

***TB 9-6625-2240-35**

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE

OS261U (TEKTRONIX, TYPE 475), OS261A(V)1U (TEKTRONIX, TYPE 475 OPTION 7), OS261B(V)1U (TEKTRONIX, TYPE 475 OPTION 4), OS261C(V)1U (TEKTRONIX, TYPE 475 OPTION 4/7), AND TEKTRONIX, TYPE 475A (TEKTRONIX, TYPE R475A)

Headquarters, Department of the Army, Washington, DC
20 August 2001

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REPORTING OF ERRORS AND SUGGESTED IMPROVEMENTS

You can help improve this publication. If you find any mistakes or if you know of a way to improve the procedure, please let us know. Mail your letter or DA Form 2028 to: Commander, U. S. Army Aviation and Missile Command, ATTN: AMSAM-MMC-MA-NP, Redstone Arsenal, AL 35898-5230. 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 FAX 256-842-6546/DSN 788-6546

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**SECTION I
IDENTIFICATION AND DESCRIPTION**

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Oscilloscope, OS261U (Tektronix, Type 475), OS261A(V)1U (Tektronix, Type 475 Option 7), OS261B(V)1U (Tektronix, Type 475 Option 4), OS261C(V)1U (Tektronix, Type 475 Option 4/7) and Tektronix, Type 475A (Tektronix, Type R475A). The manufacturer's 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. Model variations are identified in the text.

b. Time and Technique. The time required for this calibration is approximately 4 hours, using the dc and low 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 determined (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 in 11 steps (5 mV/div to 10 V/div for Tektronix, Type 475A) Accuracy: ±3% with gain set at 5 mV/div
Time and linearity A sweep or B DLY'D sweep	Range: Unmag: 0.5 s/div to 0.01 μs/div in 24 steps Mag: 0.5 s/div to 1 ns/div in 24 steps Accuracy: 5 ms/div to 0.01 μs/div Unmag: ±1% Mag: ±2% 0.5 s/div to 10 ms/div Unmag: ±2% Mag: ±3%
A delaying sweep (A intensified sweep)	Range: 0.5 s/div to 0.05 μs/div in 22 steps Accuracy: Unmag: ±2% Mag: ±3%

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications
Delay time and differential time measurement	Range: 5 s to 0.05 μ s after start of delaying A sweep Accuracy: ± 0.01 major dial divisions between dial settings of one major division or less $\pm 1\%$ between dial settings of more than 1 major dial division, increasing to $\pm 0.5\%$ over entire range
Risetime	Range: 1.75 ns with aberrations not to exceed +4% or -4%, and total p-p of 4% (1.4 ns for Tektronix, Type 475A)
Bandwidth	Dc to 200 MHz (Dc to 250 MHz for Tektronix, Type 475A)
Calibrator	Range: 300 mV, $\pm 1\%$

**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.

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. The following peculiar accessory is also required for this calibration: 5-80 pF standardizer.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
OSCILLOSCOPE CALIBRATOR	Voltage output: Range: 12 mV to 60 V Frequency: 1 kHz Accuracy: $\pm 0.75\%$ Time markers: Range: 1 ns to 0.5 s Accuracy: $\pm 0.25\%$, .01 μ s to 5 ms $\pm 0.5\%$, 10 ms to 0.5 s Risetime: 437.5 ps Aberrations: $\pm 1\%$ Level sine wave: Reference frequency: 50 kHz Amplitude: 30 mV Capacity: >200 MHz	John Fluke, Model 5820A, (5820A-5C-GHZ), MIS-38938
DIGITAL MULTIMETER	Voltage input: Range: -15.23 to +113 V dc Accuracy: $\pm 0.375\%$	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 this 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 **12** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **12**. 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. Remove TI protective cover as required for adjustment.

b. Position **CH1** and **CH2** controls as listed in (1) through (7) below:

(1) **FOCUS**, vertical **POSITION**, and **SCALE ILLUM** controls to midrange.

(2) **VOLTS/DIV** switches to **5 m** (**10 m** for Tektronix, Type 475A) and **VAR** controls fully cw (detent).

(3) **VERT MODE CH1** pushbutton pressed (in).

