*TB 9-4931-501-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE TEKTRONIX, TYPES 5403D40, 5440, AND R5440

Headquarters, Department of the Army, Washington, DC
13 May 2008

REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

You can improve this manual. If you find any mistakes or if you know of a way to improve these procedures, please let us know. Mail your letter or DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to: Commander, U.S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5000. A reply will be furnished to you. You may also send in your comments electronically to our E-mail address: 2028@redstone.army.mil or by fax 256-842-6546/DSN 788-6546. For the World Wide Web use: https://amcom2028.redstone.army.mil. Instructions for sending an electronic 2028 can be found at the back of this manual.

*This bulletin supersedes TB 9-4931-501-35, 1 October 1979, including all changes.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Oscilloscope, Tektronix Types 5403D40, 5440, and R5440. The manufacturers' manuals were used as the prime data source in compiling these instructions. The above equipment will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. None.

b. Time and Technique. The time required for this calibration is approximately 4 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 parameters	Performance specifications
Vertical amplifier:	
Bandwidth	Dc to 90 MHz (w/067-0680-00) Dc to 60 MHz (w/calibrated 5A48)
Risetime	3.9 ns or less (w/067-00680-00) [1] 5.8 ns or less (w/calibrated 5A48)
Aberrations	6% or less (w/067-0680-00) 3% or less (w/calibrated 5A48)
Vertical centering	Within ±0.5 division of graticule center
Horizontal amplifier:	
Bandwidth	Dc to 2 MHz

See footnote at end of table.

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications
Power input	100, 110, 120, 200, 220, and 240 Vrms ±10% at to 400 Hz
Calibrator:	
Voltage	400 mV ±1%
Current	4 mA ±1%
Frequency	Twice the power line frequency

[1]Time base plug-in limited to 4 ns.

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; AN/GSM-287; or AN/GSM-705. Alternate items may be used by the calibrating activity. 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. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

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 rms Accuracy: ±1%	Ridge, Model 9020A (9020A)
CALIBRATION FIXTURE	Range: 1 kHz to 1 MHz at 4 ns or less Accuracy: ±1%	Tektronix, Type 067-0680-00
MULTIMETER W/HIGH VOLTAGE PROBE	Range: -3060 to +240 V dc Accuracy: ±0.1%	Hewlett Packard, Model 3458A (3458A)
OSCILLOSCOPE CALIBRATOR	Range: 5 and 10 ns Accuracy: ±1%	Fluke, Model 5820A-5C-GHZ (5820A-5C-GHZ)
TIME BASE	Range: 10 ns/div and must be compatible with TI	Tektronix, Type 5B42 (MIS-28706-4)
VERTICAL AMPLIFIER	Must be compatible with TI	Tektronix, Type 5A48 (MIS-28706-3)

SECTION III
CALIBRATION PROCESS

6. Preliminary Instructions

a. The instructions outlined in paragraphs **6** and **7** are preparatory to the calibration process. Personnel should become familiar with the entire procedure 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 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 this TI.

d. When indications specified in paragraphs **8** through **20** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **20**. 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. REDUCE OUTPUT(S) to minimum after each step within the performance check where applicable.

a. Refer to figure 1 for location of TI circuit boards.

b. Remove top and bottom protective covers from TI. Insure that line selector block (fig. 2) for 120 V ac operation is installed.

c. Connect TI to autotransformer.

d. Connect autotransformer to 115 V ac source and adjust output to 115 V ac.

e. Install vertical amplifier into TI left compartment and time base into right compartment.

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

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

(2) **FOCUS** control to midrange.

