TB 9-6625-2139-35

CHANGE 2

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-488 AND TEKTRONIX, TYPE 2235

Headquarters, Department of the Army, Washington, DC
10 November 2004

TB 9-6625-2139-35, 6 August 2003, 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**
23 and 24	23 and 24

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

By Order of the Secretary of the Army:

Official:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

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Administrative Assistant to the Secretary of the Army

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Distribution:
To be distributed in accordance with IDN 342245, requirements for TB 9-6625-2139-35.

TB 9-6625-2139-35

CHANGE 1

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-488 AND TEKTRONIX, TYPE 2235

Headquarters, Department of the Army, Washington, DC
22 March 2004

TB 9-6625-2139-35, 6 August 2003, 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
7 and 8	7 and 8
17 and 18	17 and 18

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By Order of the Secretary of the Army:

Official:

PETER J. SCHOOMAKER
General, United States Army
Chief of Staff

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Administrative Assistant to the Secretary of the Army

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Distribution:
To be distributed in accordance with IDN 342245, requirements for TB 9-6625-2139-35.

*TB 9-6625-2139-35

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE AN/USM-488 AND TEKTRONIX, TYPE 2235

Headquarters, Department of the Army, Washington, DC
6 August 2003

Approved for public release; distribution is unlimited

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 provide DA Form 2028 information to AMCOM via e-mail, fax, or the World Wide Web. Our fax number is DSN 788-6546 or Commercial 256-842-6546. Our e-mail address is: 2028@redstone.army.mil. Instructions for sending an electronic 2028 may be found at the back of this manual. For the World Wide Web, use https://amcom2028.redstone.army.mil.

*This bulletin supersedes TB 9-6625-2139-35, dated 18 March 2002 including all changes.

SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Oscilloscope AN/USM-488 and Tektronix, Type 2235. The manufacturers' manuals were used as the prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. Variations among models are listed in text.

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 parameters	Performance specifications
Vertical	
Deflection	Range: 2 mV/div to 5 V/div Accuracy: ±2%
Bandwidth	Range: 2 mV/div Accuracy: Dc to at least 90 MHz Range: 5 mV/div to 5 V/div Accuracy: Dc to at least 100 MHz
Aberrations	Range: 2 mV/div to 0.5 V/div Accuracy: +4%, -4%, 4% p-p

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications			
Horizontal				
A sweep timing	Range: 0.5 s/div to 0.05 μs/div Accuracy: ±2% Range: (X10 mag): 50 ms/div to 5 ns/div Accuracy: ±3%			
B sweep timing	Range: 50 ms/div to 0.05 μs/div Accuracy: ±2% Range: (X10 mag): 5 ms/div to 5 ns/div Accuracy: ±3%			
Sweep linearity	Accuracy: ±5% (measured over any 2 of the center 8 divisions)			
Deflection (X-Axis)	Range: 2 mV/div to 5 V/div Accuracy: ±3%			
A trigger sensitivity	Frequency	10 MHz	60 MHz	100 MHz
	Internal	0.35 div[1]	1.0 div	1.5 div
	External	35 mV	120 mV	150 mV2
B trigger sensitivity	Internal only	0.35 div	1.0 div	1.5 div
Calibrator amplitude	Range: 0.5 V Accuracy: ±2%[3]			

[1]0.3 division for type 2235.
[2]200 mV for type 2235.
[3]±5% for type 2235.

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. 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 four-to-one 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 **4** above, and are not listed in this calibration procedure. The following peculiar accessory is also required for this calibration: standardizer, 5-80 pF.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
OSCILLOSCOPE CALIBRATOR	Volts out: Range: 10 mV to 20 V Accuracy: ±0.5% Time markers: Range: 5 ns/D to 0.5 s/D Accuracy: ±0.5% Sine wave frequency: Range: 50 kHz to >100 MHz	John Fluke, Model 5820A, MIS-38938 (5820A-5C-GHZ),
DIGITAL MULTIMETER	Range: -8.64 to < 0.1 V dc Accuracy: ±0.12%	John Fluke, Model 8840A/AF-05/09 (AN/GSM-64D)

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 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 manuals for this TI.

d. When indications specified in paragraphs **8** through **11** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **11**. Do not perform power supply check if all other parameters are within tolerance.

e. Unless otherwise specified, all controls and control settings refer to 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. Remove protective cover from TI only when necessary to make adjustments. Replace cover after completing the adjustments.

b. Connect TI to a 115 V ac source.

c. Position controls as listed in (1) through (22) below:

(1) **A** and **B INTENSITY** controls fully ccw.

(2) **POSITION** controls to midrange.

(3) **CH 2 POSITION INVERT (PULL)** control to in position (AN/USM-488).

(4) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1.**

(5) **VERTICAL MODE TRIGGER SOURCE CH 1** and **CH 2** pushbuttons pressed to **COMPOSITE** (AN/USM-488).

(6) **CH 1** and **CH 2 VOLTS/DIV CAL** controls fully cw to detent.

(7) **CH 2 INVERT** pushbutton to out position (type 2235).

(8) **CH 1** and **CH 2 AC GND DC** switches to **DC.**

(9) **BW LIMIT 20 MHz** pushbutton to out position.

(10) **HORIZONTAL MODE** switch to **A**.

(11) **A AND B SEC/DIV** switches to **.2 ms**.

(12) **X10 CAL** control fully cw and in position.

(13) **VAR HOLDOFF** control fully ccw to **NORM**.

(14) **B TRIGGER SLOPE** pushbutton to **OUT:** 

(15) **B TRIGGER LEVEL** control fully cw.

(16) **A TRIGGER P-P AUTO** pushbutton to in position.

(17) **A TRIGGER NORM** pushbutton to out position.

(18) **A TRIGGER SLOPE** pushbutton to **OUT** (positive slope).

(19) **A TRIGGER LEVEL** control to midrange.

(20) **A TRIGGER A TRIG BW** switch to **FULL** (AN/USM-488).

(21) **A TRIGGER A&B INT** switch to **VERT MODE** (type 2235).

(22) **A TRIGGER A SOURCE** switch to **INT**.

d. Press **POWER** pushbutton to **ON** and allow at least 20 minutes for warm-up.

e. Adjust **A INTENSITY** and **FOCUS** controls for suitable viewing.

8. Vertical

a. Performance Check

(1) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1**.

(2) Set **CH 1 VOLTS/DIV** switch to **2m**.

(3) Press oscilloscope calibrator **VOLTAGE** pushbutton to illuminate green **LED**. Set oscilloscope calibrator output to **10 mV** and output frequency to **1 kHz**.

(4) Adjust **A TRIGGER LEVEL** and **POSITION** controls, as necessary, to view waveform.

(5) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to obtain 5 divisions of vertical display. Oscilloscope calibrator **err** display will indicate within limits specified in table 3.

(6) Repeat technique of (4) and (5) above for settings listed in table 3. Oscilloscope calibrator **err** display will indicate within limits specified in table 3; if not, perform adjustments list in table 3.

Table 3. CH 1 Vertical Deflection

Test instrument **VOLTS/DIV** switch settings	Oscilloscope calibrator **VOLTAGE** output settings	Test instrument divisions of vertical deflection	Oscilloscope calibrator **Err** display indications (± %)	Test instrument adjustments
2 m	10 mV	5	2	**b**(1) through (40)
5 m	20 mV	4	2	
10 m	50 mV	5	2	
20 m	.1 V	5	2	
50 m	.2 V	4	2	
.1	.5 V	5	2	
.2	1 V	5	2	
.5	2 V	4	2	
1	5 V	5	2	
2	10 V	5	2	
5	20 V	4	2	

(7) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2** and move TI connections at **CH1** to **CH2**.

(8) Ensure **CH 2 VOLTS/DIV** switch is set to **2m**.

(9) Set oscilloscope calibrator **VOLTAGE** output to **10 mV** and frequency to **1 kHz.**

(10) Adjust **A TRIGGER LEVEL** and **POSITION** controls, as necessary, to view waveform.

(11) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to obtain **5** divisions of vertical display. Oscilloscope calibrator **err** display will indicate within limits specified in table 4.

(12) Repeat technique of (10) and (11) above for settings listed in table 4. Oscilloscope calibrator **err** display will indicate within limits specified in table 4; if not, perform **adjustments** listed in table 4.