(4) **AC-GND-DC** switches to **GND**.

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

(6) **INVERT** pushbutton out.

(7) **20 MHz BW/TRIG VIEW** pushbutton pressed in and released to full bandwidth.

c. Position **A** and **B** triggering controls as listed in (1) through (7) below:

- (1) **A TRIGGER LEVEL** control to **0** and **SLOPE** switch to + (positive).
- (2) **B (DLY'D) TRIGGER LEVEL** control to **0** and **SLOPE** switch to + (positive).
- (3) **A TRIGGER SOURCE** switch to **NORM**.
- (4) **B TRIGGER SOURCE** switch to **STARTS AFTER DELAY**.
- (5) **A** and **B** triggering **COUPLING** switches to **AC**.
- (6) **TRIG MODE AUTO** pushbutton pressed (in).
- (7) **A TRIG HOLDOFF** switch to **NORM**.

d. Position **TI A** and **B** sweep controls as listed in (1) through (5) below:

- (1) **A** and **B TIME/DIV** switches to **1 ms** and **VAR** control fully cw (detent).
- (2) **HORIZ DISPLAY A (A LOCKS KNOBS** for all models SN B250000 and above) pushbutton pressed (in).
- (3) **DELAY TIME** dial to **0.00**.
- (4) **X10 MAG** pushbutton out.
- (5) Horizontal **POSITION (FINE)** controls to midrange.

e. Connect **TI** to ac power source.

f. Pull **POWER** switch to **ON** and allow at least 20 minutes for warm-up.

g. Adjust **INTENSITY**, **FOCUS**, and **ASTIG** controls for suitable display.

8. Vertical Deflection

a. Performance Check

(1) Ensure **CH1 VOLTS/DIV** switch is set to **5 m (10 m** for Tektronix, Type 475A).

(2) Adjust **CH1 POSITION** control to align trace on center horizontal graticule line.

(3) Set **CH1 VOLTS/DIV** switch to **2 m (5 m** for Tektronix, Type 475A). If trace does not remain aligned with center horizontal graticule line, adjust R135 (fig. 1) to align trace with center horizontal graticule line.

(4) Repeat (1) through (3) above for minimum trace shift when changing **CH1 VOLTS/DIV** switch from **5 m** to **2 m (10 m** to **5 m** for Tektronix, Type 475A).

(5) Press **VERT MODE CH2** pushbutton.

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- (6) Repeat technique of (1) through (4) above using **CH2 POSITION** control and adjusting R235 (fig. 1).
- (7) Press **VERT MODE CH1** pushbutton and set **CH1 AC-GND-DC** switch to **DC**.
- (8) Set **CH1 VOLTS/DIV** switch to **2 m** (**5 m** for Tektronix, Type 475A) and connect TI **CH1** to oscilloscope calibrator **CHAN 1**.
- (9) Press oscilloscope calibrator **VOLTAGE** pushbutton to illuminate green **LED** and set frequency to **1 kHz**.