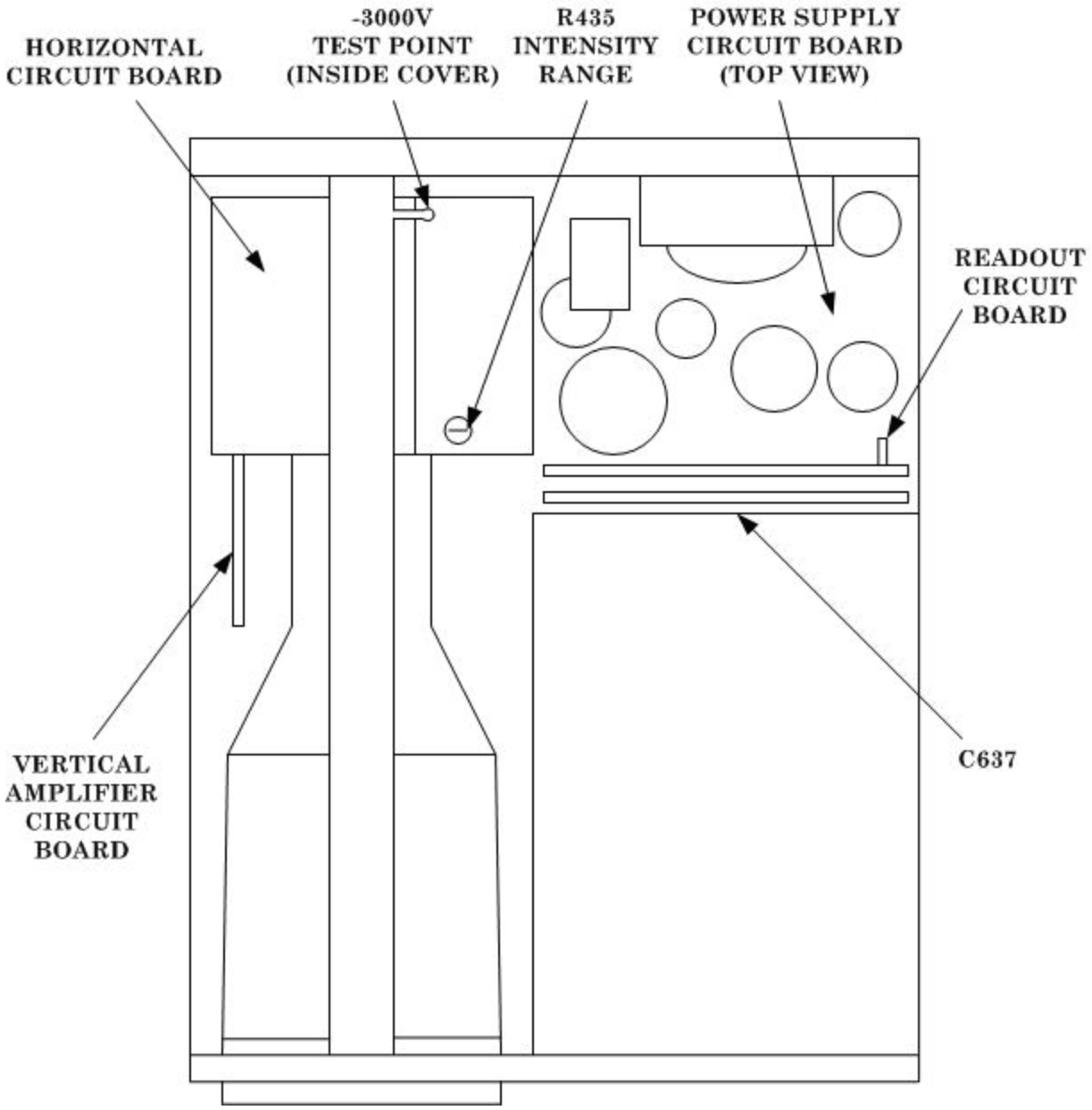

Figure 1. TI circuit board locations.