Table 4. CH 2 Vertical Deflection

Test instrument **VOLTS/DIV** switch settings	Oscilloscope calibrator **VOLTAGE** output settings	Test instrument divisions of vertical deflection	Oscilloscope calibrator **Err** display indications (± %)	Test instrument adjustments
2 m	10 mV	5	2	**b**(41) through (80)
5 m	20 mV	4	2	
10 m	50 mV	5	2	
20 m	.1V	5	2	
50 m	.2V	4	2	
.1	.5V	5	2	
.2	1 V	5	2	
.5	2 V	4	2	
1	5 V	5	2	
2	10 V	5	2	
5	20 V	4	2	

(13) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 50Ω feedthrough termination.

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.
(b) **CH 1** and **CH 2 VOLTS/DIV** switches to **2m**.
(c) Set **A AND B SEC/DIV** switch to **.05 μs**.

(15) Press oscilloscope calibrator **EDGE** pushbutton to illuminate green **LED** and set oscilloscope calibrator output to **10 mV** at **1 MHz**.

(16) Use technique of step 17 below for TI settings and oscilloscope calibrator output settings listed in table 5.

(17) Adjust **CH 1 POSITION** control to position top of waveform to center horizontal graticule line. If squarewave aberrations exceed those listed in table 5, perform adjustments listed in table 5.

Table 5. Channel 1 Vertical Deflection Aberration Limits and Adjustments

Oscilloscope calibrator **EDGE** settings		Test instrument			
Amplitude	Frequency	**A AND B SEC/DIV** switch settings (μs)	**VOLTS/DIV** switch settings	Aberration limits minor division positive or negative or minor division pk-pk <	Adjustments
10 mVpp	1 MHz	0.05	2 m	1	**b**(81) through (89)
50 mVpp	1 MHz	0.05	10 m	1	
100 mVpp	1 MHz	0.05	20 m	1	
250 mVpp	1 MHz	0.05	50 m	1	
.5 Vpp	1 MHz	0.05	.1	1	
1 Vpp	1 MHz	0.05	.2	1	

(18) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2**.

(19) Remove connection located at TI **CH 1** and connect oscilloscope calibrator **CHAN 1** to TI **CH 2** using a 50Ω feedthrough termination.

(20) Ensure **CH 2 VOLTS/DIV** switch is set to **2m** and oscilloscope calibrator **EDGE** pushbutton green **LED** is illuminated.

(21) Use technique of (22) below for TI settings and oscilloscope calibrator output settings listed in table 6.

(22) Adjust **CH 2 POSITION** control to position top of waveform to center horizontal graticule line. If squarewave aberrations exceed those listed in table 6, perform adjustments listed in table 6.

Table 6. Channel 2 Vertical Deflection Aberration Limits and Adjustments

Oscilloscope calibrator **EDGE** settings		Test instrument			
Amplitude	Frequency	**A AND B SEC/DIV** switch settings (μs)	**VOLTS/DIV** switch settings	Aberration limits minor division positive or negative or minor division pk-pk <	Adjustments
10 mVpp	1 MHz	0.05	2 m	1	**b**(90) through (95)
50 mVpp	1 MHz	0.05	10 m	1	
100 mVpp	1 MHz	0.05	20 m	1	
250 mVpp	1 MHz	0.05	50 m	1	
.5 Vpp	1 MHz	0.05	.1	1	
1 Vpp	1 MHz	0.05	.2	1	

(23) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.

(24) Connect **CH1** through 50Ω feedthrough termination to oscilloscope calibrator **CHAN 1.**

(25) Press oscilloscope calibrator **LEVEL SINE** pushbutton to illuminate green **LED**.

(26) Set TI **VOLTS/DIV, A AND B SEC/DIV** settings and oscilloscope calibrator **LEVEL SINE** output to settings listed in first row of table 7.

(27) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to adjust amplitude for 6 divisions of vertical deflection on TI.

Table 7. Channel 1 Bandwidth Measurement

Test instrument switch settings		Oscilloscope calibrator **LEVEL SINE** output settings		Test instrument amplitude limits (divisions) ≥
VOLTS/DIV	**A AND B SEC/DIV**	Amplitude	Frequency sweep	
2 m	20 µs	12 mV	50 kHz to 90 MHz [1]	4.2
10 m	20 µs	60 mV	50 kHz to 100 MHz [1]	4.2
.5	20 µs	3.0 V	50 kHz to 100 MHz [1]	4.2

[1]Press **Set to 50 kHz** blue soft button to quickly return to 50 kHz.

NOTE

To perform the step below; press **EDIT FIELD** pushbutton as required to place underline under one of the frequency digits.

(28) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to sweep oscilloscope calibrator from 50 kHz to frequency limits specified in table 7 while observing displayed waveform amplitude on TI crt. Displayed waveform amplitude will be as specified in table 7 throughout frequency range.

(29) Repeat technique of steps (27) and (28) above for remaining TI **VOLTS/DIV, A and B SEC/DIV** settings and oscilloscope calibrator **LEVEL SINE** output to settings listed in table 7.

(30) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2** and move connection located at TI **CH 1** to **CH 2**.

(31) Set TI **VOLTS/DIV, A and B SEC/DIV** settings and oscilloscope calibrator **LEVEL SINE** output to settings listed in first row of table 8.

(32) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to adjust amplitude for 6 divisions of vertical deflection on TI.

Table 8. Channel 2 Bandwidth Measurement

Test instrument switch settings		Oscilloscope calibrator **LEVEL SINE** output settings		Test instrument amplitude limits (divisions) ≥
VOLTS/DIV	**A AND B SEC/DIV**	Amplitude	Sweep frequency	
2 m	20 µs	12 mV	50 kHz to 90 MHz [1]	4.2
10 m	20 µs	60 mV	50 kHz to 100 MHz [1]	4.2
.5	20 µs	3.0 V	50 kHz to 100 MHz [1]	4.2

[1]Press **Set to 50 kHz** blue soft button to quickly return to 50 kHz.

NOTE

To perform the step below, press **EDIT FIELD** pushbutton as required to place underline under one of the frequency digits.

(33) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to sweep oscilloscope calibrator from 50 kHz to frequency limits specified in table 8 while observing displayed waveform amplitude on TI crt. Displayed waveform amplitude will be as specified in table 8 throughout frequency.

(34) Repeat technique of steps (32) and (33) above for remaining TI **VOLTS/DIV, A AND B SEC/DIV** settings and oscilloscope calibrator **LEVEL SINE** output to settings listed in table 8.

b. Adjustments

(1) Disconnect oscilloscope calibrator **CHAN 1** from TI **CH 1**.

(2) Set **CH 1 AC GND DC** switch to **AC**.

(3) Set **CH 1 VOLTS/DIV** switch to **50m**.

(4) Adjust **CH 1 POSITION** control to position trace on center horizontal graticule line.

(5) Set **CH 1 VOLTS/DIV** switch to **5m**.

(6) Adjust R10 (fig. 1) to position trace on center horizontal graticule line.

(7) Repeat (3) through (6) above for minimum trace shift when setting **CH 1 VOLTS/DIV** switch from **50m** to **5m**.

(8) Adjust **CH 1 POSITION** control to position trace on center horizontal graticule line.

(9) Set **CH 1 VOLTS/DIV** switch to **2m**.

(10) Adjust R33 (fig. 1) to position trace on center horizontal graticule line.

(11) Set **CH 1 VOLTS/DIV** switch to **5m**.

(12) Repeat (8) through (11) above for minimum trace shift when setting **CH 1 VOLTS/DIV** switch from **5m** to **2m**.

(13) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 50Ω feedthrough termination.

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

(a) **CH 1 VOLTS/DIV** switch to **10m**.