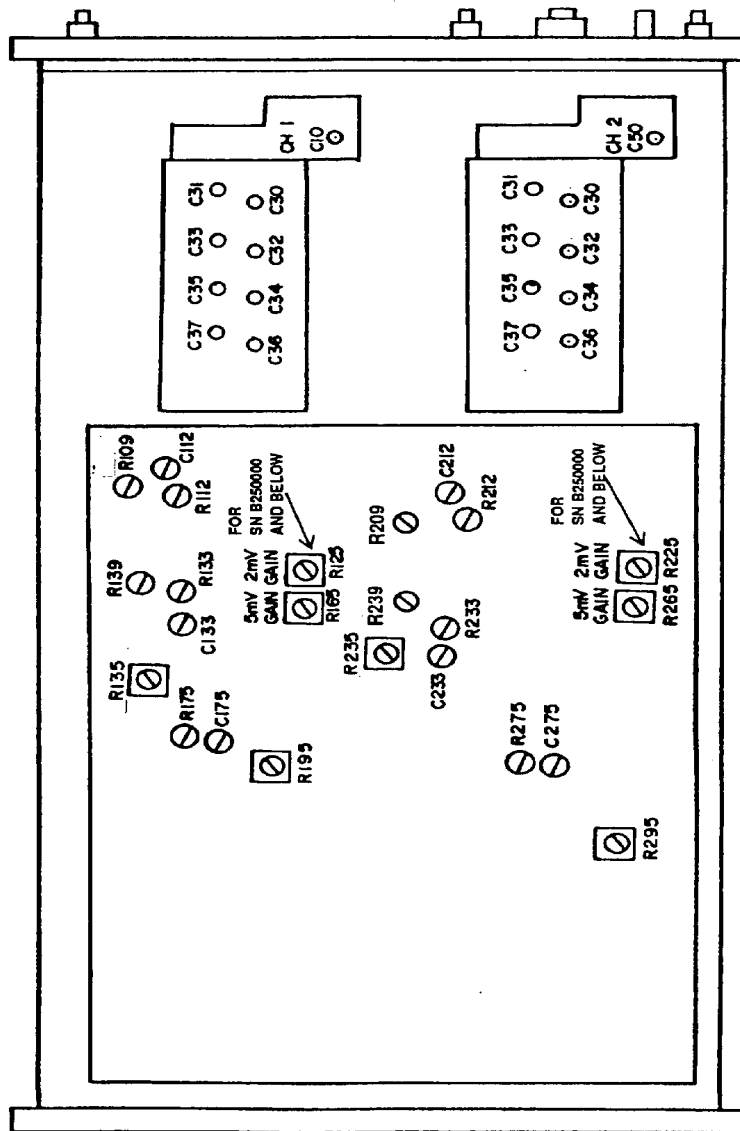


Figure 1. Left side view.

(10) Perform steps **a** through **c** below:

(a) Use technique of (b) and (c) below for **TI VOLTS/DIV** switch settings and oscilloscope calibrator **VOLTAGE** outputs listed in table 3.

(b) Rotate **CH 1 POSITION** knob to center trace on TI crt.

(c) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to obtain **6** divisions of vertical display. Oscilloscope calibrator **err** display will indicate within limits specified in table 3; if not, perform **b** below.

Table 3. Channel 1 Vertical Deflection Accuracy

Test instrument VOLTS/DIV Switch settings	Oscilloscope calibrator Voltage output	Oscilloscope calibrator Err display limits (±%)
2 m	12 mV	3
5 ¹ m	30 mV	3
10 m	60 mV	3
20 m	120 mV	3
50 m	.3 V	3
.1 V	.6 V	3
.2 V	1.2 V	3
.5 V	3.0 V	3
1 V	6.0 V	3
2 V	12.0 V	3
5 V	30.0 V	3
10 V ¹	60.0 V	3

¹For Tektronix, Type 475A.

(11) Move TI connection from **CH1** to **CH2**.

(12) Press **VERT MODE CH2** pushbutton and set **CH2 AC-GND-DC** switch to **DC**.

(13) Set **CH2 VOLTS/DIV** switch to **2 m** (**5 m** for Tektronix, Type 475A).

(14) Press oscilloscope calibrator **VOLTAGE** pushbutton to illuminate green LED and ensure frequency is set to **1 kHz**.

(15) Perform steps (a) through (c) below:

(a) Use technique of (b) and (c) below for **TI VOLTS/DIV** switch settings and oscilloscope calibrator **VOLTAGE** outputs of those listed in table 4.

(b) Rotate TI **CH 2 POSITION** knob to center trace on crt.

(c) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to obtain **6** divisions of vertical display. Oscilloscope calibrator **err** display will indicate within limits specified in table 4.

Table 4. Channel 2 Vertical Deflection Accuracy

Test instrument VOLTS/DIV switch settings	Oscilloscope calibrator Voltage output	Oscilloscope calibrator Err display limits ± %
2 m	12 mV	3
5 ¹ m	30 mV	3
10 m	60 mV	3
20 m	120 mV	3
50 m	.3 V	3
.1 V	.6 V	3
.2 V	1.2 V	3
.5 V	3.0 V	3
1 V	6.0 V	3
2 V	12.0 V	3
5 V	30.0 V	3
10 V ¹	60.0 V	3

¹For Tektronix, Type 475A.

b. Adjustments. Set oscilloscope calibrator to required parameter listed in table 5 for particular TI you are calibrating. Perform appropriate adjustments listed in table 5 for 6 divisions of vertical display on TI.