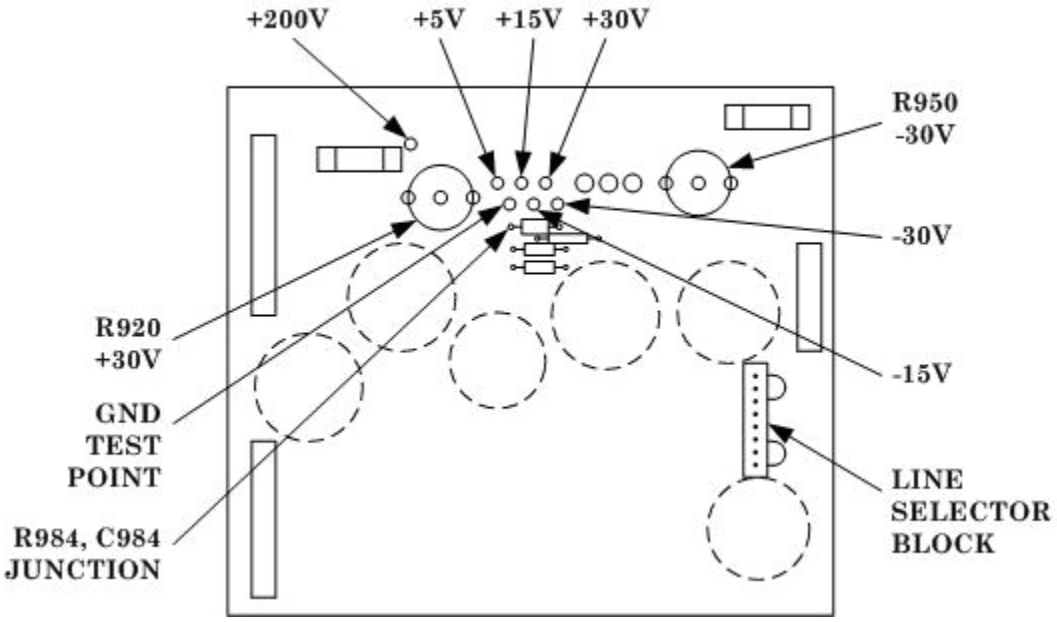

Figure 2. Power supply circuit board (bottom).

(3) **POWER** switch to on.

(4) **GRAT ILLUM** control as desired.

(5) **READOUT INTENS** control to midrange.

g. Allow approximately 15 minutes for the TI to warm up and stabilize.

8. Calibrator Output Voltage

a. Performance Check

(1) Press TI **POWER** switch to off and connect probe between the junction of R984 (fig. 2) and C984 (fig. 2), and GND TEST POINT (fig. 2).

(2) Connect multimeter between TI **CALIBRATOR** current loop and GND TEST POINT (fig. 2).

(3) Pull TI **POWER** switch to on.

(4) Multimeter should indicate between +396 and +404 mV dc.

(5) Vary autotransformer between 105 and 125 V ac and observe that multimeter indication remains between +396 and +404 mV dc.

(6) Press TI **POWER** switch to off and disconnect probe and adapter connected in (1) above.

(7) Pull TI **POWER** switch to on.

(8) Connect **CALIBRATOR** loop to vertical amplifier channel 1 **INPUT**.

(9) Adjust **INTENSITY** control, vertical amplifier **VOLTS/DIV** switch, and time base **TIME/DIV** switch as necessary to obtain a square wave display.

b. Adjustments. No adjustment can be made.

9. Intensity Range

a. Performance Check. Slowly adjust TI **INTENSITY** control cw until trace appears on TI screen. If the TI **INTENSITY** control is not between its 8 and 11 o'clock position, perform **b** below.

b. Adjustment. Turn TI **INTENSITY** control fully ccw and adjust R435 INTENSITY RANGE (fig. 1) until trace is just visible and then readjust until trace is just extinguished.

10. Focus and Astigmatism

a. Performance Check

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

(a) Channel 1 **POSITION** control to midrange.
(b) Channel 1 **INPUT COUPLING** switch to **DC**.
(c) **MODE** switch to **CH1**.
(d) **TRIGGER** switch to **CH1**.

(2) Position time base controls, as listed in (a) through (e) below:

(a) Main triggering:

1 **SLOPE** switch to **+**.
2 **MODE** switch to **AUTO TRIG**.
3 **TRIGGER SOURCE** switch to **LEFT**.

(b) **POSITION** control as desired.
(c) **SWP MAG** switch to **X1** (out).
(d) **MAIN SEC/DIV** switch to **1 ms**.
(e) **DISPLAY MODE** switch to **MAIN SWP**.

(3) Adjust TI **INTENSITY** control for a normal display.

(4) Set time base **MAIN SEC/ DIV** switch to **AMP** (fully ccw) and adjust TI **FOCUS** control fully cw. If displayed spot on TI screen is not round, perform **b** below. It may be necessary to readjust **INTENSITY** control.