(b) **CH 1 AC AND DC** switch to **DC.**

(c) **A AND B SEC/DIV** switches to **20 μs.**

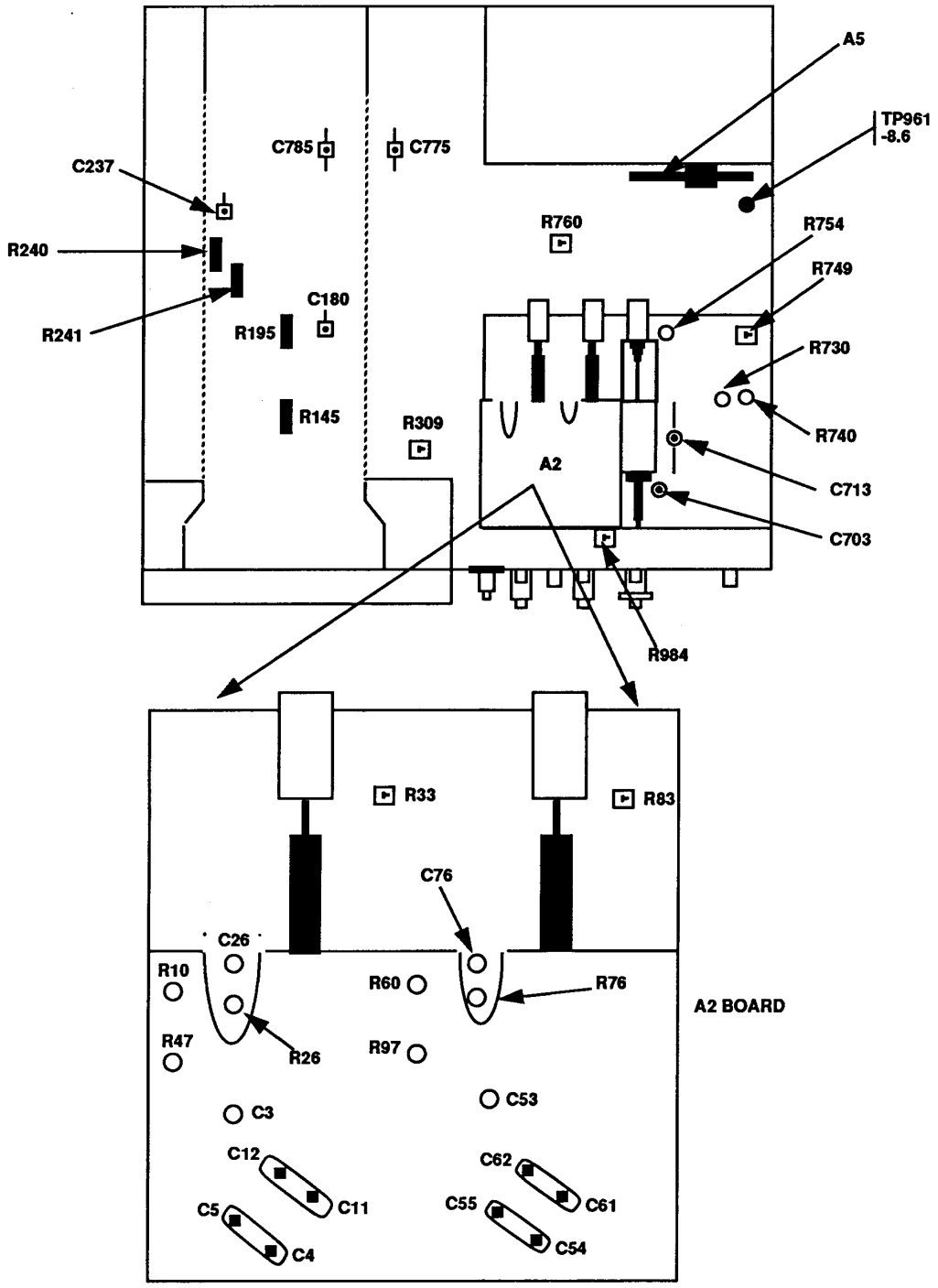

Figure 1. Adjustment locations – top view.

(15) Set oscilloscope calibrator **EDGE** output to **10 kHz** and 5 divisions of vertical deflection on TI.

(16) Adjust **CH 1 POSITION** control to position top of waveform to the center horizontal graticule line.

(17) Adjust C3 (fig. 1) and R47 (fig. 1) for the best square corner and flat top.

(18) Remove 50Ω feedthrough termination and connect calibration generator **OUTPUT** to TI **CH 1.**

(19) Set oscilloscope calibrator voltage output to 10 mV at 1 kHz .

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

(a) **CH 1 VOLTS/DIV** switch to **2m**.
(b) **A AND B SEC/DIV** switches to .**2 ms**.
(c) **CH 1 POSITION** control to view waveform.

(21) Adjust R26 (fig. 1) for 5 divisions of vertical deflection on TI (R).

(22) Set **CH 1 VOLTS/DIV** switch to **10m.**

(23) Set oscilloscope calibrator output to 50 mV.

(24) Adjust R145 (fig. 1) for 5 divisions of vertical deflection on TI (R).

(25) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 5-80 pF standardizer.

(26) Set oscilloscope calibrator **EDGE** output to **1 kHz** and amplitude for 5 divisions of vertical defection on TI.

(27) Adjust 5-80 pF standardizer for optimum square wave.

(28) Set **CH 1 VOLTS/DIV** switch to **.1**.

(29) Replace 5-80 pF standardizer with 50Ω feedthrough termination.

(30) Set oscilloscope calibrator output amplitude for 5 divisions of vertical deflection on TI.

(31) Adjust C12 (fig. 1) for best front corner.

(32) Replace 50Ω feedthrough termination with a 5-80 pF standardizer and repeat (30) above.

(33) Adjust C11 (fig. 1) for best flat top.

(34) Repeat (29) through (33) above until no further improvement is noted.

(35) Set **CH 1 VOLTS/DIV** switch to **1**.

(36) Remove 5-80 pF standardizer and connect oscilloscope calibrator **CHAN 1** to TI **CH 1.** Repeat (30) above.

(37) Adjust C5 (fig. 1) for best front corner.

(38) Connect oscilloscope calibrator **CHAN 1** to TI **CH 2** using a 5-80 pF standardizer and repeat (30) above.

(39) Adjust C4 (fig. 1) for best flat top.

(40) Repeat (36) through (39) above until no further improvement is noted.

(41) Disconnect oscilloscope calibrator **CHAN 1** from TI **CH 2.**

(42) Set **CH 2 AC GND DC** switch to **AC.**

(43) Set **CH 2 VOLTS/DIV** switch to **50m.**

(44) Adjust **CH 2 POSITION** control to position trace on center horizontal graticule line.

(45) Set **CH 2 VOLTS/DIV** switch to **5m**.

(46) Adjust R60 (fig. 1) to position trace on center horizontal graticule line.

(47) Repeat (43) through (46) above for minimum trace shift when setting **CH 2 VOLTS/DIV** switch from **50m** to **5m**.

(48) Adjust **CH 2 POSITION** control to position trace on center horizontal graticule line.

(49) Set **CH 2 VOLTS/DIV** switch to **2m**.

(50) Adjust R83 (fig. 1) to position trace on center horizontal graticule line.

(51) Set **CH 2 VOLTS/DIV** switch to **5m**.

(52) Repeat (48) through (51) above for minimum trace shift when setting **CH 2 VOLTS/DIV** switch from **5m** to **2m**.

(53) Connect oscilloscope calibrator **CHAN 1** to TI **CH 2** using a 50Ω feedthrough termination.

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

(a) **CH 2 VOLTS/DIV** switch to **10m**.

(b) **CH 2 AC GND DC** switch to **DC**.

(c) **A AND B SEC/DIV** switches to **20 μs**.

(55) Set oscilloscope calibrator **EDGE** output to **10 kHz** and amplitude for 5 divisions of vertical deflection on TI.

(56) Adjust **CH 2 POSITION** control to position top of waveform to the center horizontal graticule line.

(57) Adjust C53 (fig. 1) and R97 (fig. 1) for the best square corner and flat top.

(58) Remove 50Ω feedthrough termination and connect oscilloscope calibrator **CHAN 1** to TI **CH 2.**

(59) Set oscilloscope calibrator **VOLTAGE** output to 10 mV and 1 kHz.

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

(a) **CH 2 VOLTS/DIV** switch to **2m**.

(b) **A AND B SEC/DIV** switches to **.2 ms**.

(c) **CH 2 POSITION** control to view waveform.

(61) Adjust R76 (fig. 1) for 5 divisions of vertical deflection on TI (R).

(62) Set **CH 2 VOLTS/DIV** switch to **10m.**

(63) Set oscilloscope calibrator output to 50 mV.

(64) Adjust R195 (fig. 1) for 5 divisions of vertical deflection on TI (R).

(65) Connect oscilloscope calibrator **CHAN 1** to TI **CH 2** using a 5-80 pF standardizer.

(66) Set oscilloscope calibrator **EDGE** output to **1 kHz** and amplitude for **5** divisions of vertical defection on TI.

(67) Adjust 5-80 pF standardizer for optimum square wave.

(68) Set **CH 2 VOLTS/DIV** switch to **.1**.

(69) Replace 5-80 pF standardizer with 50Ω feedthrough termination.

(70) Set oscilloscope calibrator amplitude for 5 divisions of vertical deflection on TI.

