	Dc Transfer Standard Output.	Maximum Difference Allowed ¹ (μ V).	Adjustments (Fig. 6) ²
	Step (3)(B)	Step (5)				
1000	001X.000	002.0000	.5000000	1-volt mean	1	C2 (R)
1000	003.X000	004.0000	.2500000	1-volt mean	1	C4 (R)
1000	007.X000	008.0000	.1250000	1-volt mean	1	C8 (R)
1000	00X.0000	010.0000	.1000000	1-volt mean	1	B1 (R)
100	01.X0000	02.00000	.5000000	1-volt mean	1	B2 (R)
100	03.X0000	04.00000	.2500000	1-volt mean	1	B4 (R)
100	07.X0000	08.00000	.1250000	1-volt mean	1	B8 (R)
100	0X.00000	10.00000	.1000000	1-volt mean	1	A1 (R)
10	1.X00000	2.000000	.5000000	1-volt mean	1	A2 (R)
10	3.X00000	4.000000	.2500000	1-volt mean	1	A4 (R)
10	7.X00000	8.000000	.1250000	1-volt mean	1	A8 (R)

¹If difference exceeds this value, perform adjustment.

²Report adjustments only if difference is greater than 30 microvolts.

(8) Set POWER switch to STDBY/RESET.

b. Adjustments

WARNING

Potential exist between chassis and ground. Exercise extreme caution.

(1) Adjust DECK C adjustment 1 (fig. 6) for same indication on null detector (R). (Report only if (difference is greater than 100 microvolts.)

(2) Report **a** above until no further adjustments are required.

19. Output Accuracy and Tracking

a. Performance Check

(1) Set voltage divider (A7) to one-tenth of actual value of dc transfer standard (A2) output determined in paragraph **14i** above.

(2) Set dc transfer standard for $1.018 + \Delta E$, mean output and set ΔE dials to last three digits of standard cell value.

(3) Position TI controls as listed in (a) through (c) below:

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- (a) VOLTAGE RANGE switch to 10.
- (b) Voltage dials to 10.000000.
- (c) POWER switch to OPR.
- (4) Adjust TI voltage dials for a null indication on null detector (A4).
- (5) If TI voltage dials do not indicate between 9.999690 and 10.000310, perform **b(1)** and (2) below.
- (6) If TI voltage dials are within tolerance but not exactly 10.000000, perform **b(3)** below.
- (7) Set dc transfer standard for a 10-volt mean output.
- (8) Set voltage divider to .999999X.
- (9) Adjust TI voltage dials for a null indication on null detector.
- (10) Record TI dial indication for future use. This is the actual value of 10-volt output of dc transfer standard.
- (11) Set dc transfer standard for $1.018 + \Delta E$, mean output and set ΔE dial to 000.
- (12) Set TI voltage dials to 8.888888.
- (13) Adjust voltage divider for a null indication on null detector.
- (14) Voltage divider will indicate between .1145215 and .1145286.
- (15) Repeat technique of (12) through (14) above, using settings and indications listed in table 8. Set TI POWER switch to STDBY/RESET.

Table 8. Voltage Dial Tracking

Test Instrument Voltage Dial Settings	Voltage Divider Initial Settings.	Voltage Divider Indications.	
		Min	Max
4.444444	.2290500	.2290427	.2290574
2.222222	.4581005	.4580842	.4581159
1.111111	.9162001	.9161644	.9162358

- (16) Set voltage divider to one-hundredth of value recorded in (10) above.
- (17) Set dc transfer standard for a 10-volt mean output.
- (18) Position TI controls as listed in (a) through (c) below:

- (a) VOLTAGE RANGE switch to 100.
 - (b) Voltage dials to 100.00000.
 - (c) POWER switch to OPR.
- (19) Adjust TI voltage dials for a null indication on null detector.
- (20) If TI voltage dials do not indicate between 99.99698 and 100.00302, perform **b(4)** and (5) below.
- (21) If TI voltage dials are within tolerance but not exactly 100.00000, perform **b(6)** below.
- (22) Set POWER switch to STDBY/RESET.
- (23) Connect equipment as shown in figure 4.
- (24) Set voltage divider to .1000000.
- (25) Set operating voltage source (A5) VOLTAGE RANGE switch to 1000 and voltage dials to 1000.0000.
- (26) Set TI and operating voltage source POWER switches to OPR.
- (27) Adjust operating voltage source voltage dials for a null indication on null detector.
- (28) Set TI and operating voltage source POWER switches to STDBY/RESET.
- (29) Set voltage divider to .999999X
- (30) Set TI VOLTAGE RANGE switch to 1000 and voltage dials to 1000.0000.
- (31) Set TI and operating voltage source POWER switches to OPR.
- (32) Adjust TI voltage dials for a null indication on null detector.
- (33) If TI voltage dials do not indicate between 999.9699 and 1000.0300, perform **b(7)** and (8) below.
- (34) Set TI and operating voltage source POWER switches to STDBY/RESET.

b. Adjustments

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WARNING

Dangerous potentials exist between chassis and ground.
Exercise extreme caution.

NOTE

Due to interaction of range adjustments, adjustment of one range will require checking and, if necessary, readjustment of other ranges.

- (1) Set TI voltage dials to 10.000000.
- (2) Adjust R9, CAL 10V (fig. 5 or 6) for a null indication on null detector (R).
- (3) Perform (1) and (2) above but do not report adjustment.
- (4) Set TI voltage dials to 100.00000.
- (5) Adjust R5, CAL 100V (fig. 5 or 6) for a null indication on null detector (R).
- (6) Perform (4) and (5) above but do not report adjustment.
- (7) Set TI voltage dials to 1000.0000.
- (8) Adjust R1, CAL 1000V (fig. 5 or 6) for a null indication on null detector (R).

20. Panel Meter (Voltage)

a. Performance Check

- (1) Disconnect TI from equipment setup.
- (2) Set VOLTAGE RANGE switch to POWER switch to OPR.
- (3) Adjust voltage dials for indication of 1.0 on 0-to-1.0 scale of panel meter.
- (4) If voltage dials do not indicate between 9.700000 and 10.300000, perform **b** below.
- (5) Set POWER switch to STDBY/RESET.

b. Adjustments

WARNING

Dangerous potentials exist between chassis and ground.
Exercise extreme caution.

- (1) Set voltage dials to 10.000000.

(2) Adjust OUTPUT VOLTMETER adjust (fig. 5 or 6) for indication of 1.0 on 0-to-1.0 scale of panel meter (R).

21. Voltage Trip

a. Performance Check

(1) Position TI controls as listed in (a) through (d) below:

- (a) Voltage dials to 10.X00000.
- (b) VOLTAGE TRIP to 10.
- (c) VERNIER fully clockwise.
- (d) POWER switch to OPR.

(2) Turn VERNIER control counterclockwise until trip circuit actuates. If VERNIER control is not approximately 30 degrees from fully clockwise, perform **b** below.

(3) Repeat technique of (1) and (2) above, using settings listed in table 9.

Table 9. Voltage Trip

Test Instrument Switch Settings		
VOLTAGE TRIP	VOLTAGE RANGE	Voltage Dials
100	100	<u>10</u> X.X0000
10000	1000	<u>10</u> XX.X000

(4) Position TI controls as listed in **(a)** through **(d)** below:

- (a) VOLTAGE RANGE switch to 10.
- (b) Voltage dials to 4.000000.
- (c) VOLTAGE TRIP switch to 10.
- (d) VERNIER control to 12 o'clock.

(5) Turn VOLTAGE RANGE switch to 100. Voltage trip circuit will actuate.

(6) Turn VOLTAGE TRIP switch to 100 and reset TI.

(7) Turn VOLTAGE RANGE switch to 1000. Voltage trip circuit will actuate.

(8) Turn VOLTAGE TRIP switch to 1000 and VERNIER control fully clockwise. Reset TI.

(9) Turn VOLTAGE RANGE switch to 100. Voltage trip circuit will not actuate.