(5) Set time base **MAIN SEC/DIV** switch to **1 ms**.

b. Adjustments. Adjust R370 ASTIG (fig. 3) and TI **FOCUS** control simultaneously to obtain best defined spot on TI screen.

11. Trace Alignment

a. Performance Check. Adjust vertical amplifier and time base **POSITION** controls to center trace on TI horizontal graticule line. If trace is not aligned with TI center horizontal graticule line, perform **b** below.

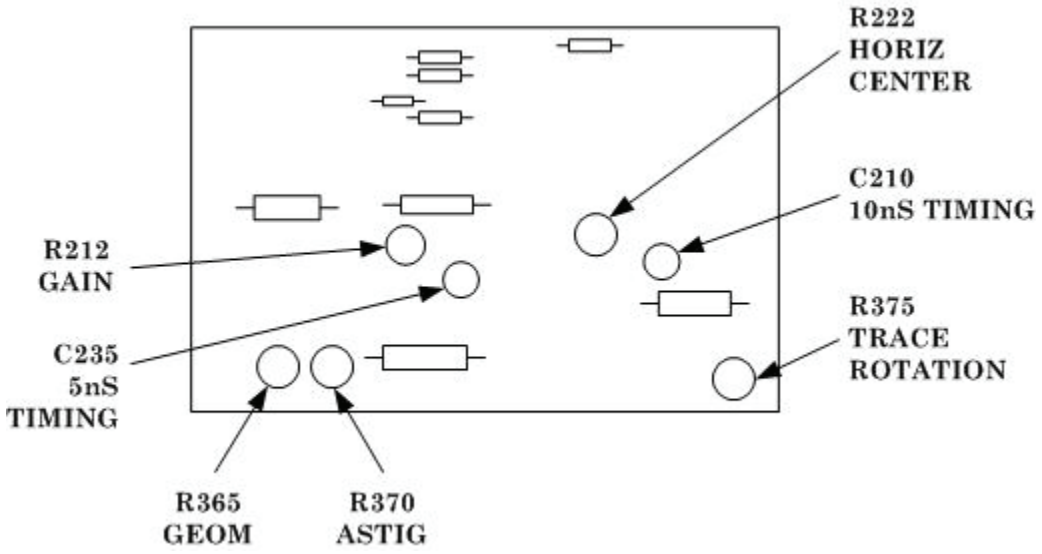

Figure 3. Horizontal circuit board (top).

b. Adjustment. Adjust R375 TRACE ROTATION (fig. 3) until trace is aligned with TI center horizontal graticule line.

12. Geometry

a. Performance Check

(1) Press TI **POWER** switch to off.

(2) Remove time base from TI right compartment and install in center compartment.

(3) Remove vertical amplifier from TI left compartment and install in right compartment.

(4) Pull TI **POWER** switch to on.

(5) Adjust TI **FOCUS** and **INTENSITY** controls for a well defined trace that extends vertically above and below graticule area.

(6) Adjust vertical amplifier **POSITION** control to move TI trace across entire graticule area. If trace bows or tilts greater than 0.1 division anywhere in graticule area, perform **b** below.

b. Adjustment. Adjust R365 GEOM (fig. 3) for minimum bowing or tilt of trace at left and right edges of graticule. It may be necessary to readjust R365 (fig. 3) to obtain less than 0.1 division of bowing and tilt everywhere in graticule area.

13. Vertical Centering

a. Performance Check

(1) Press TI **POWER** switch to off.

(2) Install calibration fixture in TI left compartment.

(3) Remove vertical amplifier from TI right compartment and remove time base from center compartment.

(4) Install time base in TI right compartment and pull TI **POWER** switch to on.

(5) Position calibration fixture controls as listed in (a) through (d) below:

(a) **POSITION** control to midrange.

(b) **AMPLITUDE** control to midrange.

(c) **TEST** switch to **COM MODE**.

(d) **REP RATE** switch to **100 kHz**.

(6) If trace is not within 0.5 division of the center horizontal graticule line, perform **b** below.

(7) Press TI **POWER** switch to off and move calibration fixture from left to center vertical compartment.

(8) Pull TI **POWER** switch to on. If trace is not within ±0.5 division of center horizontal graticule line, repeat (b) below for a compromise between left and center vertical compartments.

b. Adjustments. Adjust R135 VERT CENTER (fig. 4) to position trace to horizontal graticule line.