(71) Adjust C62 (fig. 1) for best front corner.

(72) Replace the 50Ω feedthrough termination with a 5-80 pF standardizer and repeat (70) above.

(73) Adjust C61 (fig. 1) for best flat top.

(74) Repeat (69) through (73) above until no further improvement is noted.

(75) Set **CH 2 VOLTS/DIV** switch to **1**.

(76) Remove 5-80 pF standardizer and connect oscilloscope calibrator **CHAN 1** to TI **CH 2.** Repeat (70) above.

(77) Adjust C55 (fig. 1) for best front corner.

(78) Connect oscilloscope calibrator **CHAN 1** to TI **CH 2** using a 5-80 pF standardizer and repeat (70) above.

(79) Adjust C54 (fig. 1) for best flat top.

(80) Repeat (76) through (79) above until no further improvement is noted.

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.

(b) **CH 1** and **CH 2 VOLTS/DIV** switches to **10 m**.

(c) **A AND B SEC/DIV** switch to **.05 μs**.

(82) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 10X attenuator and a 50Ω feedthrough termination.

(83) Set oscilloscope calibrator **EDGE** output to **1 MHz** and amplitude for 5 divisions of vertical deflection on TI.

(84) Adjust **CH 1 POSITION** control to position top of waveform to center horizontal graticule line.

(85) Adjust C237 (fig. 1) for minimum overshoot and R240 (fig. 1) and R241 (fig. 1) for best flat top on front corner of waveform (R).

(86) Set **CH 1 VOLTS/DIV** switch to **2m.**

(87) Set oscilloscope calibrator output for 5 divisions of vertical deflection on TI.

(88) Adjust **CH 1 POSITION** control to position top of waveform to center horizontal graticule line.

(89) Adjust C26 (fig. 1) for minimum overshoot on waveform (R).

(90) Set **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2** and repeat technique of (82) through (84) above for **CH 2.**

(91) Adjust C180 (fig. 1) for minimum overshoot on displayed waveform (R).

(92) Set **CH 2 VOLTS/DIV** switch to **2m.**

(93) Set oscilloscope calibrator output for 5 divisions of vertical deflection on TI.

(94) Adjust **CH 2 POSITION** control to position top of waveform to center horizontal graticule line.

(95) Adjust C76 (fig. 1) for minimum overshoot on waveform (R).

9. Horizontal

a. Performance Check

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.
(b) **CH 1 VOLTS/DIV** switch to **.5**.
(c) **B DELAY TIME POSITION** control fully ccw.
(d) **B TRIGGER LEVEL** control fully cw.
(e) **A TRIGGER NORM** pushbutton pressed.

(2) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 50Ω feedthrough termination.

(3) Press oscilloscope calibrator **MARKER** pushbutton to illuminate green **LED** and set oscilloscope calibrator output for settings listed in first row in table 9.

(4) Adjust **A TRIGGER LEVEL**, **A INTENSITY**, and **CH 1 POSITION** controls for suitable viewing.

(5) Adjust horizontal **POSITION** control to aline 2nd time marker with 2nd vertical graticule line.

(6) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to align 10th time marker with 10th vertical graticle line. Oscilloscope calibrator **err** display and TI linearity will be within limits listed in table 9, if not perform adjustments listed in table 9.

(7) Repeat technique of steps (4) through (6) above for remaining rows listed in table 9. Perform TI adjustments listed in table 9 as needed.

Table 9. A Sweep Timing

Test instrument **A AND B SEC/DIV** switch settings	Oscilloscope calibrator **MARKER** output settings	Oscilloscope calibrator **Err** display limits ± %	Test instrument linearity 0.1 division over any 2 center 8 divisions		Test instrument adjustments
			Yes	No	
.05 µs	50 nS/D	2			**b**(l) through (10)
.1 µs	.1 µS/D	2			
.2 µs	.2 µS/D	2			
.5 µs	.5 µS/D	2			
1 µs	1 µS/D	2			
2 µs	2 µS/D	2			
5 µs	5 µS/D	2			
10 µs	10 µS/D	2			
20 µs	20 µS/D	2			
50 µs	50 µS/D	2			
.1 ms	.1 mS/D	2			
.2 ms	.2 mS/D	2			
.5 ms	.5 mS/D	2			
1 ms	1 mS/D	2			
2 ms	2 mS/D	2			
5 ms	5 mS/D	2			
10 ms	10 mS/D	2			
20 ms	20 mS/D	2			
50 ms	50 mS/D	2			
.1 sec A ONLY	.1 S/D	2			
.2 sec A ONLY	.2 S/D	2			
.5 sec A ONLY	.5 S/D	2			

(8) Pull **X10 CAL** control to out position.

(9) Set calibration generator output for settings listed in first row in table 10 and adjust **A TRIGGER LEVEL**, **A INTENSITY**, and **CH 1 POSITION** controls for suitable viewing.

(10) Adjust horizontal **POSITION** control to aline the lst time marker that is 25 ns beyond start of sweep with the 2nd vertical graticule line.

(11) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to align 5th time marker with 10th vertical graticle line. Oscilloscope calibrator **err** display and TI linearity will be within limits listed in table 10 if not if not perform adjustments listed in table 10.

Table 10. A Sweep Timing (X10 Out)

Test instrument **A AND B SEC/DIV** switch settings	Oscilloscope calibrator **MARKER** output settings	Oscilloscope calibrator **Err** display limits ± %	Test instrument linearity 0.1 division over any 2 center 8 divisions		Test instrument adjustments
			Yes	No	
.05 µs	10 nS/D	3			**b**(1l) through (17)

(12) Set TI **A AND B SEC/DIV** switch settings and oscilloscope calibrator output to first row in table 11. Adjust **A TRIGGER LEVEL**, **A INTENSITY**, and **CH 1 POSITION** controls for suitable viewing.

(13) Adjust horizontal **POSITION** control to aline the 1st time marker that is 25 ns beyond start of sweep with the 2nd vertical graticule line.

(14) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to align 10th time marker with 10th vertical graticle line. Oscilloscope calibrator **err** display and TI linearity will be within limits listed in table 11, if not perform adjustments listed in table 11.

Table 11. A Sweep X10 Timing

Test instrument A AND B **SEC/DIV** switch settings	Oscilloscope calibrator **MARKER** output settings	Oscilloscope calibrator **Err** display limits ± %	Test instrument linearity 0.1 division over any 2 center 8 divisions		Test instrument adjustments
			Yes	No	
.1 µs	10 nS/D	3			**b**(l8) through (21)
.2 µs	20 nS/D	3			
.5 µs	50 nS/D	3			
1 µs	.1 µS/D	3			
2 µs	.2 µS/D	3			
5 µs	.5 µS/D	3			
10 µs	1 µS/D	3			
20 µs	2 µS/D	3			
50 µs	5 µS/D	3			
.1 ms	10 µS/D	3			
.2 ms	20 µS/D	3			
.5 ms	50 µS/D	3			
1 ms	.1 mS/D	3			
2 ms	.2 mS/D	3			
5 ms	.5 mS/D	3			
10 ms	1 mS/D	3			
20 ms	2 mS/D	3			
50 ms	5 mS/D	3			
.1 Sec A ONLY	10 mS/D	3			
.2 Sec A ONLY	20 mS/D	3			
.5 Sec A ONLY	50 mS/D	3			

(15) Repeat technique of (12) through (14) above for remaining settings listed in table 11. Oscilloscope calibrator **err** display and TI linearity will be within limits listed in table 11, if not perform adjustments listed in table 11.

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

(a) **HORIZONTAL MODE** switch to **B**.

(b) **X10 CAL** control to in position.

(c) Set TI switch settings and oscilloscope calibrator output to first row listed in table 12.

(17) Adjust **A** and **B TRIGGER LEVEL, B INTENSITY,** and **CH 1 POSITION** controls for suitable viewing.

(18) Adjust horizontal **POSITION** control to aline 2nd time marker with 2nd vertical graticule line.

(19) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to align 10th time marker with 10th vertical graticule line. Oscilloscope calibrator **err** display and TI linearity will be within limits listed in table 12, if perform adjustments listed in table 12.

