TB 9-6625-088-35

CHANGE 2

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE TEKTRONIX, TYPES 321 AND 321A

Headquarters, Department of the Army, Washington, DC
8 March 1991

TB 9-6625-088-35, 24 October 1988, 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	***Insert pages***
3 and 4	3 and 4

2. File this change sheet in front of the publication for reference purposes. **This change incorporates DA Form(s) 2028 dated 9 March 1990**.

By Order of the Secretary of the Army:

CARL E. VUONO
General, United States Army
Chief of Staff

OFFICIAL:

THOMAS F. SIKORA
Brigadier General, United States Army
The Adjutant General

Distribution:
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TB 9-6625-088-35

CHANGE 1

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CALIBRATION PROCEDURE FOR OSCILLOSCOPE TEKTRONIX, TYPES 321 AND 321A

Headquarters, Department of the Army, Washington, DC
3 January 1989

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By Order of the Secretary of the Army:

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General, United States Army
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Brigadier General, United States Army
The Adjutant General

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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE TEKTRONIX, TYPE 321 AND 321A

Headquarters, Department of the Army, Washington, DC
24 October 1988

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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 Missile Command, ATTN: AMSAM-TMD-EP, Redstone Arsenal, AL 35898-5000. FAX to DSN 788-2313 (Commercial: 256-842-2313). A reply will be furnished directly to you.

*This bulletin supersedes TB 9-6625-088-50, 10 November 1973.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Oscilloscope, Tektronix Types 321 and 321A. The manufacturer's 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. References and specifications enclosed in parenthesis throughout the bulletin pertain to Type 321A.

b. **Time and Technique**. The time required for this calibration is approximately 2 hours, using the dc and low frequency technique.

2. Forms, Records, and Reports

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

b. Adjustments to be reported are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) follows 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 parameter	Performance specifications
Power input requirements	11.5 to 35 V dc; or 105 to 125 V; or 210 to 250 V rms, 50 to 800 Hz single phase ac
Calibrator output	Range: 500 mV p-p Accuracy: ±3%
Vertical Gain Bandpass	Range: .01 to 20 V/div in 11 calibrated steps Accuracy: ±3% Dc to 5 MHz (dc to 6 MHz)
Horizontal timing	Range: 0.5 μs to 0.5 s/div in 19 steps X5 magnifier extends range to 0.1 μs/div Accuracy: ±3%
Trigger	Range: Internal 1 div (0.2 division) at 1 kHz

SECTION II
EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Transfer Calibration Standards Set AN/GSM-286. 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. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI.

5. Accessories Required. The accessories required for this calibration are common usage accessories issued as indicated in paragraph **4** above, and are not listed in this calibration procedure.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
AUTOTRANSFORMER	Range: 105 to 125 V ac Accuracy: ±1%	General Radio, Model W10MT3AS3 or Ridge, Model 9020F (7910809)
OSCILLOSCOPE CALIBRATOR	Volts out: Range: 40 mV to 80 V Accuracy: ±.75% Pulses: Range: 10 µs and 1 ms at 4 V Accuracy: ±4% Timing: Range: .5 µs to .5 s Accuracy: ±.75% DVM: Range: 9.9 to 10.1 V Accuracy: ±.25%	Ballantine, Model 6126M (MIS-28714 Type 1)

SECTION III
CALIBRATION PROCESS

6. Preliminary Instructions

a. The instructions outlined in paragraph **6** and **7** are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name as listed in table 2.

c. Unless otherwise specified, verify the result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturer's manual for these TIs.

d. When indications specified in paragraphs **7** through **14** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **7** through **14**. Do not perform power supply check if all other parameters are within tolerance.

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

7. Equipment Setup

WARNING

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

a. Remove protective cover from TI only for access to adjustments.

b. Connect TI to autotransformer.

c. Connect autotransformer to 115 V ac source and adjust for 115 V ac.

d. Position controls as listed in (1) through (11) below:

(1) **INTENSITY** control fully ccw.

(2) **TRIGGERING LEVEL** control to **FREE RUN**.