14. Vertical Gain

a. Performance Check

(1) Press TI **POWER** switch to off and install calibration fixture in TI left compartment.

(2) Pull TI **POWER** switch to on.

(3) Set calibration fixture **TEST** switch to **VERT OR HORIZ GAIN** and **REP RATE** switch to **1 MHz**.

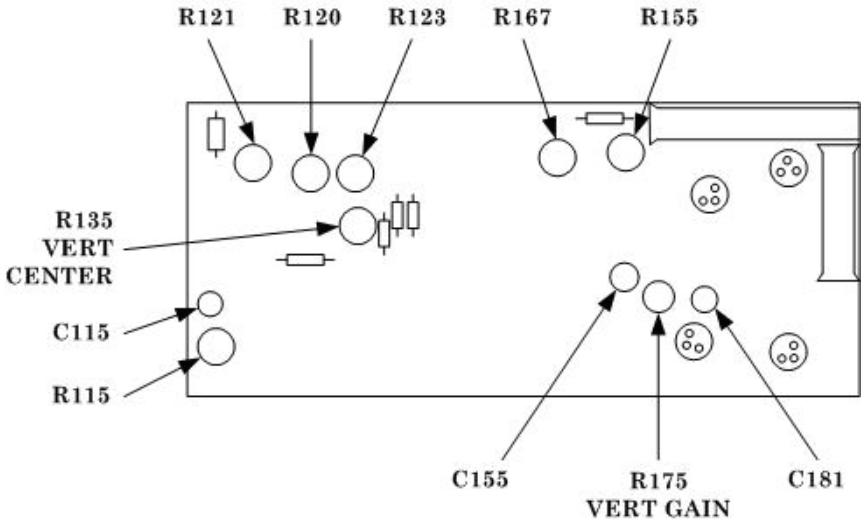

Figure 4. Vertical amplifier circuit board (left side).

(4) Adjust calibration fixture **POSITION** control to align bright center trace of display with TI center horizontal graticule line.

(5) If center seven traces do not coincide within ±0.1 division of respective horizontal graticule lines, perform **b** below.

(6) Press TI **POWER** switch to off and remove calibration fixture from left and install in TI center compartment.

(7) Pull TI **POWER** switch to on and repeat (4) and (5) above and if necessary, repeat **b** below for optimum gain setting compromise for both vertical compartments.

b. **Adjustments.** Adjust R175 VERT GAIN (fig. 4) for a 6 division deflection over center seven horizontal graticule lines (R).

15. Vertical Compensation

a. Performance Check

(1) Press TI **POWER** switch to off. Remove calibration fixture from center and install in TI left compartment. Pull TI **POWER** switch to on.

(2) Set calibration fixture **TEST** switch to **VERT OR HORIZ + STEP RESP** and **REP RATE** switch to **100 kHz**. Adjust **AMPLITUDE** and **POSITION** controls for a 6 division display centered vertically on TI graticule.

(3) Position time base controls as listed in (a) through (f) below:

(a) **MAIN SEC/DIV** switch to **2 μs**.
(b) **VARIABLE** control to **CAL**.
(c) **AUTO TRIG** switch in.
(d) **AC COUPL** switch in.
(e) **POSITION** control to center display.
(f) **MAIN TRIG LEVEL** control for a stable display, triggered on the rising portion of the pulse.

(4) If pulse displayed does not have a flat top and square leading corner (aberrations less than 0.36 division), perform **b** (1) through (4) below.

(5) Set calibration fixture **REP RATE** switch to **1 MHz**.

(6) Set time base **MAIN SEC/DIV** switch to **0.1** and, adjust **MAIN TRIG LEVEL** control for a stable display triggered on rising portion of the pulse.

(7) If pulse displayed on TI does not have a square leading corner and aberrations are not less than 0.36 division, perform **b** (5) below.

(8) Press TI **POWER** switch to off and remove calibration fixture from left and install in TI center vertical compartment. Set time base **TRIG SOURCE** switch to **RIGHT**.