Table 12. B Sweep Timing

Test instrument **SEC/DIV** switch settings		Oscilloscope calibrator **MARKER** output settings	Oscilloscope calibrator **Err** display limits ± %	Test instrument linearity 0.1 division over any 2 center 8 divisions		Test instrument adjustments
A	**B**			Yes	No	
.1 µs	.05µs	50 nS/D	2			**b**(22) through (24)
.2 µs	.1 µs	.1 µS/D	2			
.5 µs	.2 µs	.2 µS/D	2			
1 µs	.5 µs	.5 µS/D	2			
2 µs	1 µs	1 µS/D	2			
5 µs	2 µs	2 µS/D	2			
10 µs	5 µs	5 µS/D	2			
20 µs	10 µs	10 µS/D	2			
50 µs	20 µs	20 µS/D	2			
.1ms	50 µs	50 µS/D	2			
.2 ms	.1 ms	.1 mS/D	2			
.5 ms	.2 ms	.2 mS/D	2			
1 ms	.5 ms	.5 mS/D	2			
2 ms	1 ms	1 mS/D	2			
5 ms	2 ms	2 mS/D	2			
10 ms	5 ms	5 mS/D	2			
20 ms	10 ms	10 mS/D	2			
50 ms	20 ms	20 mS/D	2			
.1 sec A ONLY	50 ms	50 mS/D	2			

(20) Repeat technique of (17) through (19) for remaining TI settings and oscilloscope output settings listed in table 12. Oscilloscope calibrator **err** display and TI linearity will be within limits listed in table 12, if not perform adjustments listed in table 12.

(21) Set X10 CAL control to out position.

(22) Set TI A AND B SEC/DIV switches and oscilloscope calibrator output as listed in table 13.

(23) Adjust **A** and **B TRIGGER LEVEL**, **B INTENSITY**, and **CH 1 POS**ITION controls for suitable viewing.

(24) Adjust horizontal **POSITION** control to aline the 1st time marker that is 25 ns beyond start of sweep with the 2nd vertical graticule line.

(25) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to align 5th time marker with 10th vertical graticule line. Oscilloscope calibrator **err** display and TI linearity will be within limits listed in table 13, if not perform adjustments listed in table 13.

Table 13. B Sweep Timing (X10 Out)

Test instrument **SEC/DIV** switch settings		Oscilloscope calibrator **MARKER**	Oscilloscope calibrator **Err** display limits	Test instrument linearity 0.1 division over any 2 center 8 divisions		Test instrument
A	**B**	output settings	± %	Yes	No	adjustments
.1 µs	.05 µs	10 nS/D	3			**b**(25) through (28)

(26) Set **A AND B SEV/DIV** switches and oscilloscope calibrator output as listed in first row of table 14.

(27) Adjust horizontal **POSITION** control to aline the 1st time marker that is 25 ns beyond start of sweep with the 2nd vertical graticule line.

(28) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to align 10th time marker with 10th vertical graticule line. Oscilloscope calibrator **err** display will indicate and linearity will be within limits specified in table 14.

(29) Repeat technique of (27) and (28) above for settings listed in table 14. Oscilloscope calibrator **err** display and linearity will indicate be within limits listed in table 14.

Table 14. B Sweep X10 Mag Timing

Test instrument **SEC/DIV** switch settings		Oscilloscope calibrator **MARKER**	Oscilloscope calibrator **Err** display limits	Test instrument linearity 0.1 division over any 2 center 8 divisions	
A	**B**	output settings	± %	Yes	No
.2 µs	.1 µs	10 nS/D	3		
.5 µs	.2 µs	20 nS/D	3		
1 µs	.5 µs	50 nS/D	3		
2 µs	1 µs	.1 µS/D	3		
5 µs	2 µs	.2 µS/D	3		
10 µs	5 µs	.5 µS/D	3		
20 µs	10 µs	1 µS/D	3		
50 µs	20 µs	2 µS/D	3		
.1 ms	50 µs	5 µS/D	3		

Table 14. B Sweep X10 Mag Timing Continued

Test instrument **SEC/DIV** switch settings		Oscilloscope calibrator **MARKER** output settings	Oscilloscope calibrator **Err** display limits	Test instrument linearity 0.1 division over any 2 center 8 divisions	
A	**B**		± %	Yes	No
.2 ms	.1 ms	10 µS/D	3		
.5 ms	.2 ms	20 µS/D	3		
1 ms	.5 ms	50 µS/D	3		
2 ms	1 ms	.1 mS/D	3		
5 ms	2 ms	.2 mS/D	3		
10 ms	5 ms	.5 mS/D	3		
20 ms	10 ms	1 mS/D	3		
50 ms	20 ms	2 mS/D	3		
.1 sec A ONLY	50 ms	5 mS/D	3		

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

(a) **Xl0 CAL** control to in position.
(b) **B DELAY TIME POSITION** dial to **1.00**.
(c) **B TRIGGER LEVEL** control fully cw.
(d) **A TRIGGER P-P AUTO** pushbutton pressed.

(31) Set TI switch settings and oscilloscope calibrator out setting to first row listed in table 15.

(32) Adjust **A TRIGGER LEVEL, B INTENSITY,** and **CH 1 POSITION** controls for suitable viewing.

(33) Adjust horizontal **POSITION** control to aline the first fully displayed time marker with the center vertical graticule line.

(34) Adjust **B DELAY TIME POSITION** dial to approximately 9.00 to aline time marker with the center vertical graticule line. **B DELAY TIME POSITION** dial indication will be within dial limits listed in table 15, if not perform adjustments listed in table 15.

Table 15. B Delay Time Position Accuracy

Test instrument **VOLTS/DIV** switch setting	Test instrument **TIME/DIV** switch setting		Oscilloscope calibrator **MARKER** output setting	Test instrument **B DELAY TIME POSITION** dial limits		Test instrument adjustments
	A	**B**		Min	Max	
.5	.5 µs	.05µs	.5 µs	8.91	9.09	**b**(29) through (36)
.5	5 µs	.5 µs	5 µs	8.91	9.09	**b**(29) through (36)
.5	.5 ms	50 µs	.5 ms	8.91	9.09	**b**(29) through (36)
.5	5 ms	.5 ms	5 ms	8.91	9.09	**b**(29) through (36)
.5	.5 s	50 ms[1]	.5 s	8.91	9.09	**b**(29) through (36)

[1]Press **A TRIGGER NORM** pushbutton.

(35) Repeat technique of (32) through (34) above for settings listed in the remaining rows of table 15. If **B DELAY TIME POSITION** dial indication is not within dial limits listed in table 15, perform test instrument adjustments listed in table 15.

(36) Remove 50Ω feedthrough termination and connect oscilloscope calibrator **CHAN 1** to TI **CH 1.**

(37) Position controls as listed in (a) and (b) below:

(a) **HORIZONTAL MODE** switch to **A**.
(b) **A TRIGGER P-P AUTO** pushbutton pressed.

(38) Set TI switch settings and oscilloscope calibrator output setting as listed in table 16.

(39) Adjust **A INTENSITY, CH 2 POSITION** (vertical adjustment) or **POSITION** (horizontal adjustment) controls for suitable viewing.

(40) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to for 5 divisions of horizontal display. Oscilloscope calibrator **err** display will be within limits listed in table 16, if not perform adjustments listed in table 16.

Table 16. Bandwidth

Test instrument **CH 1 VOLTS/DIV** switch settings	Test instrument **A AND B SEC/DIV** switch settings	Oscilloscope calibrator **VOLTAGE** output settings	Oscilloscope calibrator **Err** display limits ± %	Test instrument adjustments
10 m	**X-Y**	50 mV at 1 kHz	3	**b**(37) and (39)

b. Adjustments

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

(a) **HORIZONTAL MODE** switch to **A**.
(b) **A AND B SEC/DIV** switches to **.1 ms.**
(c) **X10 CAL** control to in position.

(2) Set oscilloscope calibrator **MARKER** output to **.1 mS/D**.

(3) Adjust horizontal **POSITION** control to aline 1st time marker with the 1st (extreme left) vertical graticule line.

(4) Adjust R740 (fig. 1) for 1 time marker per division over the center 8 divisions (R).

(5) Set **HORIZONTAL MODE** switch to **B** and adjust **B INTENSITY** control for suitable viewing. Adjust horizontal **POSITION** control to aline 1st time marker with 1st vertical graticule line.

(6) Adjust R730 (fig. 1) for 1 time marker per division over the center 8 divisions (R).

(7) Set **HORIZONTAL MODE** switch to **A** and pull **X10 CAL** control to out position.

(8) Set oscilloscope calibrator **MARKER** output to **10 μS/D**.

(9) Adjust horizontal **POSITION** control to aline the nearest time marker to the lst vertical graticule line.

(10) Adjust R754 (fig. 1) for 1 time marker per division (R).