(3) **TRIGGERING SLOPE** switch to **+** (positive).

(4) **TRIGGERING AC DC** switch to **AC**.

(5) **TRIGGERING INT EXT** switch to **INT**.

(6) **TIME/DIV** switch to **1 MILLISEC**.

(7) **VARIABLE TIME/DIV** control to **CALIB**.

(8) **VOLTS/DIV** switch to **.1** and **VARIABLE** to **CALIB**.

(9) **VERTICAL AMPLIFIER AC DC (AC DC GND)** switch to **AC**.

(10) **5X MAG** switch to "in" position.

(11) **VERTICAL POSITION** and **HORIZONTAL POSITION** controls to midrange.

e. Energize TI and allow sufficient time for warmup and stabilization.

f. Adjust **INTENSITY**, **FOCUS**, and **ASTIGMATISM** controls for a well-defined trace.

8. Calibrator Output

a. Performance Check

(1) Connect **CAL OUT 500 MV** jack to **INPUT**.

(2) Adjust **VOLTS/DIV** for 4 divisions of vertical deflection.

(3) Disconnect cable from **CAL OUT 500 MV** jack and connect to oscilloscope calibrator **VOLTS OUT** jack.

(4) Set oscilloscope calibrator for 1 kHz output and .5 V amplitude.

(5) Adjust oscilloscope calibrator for 4 divisions of vertical deflection on TI at 1 kHz. If **DEVIATION** indication is not within ±3%, perform **b** below.

b. Adjustments

(1) Set oscilloscope calibrator to **.5 V** output and adjust TI controls for 5 divisions of vertical deflection.

(2) Disconnect cable from oscilloscope calibrator and connect to **CAL OUT 500 MV** jack on TI. Adjust CAL ADJ R884 (fig. 1), (CAL AMPL R884, fig. 2) for 5 divisions of vertical deflection on TI (R).

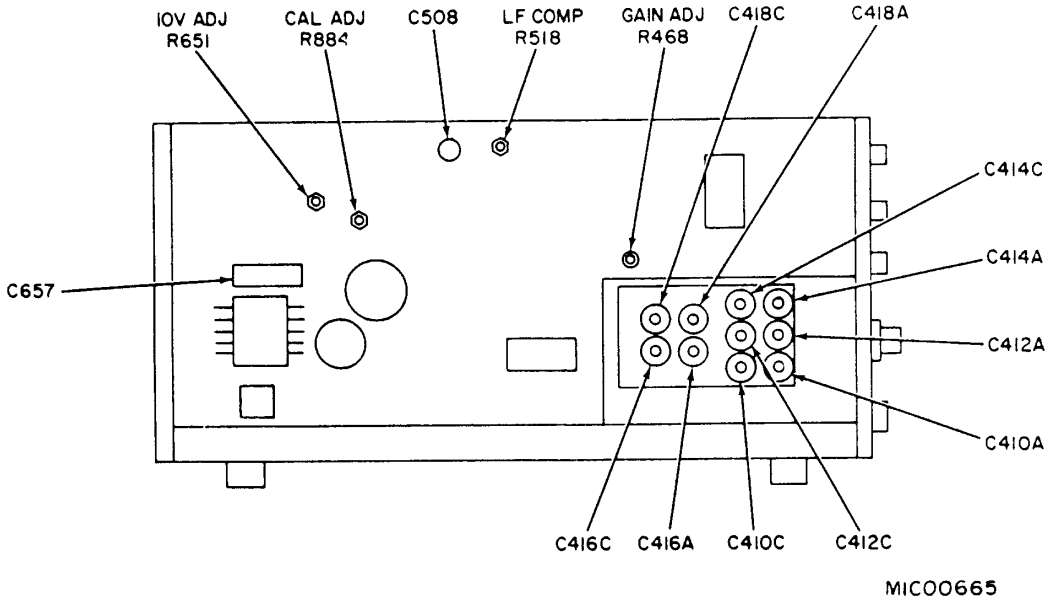

Figure 1. Oscilloscope – left interior view (Type 321).