(9) Pull TI **POWER** switch to on and repeat (2) through (7) above. If necessary, compromise vertical compensation adjustments for TI left and center vertical compartments.

b. Adjustments

(1) Adjust R121 (fig. 4) for optimum flat top on pulse displayed on TI screen.

(2) Set time base **MAIN SEC/DIV** switch to **1 μs** and adjust R120 (fig. 4) for optimum flat top on displayed pulse.

(3) Set time base **MAIN SEC/DIV** switch to **0.5 μs** and adjust R123 (fig. 4) for optimum flat top on displayed pulse.

(4) Repeat (1) through (3) above as necessary to obtain optimum flat top on displayed pulse.

(5) Adjust C637 (fig. 1) (main interface board between vertical compartments, serial number B063251 and up), C115 (fig. 4), R115 (fig. 4), C155 (fig. 4), R155 (fig. 4), R167 (fig. 4), and C181 (fig. 4) for optimum pulse display on TI screen.

NOTE

There is interaction between C115 (fig. 4) and R115 (fig. 4), and between C155 (fig. 4) and R155 (fig. 4). Readjust if required.

16. Risetime

NOTE

Perform paragraphs **17**, **18**, and **19** before performing paragraph **16**.

a. Performance Check

(1) Adjust calibration fixture **AMPLITUDE** and **POSITION** controls for a convenient display centered on TI crt graticule.

(2) Position time base controls as listed in (a) through (c) below:

(a) **MAIN SEC/DIV** switch to **.1 μ**.
(b) **SWP MAG** switch in.
(c) **MAIN TRIG LEVEL** control for stab display.

(3) Measure risetime, using standard risetime technique. Risetime will be 4 ns or less.

(4) Press TI **POWER** switch to off. Move calibration fixture to TI left compartment. Pull TI **POWER** switch to on.

(5) Press time base **TRIG SOURCE LEFT** switch and adjust **MAIN TRIG LEVEL** control for stable display. Repeat (3) above.

b. Adjustments. No adjustment can be made.

17. Horizontal Centering

a. Performance Check

(1) Press TI **POWER** switch to off. Install calibration fixture in TI right compartment and time base in left compartment.

(2) Position calibration fixture controls as listed in (a) through (d) below:

(a) **POSITION** control to midrange.
(b) **AMPLITUDE** control to midrange.
(c) **TEST** switch to **COM MODE**.

(d) **REP RATE** switch to **1 MHz**.

(1) Pull TI **POWER** switch to on. If a vertical trace is not displayed within ±0.5 division of TI center vertical graticule line, perform **b** below.

b. Adjustments. Adjust R222 HORIZ CENTER (fig. 3) to position trace to TI center vertical graticule line.

18. Horizontal Gain

a. Performance Check

(1) Set calibration fixture **TEST** switch to **VERT OR HORIZ GAIN** and adjust **POSITION** control to align bright center trace on TI with center vertical graticule line.

(2) If center seven traces do not coincide within ±0.25 division of respective vertical graticule lines, perform **b** below.

b. Adjustments. Adjust R212 GAIN (fig. 3) for a 6 division deflection over center seven vertical graticule lines (R).

19. 10 and 5 ns Timing

a. Performance Check

(1) Press TI **POWER** switch to off. Install calibration fixture in TI left compartment and time base in right compartment. Pull TI **POWER** switch to on.

(2) Set calibration fixture **TEST** switch to **AUX IN**.

(3) Connect oscilloscope calibrator **SOURCE/MEASURE CHAN 1** output to calibration fixture **AUX IN**, and oscilloscope calibrator **EXT TRIG CHAN 5** output to time base **EXT TRIG**.

(4) Set oscilloscope calibrator marker output to 10 ns and trigger output to **/10**. Adjust calibration fixture **AMPLITUDE** control for convenient display on TI screen.

(5) Position time base controls as listed in (a) through (f) below:

(a) **AUTO TRIG** switch in.
(b) **MAIN SEC/DIV** switch to 0.1 μs.
(c) **SWP MAG** switch in.
(d) **TRIG SOURCE LEFT** and **EXT** switches in.
(e) **MAIN TRIG LEVEL** control for a stable display on TI screen.
(f) **POSITION** control to align 4th time marker with 2d vertical graticule line on TI.