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- (10) Turn VOLTAGE RANGE switch to 10. Voltage trip circuit will not actuate.
- (11) Set POWER switch to STDBY/RESET.

b. Adjustments

- (1) Position TI controls as listed in (a) through (d) below:
 - (a) VOLTAGE RANGE switch to 1000.
 - (b) Voltage dials to 125.0000.
 - (c) VOLTAGE TRIP switch to 100.
 - (d) VERNIER control fully clockwise.
- (2) Turn VOLTAGE TRIPOUT ADJUST (fig. 5 or 6) fully counterclockwise.
- (3) Set POWER switch to OPR.
- (4) Adjust VOLTAGE TRIPOUT ADJUST clockwise until voltage trip circuit actuates (R).
- (5) Repeat **a**(1) and (2) above.

22. Panel Meter (Current) and Current Limit

a. Performance Check

- (1) Adjust decade resistor (A3) for 100 ohms and connect to OUTPUT terminals.
- (2) Position TI controls as listed in (a) through (f) below:
 - (a) METER switch to CURRENT.
 - (b) VOLTAGE RANGE switch to 10.
 - (c) VOLTAGE TRIP switch to 1000.
 - (d) VERNIER control fully clockwise.
 - (e) Voltage dials to 0000000.
 - (f) POWER switch to OPR.
- (3) Adjust voltage dials for indication of 55 milliamperes on panel meter. If voltage dials do not indicate between 5.335000 and 5.665000, perform **b**(1) and (2) below.

(4) Adjust voltage dials to 6.000000. If CURRENT LIMIT lamp is not on, perform **b(3)** below.

(5) Adjust CURRENT LIMIT control fully counterclockwise. If panel meter does not indicate .5 milliamperes and CURRENT LIMIT lamp is not on, perform **b(4)** below.

(6) Set POWER switch to STDBY/RESET.

b. Adjustments

(1) Set voltage dials to 5.500000.

(2) Adjust R2, OUTPUT CURRENT METER ADJUST (fig. 5 or 6) for indication of 55 milliamperes on panel meter (R).

(3) Adjust R23 (fig. 5 or 6) until CURRENT LIMIT lamp comes on, then back off until lamp just goes out (R).

(4) Adjust R24 (fig. 5 or 6) for indication of .5 milliamperes on panel meter (R).

23. Power Supply (Model 332B)

a. Performance Check

NOTE

Do not perform power supply checks if all other parameters are within tolerance.

WARNING

Dangerous potentials exist between chassis and ground. Exercise extreme caution.

(1) Connect voltmeter (A9) to MASTER REF TEST points (fig. 5)

(2) Position TI controls as listed in (a) through (g) below:

(a) METER switch to VOLTAGE.

(b) VOLTAGE RANGE switch to 1000.

(c) Voltage dials to 00X.0000.

(d) VOLTAGE TRIP switch to 1000.

(e) VERNIER control fully clockwise.

(f) CURRENT LIMIT control fully clockwise.

(g) POWER switch to OPR.

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(3) If voltmeter does not indicate between 6.01999 and 6.02001 volts dc, perform **b** below.

b. Adjustments. Adjust R9, MASTER REF ADJUST (fig. 5) for an indication of 6.02000 volts dc on voltmeter (R)

24. Power Supply (Model 332B/AF)

a. Performance Check

NOTE

Do not perform power supply check if all other parameters are within tolerance.

(1) Connect equipment as shown in figure 1, except connect TI from MASTER REF TEST points (fig. 6), observing polarity.

(2) Set voltage divider (A7) to .0666667.

(3) Set dc transfer standard (A2) for 1 V mean output.

(4) Position TI controls as listed in (a) through (g) below:

(a) METER switch to VOLTAGE.

(b) VOLTAGE RANGE switch to 1000.

(c) Voltage dials to 00X.0000.

(d) VOLTAGE TRIP switch to 1000.

(e) VERNIER control fully clockwise.

(f) CURRENT LIMIT control fully clockwise.

(g) POWER switch to OPR.

(5) If null detector (A4) does not indicate null, perform **b** below.

b. Adjustments. Adjust R9 REF VOLTAGE ADJUST (fig. 6) for a null indication on null detector (R).

25. Final Procedure

a. Deenergize and disconnect all equipment.

b. In accordance with TM 38-750, annotate and affix DA Label 80 (US Army Calibration System). When TI cannot be adjusted within tolerance, annotate and affix DA Form 2417 Unserviceable or Limited Use) tag.

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By Order of the Secretary of the Army:

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