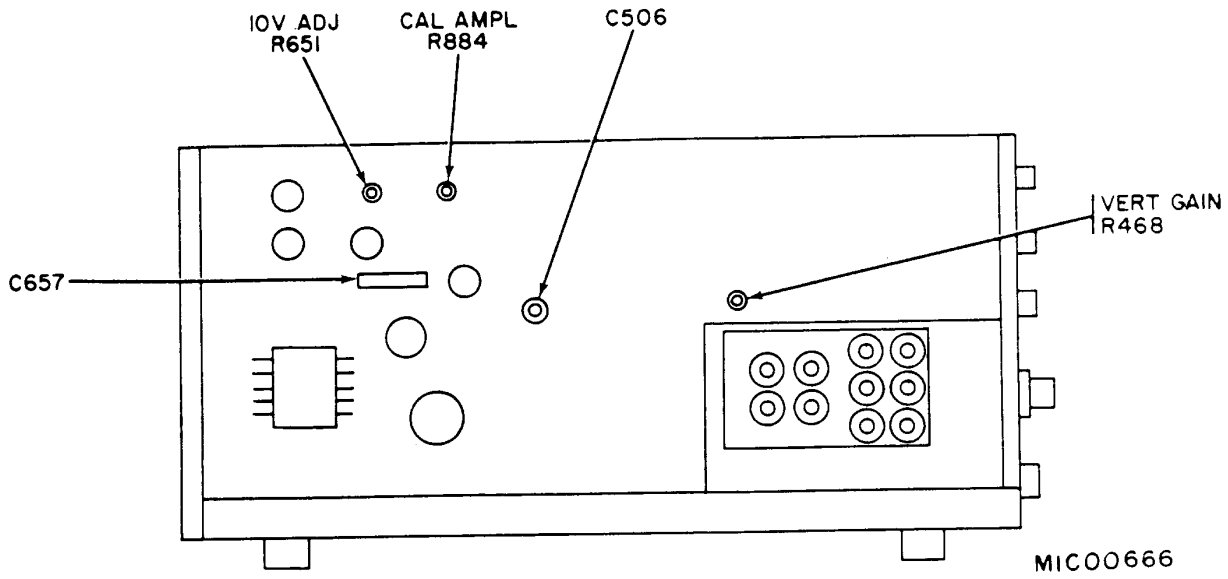

Figure 2. Oscilloscope – left interior view (Type 321A).

9. Vertical Amplifier Gain, Volts/Division, and Stability

a. Performance Check

(1) Connect **VOLTS OUT** of oscilloscope calibrator to TI **INPUT**.

(2) Set **VOLTS/DIV** switch to **.01** and **AC DC (AC DC GND)** switch to **DC**.

(3) Set **VARIABLE VOLTS/DIV** to **CALIB** (detent).

(4) Adjust oscilloscope calibrator controls for a 4-division display. If oscilloscope calibrator **DEVIATION** indication is not within ±3%, perform **b** below.

(5) While maintaining a 4-division display, vary autotransformer from 105 to 125 and then back to 115 V. Oscilloscope calibrator **DEVIATION** indication will remain within ±3%.

(6) Repeat the technique of (2) through (4) above for settings listed in table 3. Oscilloscope calibrator **DEVIATION** indication will remain within ±3%.

Table 3. Volts/Division Check

Test instrument **VOLTS/DIV** switch settings	Oscilloscope calibrator output
.02	.08
.05	.2
.1	.4
.2	.8
.5	2
1	4
2	8
5	20
10	40
20	80

b. Adjustments

(1) Set oscilloscope calibrator for **VOLTS OUT** of .04 V.

(2) Adjust GAIN ADJ R468 (fig. 1) (VERT GAIN R468, fig. 2) for 4 divisions on TI.

10. High Frequency Compensation

a. Performance Check

(1) Connect oscilloscope calibrator **+FAST RISE** output to **INPUT**, using 20 dB attenuator and 50Ω termination.