(11) Set **A AND B SEC/DIV** switches to **.2 ms**.

(12) Set oscilloscope calibrator **MARKER** output to **1 mS/D**.

(13) Adjust horizontal **POSITION** control to position middle time marker to center vertical graticule line.

(14) Push **X10 CAL** control to in position.

(15) Adjust R749 (fig. 1) to position the middle time marker to the center vertical graticule line.

(16) Pull **X10 CAL** control to out position and check that there is no horizontal shift in time marker position.

(17) Repeat (13) through (16) above until no further improvement is noted.

(18) Set **A AND B SEC/DIV** switches to **.1 µs** and push **X10 CAL** control to in position.

(19) Set oscilloscope calibrator **MARKER** output to **.1 µS/D**.

(20) Adjust **A TRIGGER LEVEL** control for a triggered display and horizontal **POSITION** control to aline 1st time marker with 1st vertical graticule line.

(21) Adjust C703 (fig. 1) for 1 time marker per division over the center 8 divisions (R).

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

(a) **HORIZONTAL MODE** switch to **B**.
(b) **A SEC/DIV** switch to **1 µs**.
(c) **B SEC/DIV** switch to **.1 µs**.

(23) Adjust horizontal **POSITION** control to aline 1st time marker with 1st vertical graticule line.

(24) Adjust C713 (fig. 1) for 1 time marker per division over the center 8 divisions (R).

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

(a) **HORIZONTAL MODE** switch to **A**.
(b) **A AND B SEC/DIV** switches to **.05 µs**.
(c) **X10 CAL** control to out position.

(26) Set oscilloscope calibrator **MARKER** output to **10 nS/D**.

(27) Adjust horizontal **POSITION** control to aline the 1st time marker that is 25 ns beyond start of sweep with the 2nd vertical graticule line.

(28) Adjust C775 (fig. 1) and C785 (fig. 1) alternately for 1 time marker every 2 divisions over the center 8 divisions (R).

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

(a) **HORIZONTAL MODE** switch to **ALT**.

(b) **A SEC/DIV** switch to **.1 ms**.

(c) **B SEC/DIV** switch to **1 μs**.

(d) **B DELAY TIME POSITION** dial to **1.00**.

(30) Set oscilloscope calibrator **MARKER** output for **.1 mS/D**.

(31) Adjust **A/B SWP SEP** control to separate A and B sweeps.

(32) Adjust R646 DELAY START (fig. 2) so that the 2nd A sweep time marker is intensified and the B sweep time marker's rising edge starts at the beginning of B sweep (R).

(33) Adjust **B DELAY TIME POSITION** dial to **9.00.**

(34) Adjust R652 DELAY END (fig. 2) so that the 10th A sweep time marker is intensified and the B sweep time marker's rising edge starts at the beginning of B sweep.

(35) Adjust **B DELAY TIME POSITION** dial to **1.00.**

(36) Repeat (32) through (35) above until no further improvement is noted.

(37) Set **HORIZONTAL MODE** switch to **B.**

(38) Adjust R760 (fig. 1) for 5 divisions of horizontal display (R).

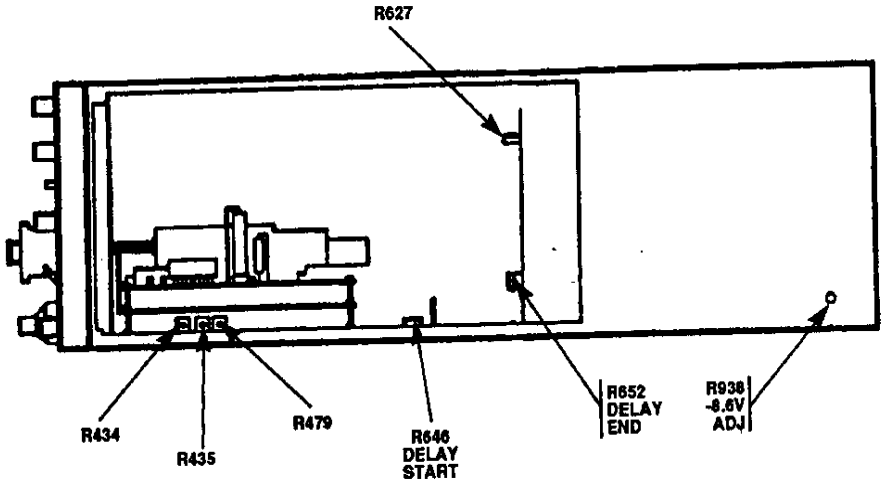

Figure 2. Adjustment locations - right side view.

10. Triggering

a. Performance Check

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.

(b) **CH 1** and **CH 2 VOLTS/DIV** switches to **5m**.

(c) **A AND B SEC/DIV** switches to **.2 μs**.
(d) **B DELAY TIME POSITION** dial fully ccw.
(e) **B TRIGGER SLOPE** pushbutton to **OUT**.
(f) **B TRIGGER LEVEL** control to midrange.
(g) **A TRIGGER P-P AUTO** pushbutton pressed.
(h) **A TRIGGER SLOPE** pushbutton to **OUT**.
(i) **A TRIGGER LEVEL** control to midrange.
(j) **A TRIGGER A TRIG BW** switch to **FULL** (AN/USM-488).
(k) **A TRIGGER A&B INT** switch to **VERT MODE** (type 2235).
(l) **A TRIGGER A SOURCE** switch to **INT**.
(m) **A TRIGGER A EXT COUPLING** switch to **DC**.

(2) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 50Ω feedthrough termination.

(3) Set oscilloscope calibrator **LEVEL SINE** output at **10 MHz** and approximately 17 mVpp for 3.5 divisions (3.0 divisions for type 2235) of vertical display on TI.

(4) Set **CH 1 VOLTS/DIV** switch to **50m**.

(5) Set **A TRIGGER** pushbutton to first row listed in table 17 and adjust **A TRIGGER LEVEL** control to obtain a stable display. If a stable display cannot be obtained, perform adjustments listed in table 17.

(6) Repeat technique of step (5) above for remaining **A TRIGGER** pushbutton combinations listed in table 17. If a stable display cannot be obtained for each combination, perform adjustments list in table 17.

Table 17. A Trigger Level Channel 1

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** stable display test		Test instrument adjustments
MODE	**SLOPE**	YES	NO	**b**
NORM	IN:			**b**
P-P AUTO	IN:			**b**
P-P AUTO	OUT:			**b**

(7) Set **HORIZONTAL MODE** switch to **B**. Adjust **B INTENSITY** control for suitable viewing.

(8) Verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

(9) Press **B TRIGGER SLOPE** pushbutton to IN and verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

(10) Position controls as listed in (a) through (e) below:

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2**.
(b) **VERTICAL MODE TRIGGER SOURCE CH 1** pushbutton to out position (AN/USM-488).

(c) **HORIZONTAL MODE** switch to **A**.
(d) **B TRIGGER SLOPE** pushbutton to **OUT.**
(e) **A TRIGGER A&B INT** switch to **CH 2** (type 2235).

(11) Move connection at **CH 1** to **CH 2** using a 50Ω feedthrough termination**.**

NOTE
Ensure **CH 2 VOLTS/DIV** is set to **5m.**

(12) Set oscilloscope calibrator **LEVEL SINE** output to **10 MHz** and approximately 17 mVpp for 3.5 divisions (3.0 divisions for type 2235) of vertical display on TI.

(13) Set **CH 2 VOLTS/DIV** switch to **50m**.

(14) Set TI **A TRIGGER** pushbutton to first row listed in table 18 and adjust **A TRIGGER LEVEL** control to obtain a stable display. If a stable display cannot be obtained, perform adjustments listed in table 18.

(15) Repeat technique of step (14) above for remaining **A TRIGGER** pushbutton combinations listed in table 18. If a stable display cannot be obtained for each combination, perform adjustments list in table 18.

Table 18. A Trigger Level Channel 2

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** stable display test		Test instrument adjustments
MODE	**SLOPE**	Yes	No	**b**
NORM	IN:			**b**
P-P AUTO	IN:			**b**
P-P AUTO	OUT:			**b**

(16)Set **HORIZONTAL MODE** switch to **B**. adjust **B INTENSITY** control for suitable viewing.

(17)Verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

(18)Press **B TRIGGER SLOPE** pushbutton to IN and verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY**; if not, perform b below.