(6) If the 12th time marker is not within ±2.5 minor divisions of 10th vertical graticule line, perform **b** (1) below.

(7) Set oscilloscope calibrator marker output to 5 ns and adjust calibration fixture **AMPLITUDE** control for convenient display on TI.

(8) Adjust TI **MAIN TRIG LEVEL** control for a stable display and time base **POSITION** control to align 7th time marker with 2d vertical graticule line on TI screen.

(9) If 23^{d} time marker is not within ±3 minor divisions of 10th vertical graticule line, perform **b** (2) and (3) below.

b. Adjustments

(1) Adjust C210 10ns TIMING (fig. 3) for one time marker per division over center eight vertical graticule lines (R).

(2) Adjust C235 5ns TIMING (fig. 3) for two time markers per division over center eight vertical graticule lines (R).

(3) Due to interaction between C210 (fig. 3) and C235 (fig. 3), repeat **a** (4) through (9) above to obtain best timing compromise.

20. Readout System

NOTE
Perform paragraph **16** before continuing.

a. Performance Check

(1) Press TI **POWER** switch to off. Remove calibration fixture and time base from TI compartments.

(2) Remove Q1040 (fig. 5).

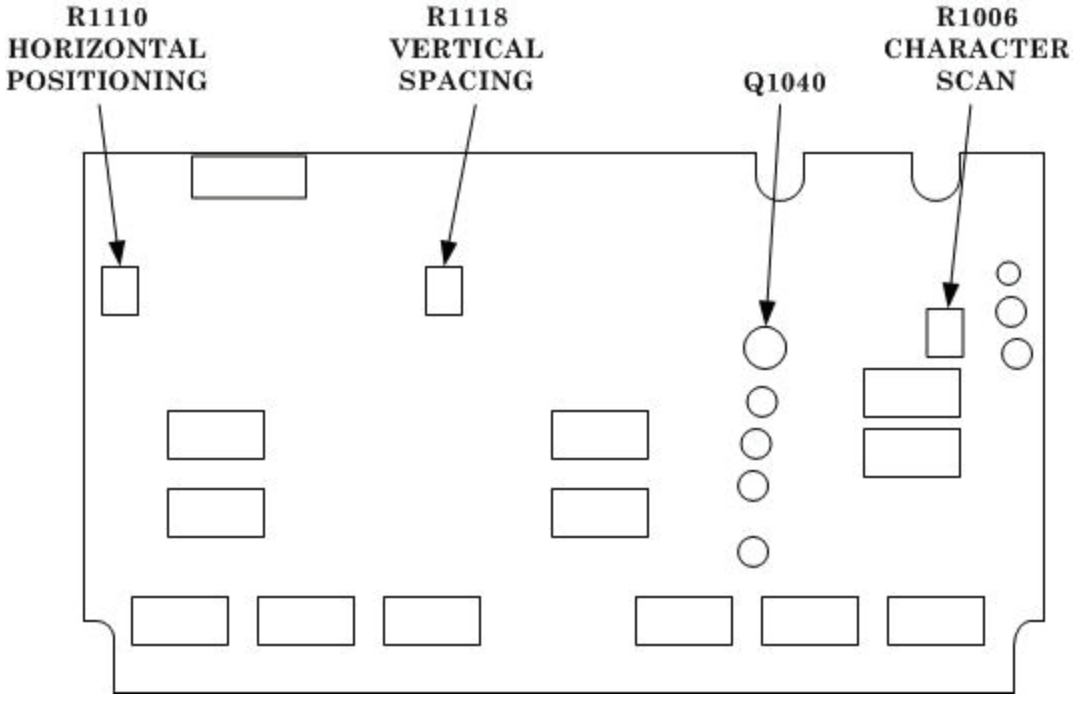

Figure 5. Readout circuit board (top).

(3) Pull TI **POWER** switch to on and adjust **READOUT** control for visible characters.

(4) If TI does not display two rows of zeros located in middle of top and bottom graticule divisions, with 4 zeros in each row with no overlap, perform **b** (1) below.

(5) If the first and last zero of both rows are not within the TI graticule area, perform **b** (2) below.

(6) If zeros are not complete or have over scanning, (over scanning causes a bright dot where traces overlap) perform **b** (3) below.