(2) Set oscilloscope calibrator **TRIGGER PULSE PERIOD** switch to **10 μS**, and adjust **FAST RISE VARIABLE** to minimum.

(3) Set **VOLTS/DIV** switch to **.01** and **TIME/DIV** switch to **2 μSEC**.

(4) Adjust **FAST RISE VARIABLE** control for a 4-division display on TI. Adjust **LEVEL** control for a triggered display. If display does not display square corners and flat tops, perform **b** below.

b. Adjustments. Adjust C508 (fig. 1) (C506, fig. 2) for optimum square waves on TI.

11. VOLTS/DIV Attenuator Frequency Compensation

a. Performance Check

(1) Connect oscilloscope calibrator **+FAST RISE OUTPUT** to TI **INPUT**, using 50Ω termination and standardizer.

(2) Set **TIME/DIV** switch to **.2 MILLISEC**.

(3) Set oscilloscope calibrator **TRIGGER PULSE PERIOD** switch to **1 mS** and **FAST RISE VARIABLE** for a 4-division display.

(4) Adjust controls as listed in (a) through (c) below for a stable display:

(a) **HORIZONTAL POSITION**.

(b) **VERTICAL POSITION**.

(c) **TRIGGERING LEVEL.**

(5) If TI does not display optimum square wave with square corners and flat tops, adjust standardizer for best square wave display.

(6) Set **VOLTS/DIV** switch to **.02** and repeat (3) and (4) above. If TI does not display square corners and flat tops, perform **b** below.

(7) Repeat technique of (6) above using settings listed in table 4. If TI does not display optimum square waves for each **VOLTS/DIV** switch setting, perform adjustments listed in table 4.

b. Adjustments. Adjust C418A (fig. 1) for best flat tops and C418C (fig. 1) for best square corners (R).

Table 4. Volts/Div Attenuator Check

Test instrument VOLTS/DIV switch settings	Adjustments[1] (fig. 1)	
	Flat top	Square corner
.05	C416A	C416C
.1[2]	C414A	C414C
1	C412A	C421C
10[3]	C410A	C410C

[1]Adjustment locations on Types 321 and 321A are identical.
[2]Move cable to **HIGH AMPL OUTPUT**.
[3]Adjust oscilloscope calibrator **HI AMPL VARIABLE** for maximum and remove 50Ω termination.

12. Low Frequency Compensation

a. Performance Check

(1) Set **TRIGGERING LEVEL** control to **FREE RUN**.

(2) Set **VOLTS/DIV** switch to **.5** and adjust **VERTICAL POSITION** control to position trace to second horizontal graticule line from bottom.

(3) Connect oscilloscope calibrator **VOLTS OUT** to **INPUT**.

(4) Adjust oscilloscope calibrator for dc output to position trace at top graticule line.

(5) While observing display, alternately connect and disconnect oscilloscope calibrator. If TI displays a vertical drift as trace comes to rest in each position, perform **b** below.

b. Adjustments. Repeat **a**(5) above and adjust LF COMP R518 (fig. 1) until no vertical drift of trace is observed in either position (R).

NOTE
No adjustment can be made on Type 321A.

13. Sweep Timing

a. Performance Check

(1) Connect oscilloscope calibrator **MARKER OUT** to **INPUT**, using 50Ω termination.

(2) Set **TIME/DIV** switch to **1 MILLISEC**.

(3) Set oscilloscope calibrator **TIME/DIV** switch to **.5 mS** and adjust **TRIGGERING LEVEL** control to obtain a stable display.

(4) Adjust **HORIZONTAL POSITION** control to position 3d marker with 2nd vertical graticule line.

(5) With the oscilloscope calibrator, position the 19th marker to the 10th vertical graticule line. If the oscilloscope calibrator **DEVIATION** indication is not within ±3%, perform **b**(1) below.

(6) Adjust **HORIZONAL POSITION** control to position 19th marker to 8th vertical graticule line. If sweep does not end at 22d marker, perform **b**(2) below.