(19) Position controls as listed in (a) through (f) below:

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.
(b) **VERTICAL MODE TRIGGER SOURCE CH 1** and **CH 2** pushbuttons to **COMPOSITE** (AN/USM-488).
(c) **HORIZONTAL MODE** switch to **A**.
(d) **A AND B SEC/DIV** switches to **.1 μs.**
(e) **B TRIGGER SLOPE** pushbutton to **OUT**.
(f) **A TRIGGER A&B INT** switch to **VERT MODE** (type 2235).

(20) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 50Ω feedthrough termination.

(21) Set oscilloscope calibrator **LEVEL SINE** output to 60 MHz and approximately 50 mVpp for 1.0 division of vertical display on TI.

(22) Set **A TRIGGER** pushbutton to first row listed in table 19 and adjust **A TRIGGER LEVEL** control to obtain a stable display. If a stable display cannot be obtained, perform adjustments listed in table 19.

(23) Repeat technique of step (22) above for remaining **A TRIGGER** pushbutton combinations listed in table 19. If a stable display cannot be obtained for each combination, perform adjustments list in table 19.

Table 19. A Trigger Level Channel 1

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** stable display test		Test instrument adjustments
MODE	**SLOPE**	Yes	No	**b**
NORM	IN:			**b**
P-P AUTO	IN:			**b**
P-P AUTO	OUT:			**b**

(24) Set **HORIZONTAL MODE** switch to **B** adjust **B INTENSITY** control for suitable viewing.

(25) Verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

(26) Press **B TRIGGER SLOPE** pushbutton to IN and verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2**.
(b) **HORIZONTAL MODE** switch to **A**.
(c) **B TRIGGER SLOPE** pushbutton to: **OUT**.
(d) Connect oscilloscope calibrator **CHAN 1** to TI **CH 2** using a 50Ω feedthrough termination.

(28) Set **A TRIGGER** pushbutton to first row listed in table 20 and adjust **A TRIGGER LEVEL** control to obtain a stable display. If a stable display cannot be obtained, perform adjustments listed in table 20.

(29) Repeat technique of step (28) above for remaining **A TRIGGER** pushbutton combinations listed in table 20. If a stable display cannot be obtained for each combination, perform adjustments list in table 20.

Table 20. A Trigger Level Channel 2

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** stable display test		Test instrument adjustments
MODE	**SLOPE**	YES	NO	**b**
NORM	IN:			**b**
P-P AUTO	IN:			**b**
P-P AUTO	OUT:			**b**

(30) Set **HORIZONTAL MODE** switch to **B** adjust **B INTENSITY** control for suitable viewing.

(31) Verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

(32 Press **B TRIGGER SLOPE** pushbutton to IN and verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.
(b) **HORIZONTAL MODE** switch to **A**.
(c) **A AND B SEC/DIV** switches to **.05 µs**.
(d) **B TRIGGER SLOPE** pushbutton to **OUT**.

(34) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 50Ω feedthrough termination.

(35) Set oscilloscope calibrator **LEVEL SINE** output to **100 MHz** and approximately 100 mVpp for 1.5 divisions of vertical display on TI.

(36) Set **A TRIGGER** pushbutton to first row listed in table 21 and adjust **A TRIGGER LEVEL** control to obtain a stable display. If a stable display cannot be obtained, perform adjustments listed in table 21.

(37) Repeat technique of step (36) above for remaining **A TRIGGER** pushbutton combinations listed in table 21. If a stable display cannot be obtained for each combination, perform adjustments list in table 21.

Table 21. A Trigger Level Channel 1

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** stable display test		Test instrument adjustments
MODE	**SLOPE**	Yes	No	**b**
NORM	IN:			**b**
P-P AUTO	IN:			**b**
P-P AUTO	OUT:			**b**

(38)Set **HORIZONTAL MODE** switch to **B** adjust **B INTENSITY** control for suitable viewing.

(39)Verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

(40)Press **B TRIGGER SLOPE** pushbutton to IN and verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 2**.
(b) **HORIZONTAL MODE** switch to **A**.
(c) **B TRIGGER SLOPE** pushbutton to **OUT.**

(42) Connect oscilloscope calibrator **CHAN 1** to TI **CH2** using a 50Ω feedthrough termination.

(43) Set oscilloscope calibrator **LEVEL SINE** output to **100 MHz** and approximately 100 mVpp for 1.5 divisions of vertical display on TI.

(44) Set **A TRIGGER** pushbutton to first row listed in table 22 and adjust **A TRIGGER LEVEL** control to obtain a stable display. If a stable display cannot be obtained, perform adjustments listed in table 22.

(45) Repeat technique of step (44) above for remaining **A TRIGGER** pushbutton combinations listed in table 22. If a stable display cannot be obtained for each combination, perform adjustments list in table 22.

Table 22. A Trigger Level Channel 2

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** stable display test		Test instrument adjustments
MODE	**SLOPE**	Yes	No	**b**
NORM	IN:			**b**
P-P AUTO	IN:			**b**
P-P AUTO	OUT:			**b**

(46) Set **HORIZONTAL MODE** switch to **B** adjust **B INTENSITY** control for suitable viewing.

(47) Verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

(48) Press **B TRIGGER SLOPE** pushbutton to IN and verify a stable display can be obtained by adjusting **B TRIGGER LEVEL** control in a position other than **B RUNS AFTER DLY;** if not, perform b below.

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.
(b) **HORIZONTAL MODE** switch to **A**.
(c) **A TRIGGER NORM** pushbutton pressed.
(d) **A TRIGGER A SOURCE** switch to **EXT**.

(50) Connect oscilloscope calibrator **CHAN 1** to TI **EXT INPUT** using a 50Ω feedthrough termination.

(51) Set oscilloscope calibrator **LEVEL SINE** output to 35 mV and 10 MHz.

(52) Press in and hold **TRIG VIEW** pushbutton while adjusting **A TRIGGER LEVEL** control to obtain a stable display.

(53) Repeat technique of step (52) above for **A TRIGGER** pushbutton combinations listed in table 23.

Table 23. A Trigger Level A Source to EXT INPUT

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** with **TRIG VIEW** in stable display test		Test instrument adjustments
MODE	**SLOPE**	YES	NO	**b**
NORM	IN:			**b**
P-P AUTO	IN:			**b**
P-P AUTO	OUT:			**b**

(54) Release **TRIG VIEW** pushbutton.

(55) Pull **X10 CAL** control to out position and press **A TRIGGER NORM** pushbutton.

(56) Set oscilloscope calibrator **LEVEL SINE** output to 120 mV and 60 MHz.

(57) Press in and hold **TRIG VIEW** pushbutton while adjusting **A TRIGGER LEVEL** control to obtain a stable display.

(58) Repeat technique of step (57) above for **A TRIGGER** pushbutton combinations listed in table 24.

Table 24. A Trigger Level A Source to EXT INPUT

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** with **TRIG VIEW** in stable display test		Test instrument adjustments
MODE	**SLOPE**	Yes	No	**b**
NORM	IN:			**b**
P-P AUTO	IN:			**b**
P-P AUTO	OUT:			**b**

(59) Release **TRIG VIEW** pushbutton.

(60) Set oscilloscope calibrator **LEVEL SINE** output to 150 mV (200 mV for type 2235) and 100 MHz output.

(61) Press **A TRIGGER NORM** pushbutton. Next press in and hold **TRIG VIEW** pushbutton and adjust **A TRIGGER LEVEL** control to obtain a stable display.

(62) Repeat technique of step (61) above for **A TRIGGER** pushbutton combinations listed in table 25.

Table 25. A Trigger Level A Source to **EXT INPUT**

Test instrument **A TRIGGER** pushbutton combinations		Test instrument **A TRIGGER LEVEL** with **TRIG VIEW** in stable display test		Test instrument adjustments
MODE	**SLOPE**	YES	NO	**B**
NORM	IN:			**B**
P-P AUTO	IN:			**B**
P-P AUTO	OUT:			**B**

b. Adjustments

(1) Disconnect oscilloscope calibrator and 50Ω feedthrough termination from TI.