(7) Set TI **POWER** switch to off and install Q1040 (fig. 5).

b. Adjustments

(1) Adjust R135 VERT CENTER (fig. 4) to position the bottom row of zeros to the middle of the TI screen bottom graticule division. Adjust R1118 VERTICAL SPACING (fig. 5) to position the top row of zeros to the middle of the TI screen top graticule division. Due to interaction, it may be necessary to readjust R135 (fig. 4) and R1118 (fig. 5) until correct zero location is obtained.

(2) Adjust R1110 HORIZONTAL POSITIONING (fig. 5) until first and last zero of both rows arc within TI graticule.

(3) Adjust R1006 CHARACTER SCAN (fig. 5) for fully scanned zeros without over scanning. Turn TI **POWER** switch to off, and install transistor Q1040.

21. Power Supply

NOTE

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

a. Performance Check

(1) Install vertical amplifier in TI left compartment and time base in right compartment. Pull TI **POWER** switch to on.

(2) Connect multimeter between test point -30 V (fig. 2) and chassis ground.

(3) If multimeter does not indicate between -29.925 and -30.075 V dc, perform **b** (1) below.

(4) Connect multimeter between test point +30 V (fig. 2) and chassis ground.

(5) If multimeter does not indicate between +29.925 and +30.075 V dc, perform **b** (2) below.

(6) Connect multimeter between voltage test points listed in table 4 and chassis ground. Multimeter indications should be within limits specified in table 4.

Table 4. Power Supply Check

Test instrument voltage test points (fig. 2)	Multimeter indications (V dc)	
	Min	Max
-15 V	-14.85	-15.15
+5 V	+4.9	+5.1
+15 V	+14.85	+15.15
+200	+180	+220

(7) Press TI **POWER** switch to off'. Remove the time base from the right compartment and install vertical amplifier into the right compartment.

(8) Remove the high voltage cover and connect digital voltmeter between -3000 V TEST POINT (fig. 1) and chassis ground, using high voltage probe supplied with multimeter.

(9) Pull TI **POWER** switch to on. Multimeter should indicate between -2940 Vdc and -3060 V dc.

(10) Press TI **POWER** switch to off and replace high voltage cover.

b. Adjustment

(1) Adjust R950 -30 V (fig. 2) until multimeter indicates -30 V dc (R).

(2) Adjust R920 +30 V (fig. 2) until multimeter indicates +30 V dc (R).

22. Final Procedure

a. Deenergize and disconnect all equipment and reinstall protective covers on TI if necessary.

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

By Order of the Secretary of the Army:

GEORGE W. CASEY, JR.
General, United States Army
Chief of Staff

Official:

JOYCE E. MORROW
Administrative Assistant to the
Secretary of the Army

0807911

Distribution:

To be distributed in accordance with the initial distribution number (IDN) 342067, requirements for calibration procedure TB 9-4931-501-24.

Instructions for Submitting an Electronic 2028

The following format must be used if submitting an electronic 2028. The subject line must be exactly the same and all fields must be included; however, only the following fields are mandatory: 1, 3, 4, 5, 6, 7, 8, 9, 10, 13, 15, 16, 17, and 27.

From: "Whomever" whomever@redstone.army.mil
To: <2028@redstone.army.mil

Subject: DA Form 2028

1. **From**: Joe Smith
2. Unit: home
3. **Address**: 4300 Park
4. **City**: Hometown
5. **St**: MO
6. **Zip**: 77777
7. **Date Sent**: 19-OCT –93
8. **Pub no:** 55-2840-229-23
9. **Pub Title**: TM
10. **Publication Date**: 04-JUL-85
11. Change Number: 7
12. Submitter Rank: MSG
13. **Submitter FName**: Joe
14. Submitter MName: T
15. **Submitter LName**: Smith
16. **Submitter Phone**: 123-123-1234
17. **Problem**: 1
18. Page: 2
19. Paragraph: 3
20. Line: 4
21. NSN: 5
22. Reference: 6
23. Figure: 7
24. Table: 8
25. Item: 9
26. Total: 123
27. **Text**

This is the text for the problem below line 27.

PIN: 084708-000