(7) Set **TIME/DIV** and oscilloscope calibrator **TIME/DIV** switches to settings listed in table 5. At each setting, adjust **HORIZONTAL POSITION** control to position 2d marker behind 2d vertical graticule line and oscilloscope calibrator for 1 marker per division. If oscilloscope calibrator **DEVIATION** indication is not within ±3%, perform appropriate adjustment listed in table 5.

Table 5. Sweep Timing Check

Test instrument **TIME/DIV** switch settings		Oscilloscope calibrator **TIME/DIV** switch settings	
.5	MILLISEC	.1	mS[1]
.5	µSEC	.5	µS[2 3]
1	µSEC	1	µS
2	µSEC	2	µS
5	µSEC	5	µS
10	µSEC	10	µS
20	µSEC	20	µS
50	µSEC	50	µS
.1	MILLISEC	.1	mS
.2	MILLISEC	.2	mS
.5	MILLISEC	.5	mS
1	MILLISEC	1	mS
2	MILLISEC	2	mS
5	MILLISEC	5	mS

See footnotes at end of table.

Table 5. Sweep Timing Check - Continued

Test instrument **TIME/DIV** switch settings		Oscilloscope calibrator **TIME/DIV** switch settings	
10	MILLISEC	10	mS
20	MILLISEC	20	mS
50	MILLISEC	50	mS
.1	SEC	.1	S
.2	SEC	.2	S
.5	SEC	.5	S

[1]Pull out **5X MAG** switch and, if necessary, adjust MAG GAIN R348 (fig. 3 or 4).
[2]Adjust C160L (fig. 3 or 4).
[3]**5X MAG** switch pushed in.

b. Adjustment

(1) Adjust HORIZ GAIN ADJ R338 (fig. 3) (HORIZ GAIN R338, fig. 4) for two markers per division (R).

(2) Adjust SWP LENGTH R176 (fig. 3) (SWEEP LENGTH R176, fig. 4) for sweep to end at 22d marker (R).

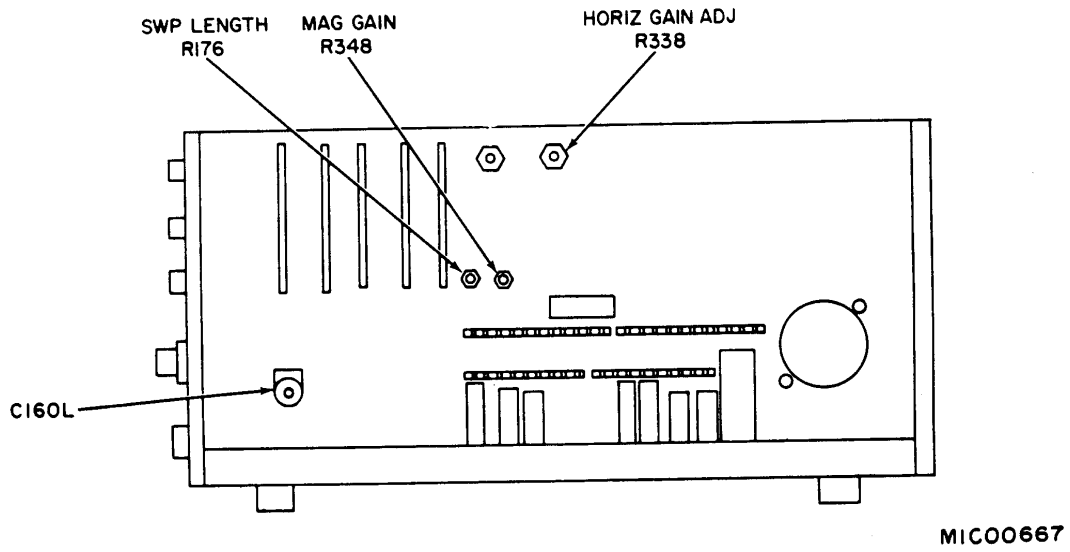

Figure 3. Oscilloscope – right interior view (Type 321).