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

(a) **POSITION** controls to midrange.
(b) **VERTICAL MODE CH 1 BOTH CH 2** switch to **BOTH.**
(c) **VERTICAL MODE TRIGGER SOURCE CH 1** pushbutton to out position (AN/USM-488).
(d) **VERTICAL MODE TRIGGER SOURCE CH 2** pushbutton to in position (AN/USM-488).
(e) **VERTICAL MODE ADD ALT CHOP** switch to **ALT.**
(f) **CH 1** and **CH 2 VOLTS/DIV** switches to **.5.**
(g) **CH 1** and **CH 2 AC GND DC** switches to **GND.**
(h) **HORIZONTAL MODE** switch to **A.**
(i) **A AND B SEC/DIV** switches to **1 ms**.
(j) **B TRIGGER SLOPE** to **OUT:** _/‾
(k) **B TRIGGER LEVEL** control to midrange.
(l) **A TRIGGER P-P AUTO** pushbutton pressed.
(m) **A TRIGGER SLOPE** pushbutton to **OUT:** _/‾
(n) **A TRIGGER LEVEL** control to midrange.
(o) **A TRIGGER A&B INT** switch to **CH 2** (type 2235).

(3) Adjust **CH 1** and **CH 2 POSITION** controls to set both traces to the center horizontal graticule line.

(4) Connect digital multimeter **LO** to chassis ground and **HI** to pin 1 on A5 (fig. 1) board connector. Digital multimeter indication will be less than 100 mV dc. Record digital multimeter indication.

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

(a) **VERTICAL MODE TRIGGER SOURCE CH 1** pushbutton to in position (AN/ USM-488).
(b) **VERTICAL MODE TRIGGER SOURCE CH 2** pushbutton to out position (AN/ USM-488).
(c) **A TRIGGER A&B INT** switch to **CH 1** (type 2235).

(6) Adjust R309 (fig. 1) for digital multimeter indication recorded in (4) above.

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

(a) **VERTICAL MODE TRIGGER SOURCE CH 1** pushbutton to out position (AN/USM-488).
(b) **VERTICAL MODE TRIGGER SOURCE CH 2** pushbutton to in position (AN/USM-488).
(c) **A TRIGGER A&B INT** switch to **CH 2** (type 2235).

(8) Repeat (4) through (7) above until digital multimeter indications in (4) and (6) above are equal within ±1 mV dc.

(9) Disconnect digital multimeter.

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

(a) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.
(b) **VERTICAL MODE TRIGGER SOURCE CH 1** pushbutton to in position (AN/USM-488).

(c) **VERTICAL MODE TRIGGER SOURCE CH 2** pushbutton to out position (AN/USM-488).

(d) **CH 1 VOLTS/DIV** switch to **1**.

(e) **CH 1 AND CH 2 AC GND DC** switches to **AC**.

(f) **A AND B SEC/DIV** switches to **10 μs**.

(g) **A TRIGGER A&B INT** switch to **CH 1** (type 2235).

(11) Connect oscilloscope calibrator **CHAN 1** to TI **CH 1** using a 50Ω feedthrough termination.

(12) Set oscilloscope calibrator **LEVEL SINE** output to **50 kHz** and 2.2 divisions of vertical display on TI.

(13) Set **CH 1 VOLTS/DIV** switch to **1**.

(14) Adjust R479 (fig. 2) while rotating **A TRIGGER LEVEL** control slowly so that the **A** trigger is just able to be maintained (R).

(15) Set **CH 1 VOLTS/DIV** switch to 50m and adjust **A TRIGGER LEVEL** control fully cw.

(16) Set oscilloscope calibrator **LEVEL SINE** output for 5 divisions of vertical display on TI.

(17) Set **CH 1 VOLTS/DIV** switch to **.5**.

(18) Adjust R434 (fig. 2) so display just solidly triggers on positive peak of signal (R).

(19) Press **A TRIGGER SLOPE** pushbutton to **IN:** ⌝⎽ and adjust **A TRIGGER LEVEL** control fully ccw.

(20) Adjust R435 (fig. 2) so display just solidly triggers on the negative peak of signal (R).

(21) Connect oscilloscope calibrator **CHAN 1** with **LEVEL SINE** output to one side of a BNC tee. Connect BNC tee to TI **CH 1** using an Xl0 attenuator and a 50Ω feedthrough termination. Connect the other side of BNC tee to TI **EXT INPUT.**

(22) Set **CH 1 VOLTS/DIV** switch to **10m** and **A TRIGGER A SOURCE** switch to **EXT**.

(23) Set oscilloscope calibrator **LEVEL SINE** output for 2.2 divisions of vertical display on TI.

(24) Adjust **A TRIGGER LEVEL** control for a stable display.

(25) Set **HORIZONTAL MODE** switch to **B** and adjust **B TRIGGER LEVEL** control for a stable display.

(26) Set **CH 1 VOLTS/DIV** switch to **.1**.

(27) Adjust R627 (fig. 2) so that a display can just be maintained by adjusting **B TRIGGER LEVEL** control (R).

11. Calibrator Amplitude

a. Performance Check

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

(a) **POSITION** controls to midrange.
(b) **VERTICAL MODE CH 1 BOTH CH 2** switch to **CH 1**.
(c) **VERTICAL MODE TRIGGER SOURCE CH 1** and **CH 2** pushbuttons to **COMPOSITE** (AN/USM-488).
(d) **CH 1 AC GND DC** switch to **DC**.
(e) **HORIZONTAL MODE** switch to **A**.
(f) **X10 CAL** control to in position.
(g) **A TRIGGER P-P AUTO** pushbutton pressed.
(h) **A TRIGGER SLOPE** pushbutton to **OUT.**
(i) **A TRIGGER LEVEL** control to midrange.
(j) **A TRIGGER A TRIG BW** switch to **FULL** (AN/USM-488).
(k) **A TRIGGER A&B INT** switch to **VERT MODE** (type 2235).
(l) **A TRIGGER A SOURCE** switch to **INT**.

(2) Connect TI **CH 1** to TI **AMP CAL** (**PROBE ADJUST** on type 2235).

(3) Set **TIME/DIV** and **CH1 VOLTS/DIV** switches as listed in table 26. Adjust **CH1 VOLTS/DIV CAL** control for 5 divisions of vertical deflection on TI.

(4) Remove connection at TI **CALIBRATOR** and connect to oscilloscope calibrator **CHAN 1**.

(5) Set oscilloscope calibrator **VOLTAGE** output as listed in table 26.

(6) Adjust **A TRIGGER LEVEL** and **CH 1** and horizontal **POSITION** controls, as necessary, to view waveform.

(7) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to adjust for 5 divisions of vertical deflection on TI. Oscilloscope calibrator **err** display will indicate as specified in table 26, if not perform **b** below.

Table 26. Test Instrument Calibrator Output Check

Test instrument switch settings		Oscilloscope calibrator **VOLTAGE** output settings		Test instrument **Err** display limits
VOLTS/DIV	**TIME/DIV**	Amplitude	Frequency	(±%)
.1	.5 ms	500 mV pp	1 kHz	2[1]

[1]±5 % for type 2235.

b. Adjustments

(1) Rotate **CH 1 VOLTS/DIV CAL** knob fully clockwise to detent.

(2) Connect **CH 1** input to oscilloscope calibrator **CHAN 1**.

(3) Set oscilloscope calibrator **VOLTAGE** output as listed in table 26.

(4) Adjust TI **CH 1 POSITION** control to view waveform.

(5) Record waveform amplitude.

(6) Move connection from oscilloscope calibrator **CHAN 1** to **AMP CAL** located on TI front panel using adaptors as necessary.

(7) Adjust R984 (fig. 1) for waveform amplitude for recorded amplitude in (4) above.(R).

12. Power Supply

NOTE

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

a. Performance Check. Connect digital multimeter to TI TP961 -8.6 (fig. 1) and chassis ground. Digital multimeter will indicate as listed in table 27; if not, perform **b** below.

Table 27. Power Supply Voltage

Test instrument test points (fig. 1)	Digital multimeter indications (V dc)	
	Min	Max
TP961 –8.6	-8.56	-8.64

b. Adjustments. Adjust R938 -8.6V ADJ (fig. 2) for a -8.60 V dc indication on digital multimeter (R).

13. Final Procedure

a. Deenergize and disconnect all equipment.

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

By Order of the Secretary of the Army:

ERIC K. SHINSEKI
General, United States Army
Chief of Staff

OFFICIAL:

JOEL B. HUDSON
Administrative Assistant to the
Secretary of the Army
0316001

Distribution:

To be distributed in accordance with IDN 342245, requirements for calibration procedure TB 9-6625-2139-35.

THESE ARE THE INSTRUCTIONS FOR SENDING 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@avma27.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**: TB 9-6625-xxxx-35
9. **Pub Title**: Calibration Procedure for …
10. **Publication Date**:
11. Change Number:
12. **Submitted Rank**: MSG
13. **Sumitter 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: 058614-000