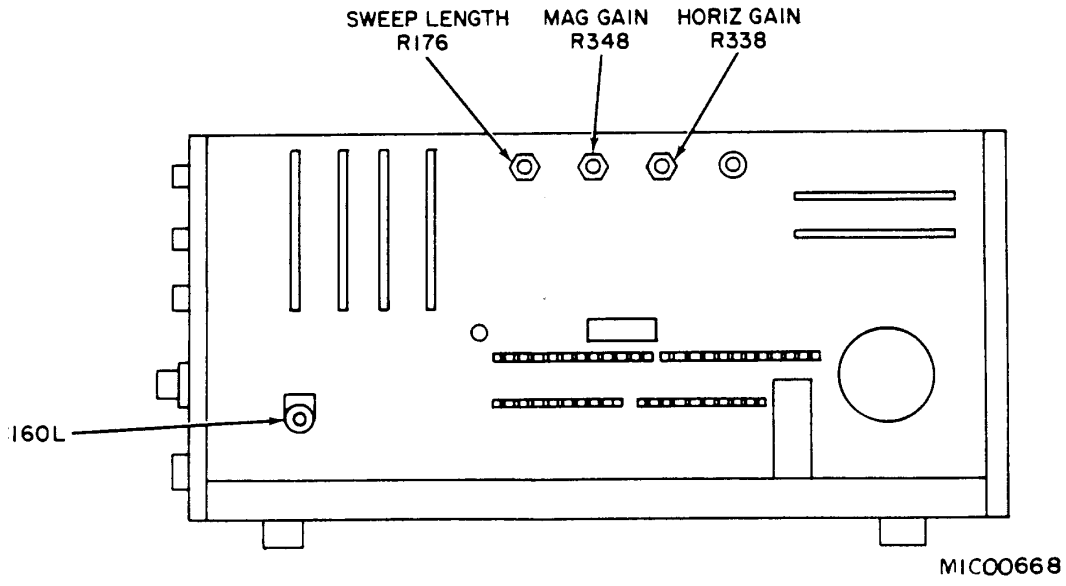

Figure 4. Oscilloscope – right interior view (Type 321A)

14. Trigger Sensitivity

a. Performance Check

(1) Position controls as listed in (a) through (e) below.

(a) **TRIGGERING LEVEL** fully ccw.

(b) **5X MAG** switch pushed in.

(c) **TIME/DIV** switch to **.5 MILLISEC**.

(d) **VERTICAL AMPLIFIER AC DC (AC DC GND)** switch to **AC**.

(e) **VOLTS/DIV** switch to **.01**.

(2) Connect oscilloscope calibrator **VOLTS OUT** to **INPUT**.

(3) Adjust oscilloscope calibrator for 10 mV output at 1 kHz.

(4) Adjust **VARIABLE VOLTS/DIV** control for 1 major (minor) division.

(5) Adjust **TRIGGERING LEVEL** control ccw until a stable display is obtained. Observe that triggering occurs on positive slope of square wave. If stable triggering cannot be obtained, perform **b**. below.

b. Adjustments

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

(a) Set **TIME/DIV** switch to **.1 MILLISEC**.

(b) Set **TRIGGERING LEVEL** to **AUTO**.

(c) Adjust **STABILITY** control fully ccw.

(2) Adjust **STABILITY** control cw until trace just appears. Record **STABILITY** control setting.

(3) Adjust **STABILITY** control further cw until trace just brightens. Record control setting.

(4) Adjust **STABILITY** control halfway between settings recorded in (2) and (3) above.

(5) Repeat **a**(1) through (5) above.

15. Power Supply

NOTE

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

a. Performance Check

(1) Connect digital voltmeter across C657 (fig. 1 or 2).

(2) If digital voltmeter does not indicate within 9.9 and 10.2 V, perform **b** below.

b. Adjustments. Adjust 10 V ADJ R651 (fig. 1 or 2) for +10.00 V indication on digital voltmeter (R).

16. Final Procedure

a. Deenergize and disconnect all equipment.

b. Annotate and affix DA label/form in accordance with TB 750-25.

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