Table 5. Adjustment Guide

Parameter (mV gain)	Tektronix type	Serial number	Adjustments (fig. 1) (R)
2	475	Below B250000	CH 1 R125 CH 2 R225
2	475	B250000 and up	CH 1 R195 CH 2 R295
5	475	All SN's	CH 1 R165 CH 2 R265
5	475A	---	CH 1 R195 CH 2 R295
10	475A	---	CH 1 R165 CH 2 R265

9. Main Sweep Timing

NOTE

For oscilloscopes with digital multimeters attached, refer to calibration section of digital multimeter manual at this point.

a. Performance Check

- (1) Press **VERT MODE CH1** pushbutton and set **VOLTS/DIV** switch to **.5 V**.
- (2) Perform steps (a) through (d) below:

(a) Press oscilloscope calibrator **MARKER** pushbutton to illuminate green **LED** and ensure oscilloscope calibrator output is set to **1.000 ms**.

(b) Connect oscilloscope calibrator **CHAN 1** to TI **CH1** through **50W** termination.

(c) Press oscilloscope calibrator **OPR/STBY** pushbutton for **OPR** indication on oscilloscope calibrator display.

(d) Ensure TI **TIME/DIV** is set to **1 ms**.

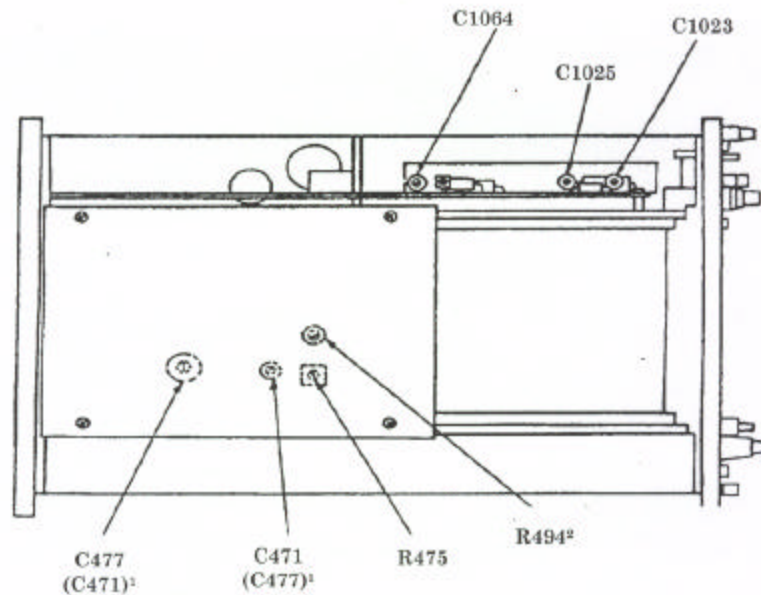
(3) Rotate **POSITION** knob to align 1st time marker to 1st verticule graticule line on TI crt.

(4) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton for 1 time marker per division on crt. Oscilloscope calibrator **err** display will indicate within limits specified in table 6.

(5) Repeat technique of (3) and (4) above for TI settings and oscilloscope calibrator **MARKER** outputs listed in table 6. Perform TI adjustments for each **TIME/DIV** switch position listed in table 6 as needed.

Table 6. Timing Accuracy

Oscilloscope calibrator MARKER output settings	Test instrument TIME/DIV switch settings	Test instrument X10 MAG pushbutton settings	Oscilloscope calibrator err display limits (±%)	Adjustments (R)
1 ms	1 ms	Out	1	b1
1 μs	10 μs	In	2	
10 μs	10 μs	Out	1	C1064 (fig. 2)
1 μs	10 μs	In	2	
.1 μs	.1 μs	Out	1	C1009 (fig. 3)
10 ns	.1 μs	In	2	



¹Type 475 with SN B250000-up.

²Optional with SN B250000-up

Figure 2. Adjustment locations - top view.

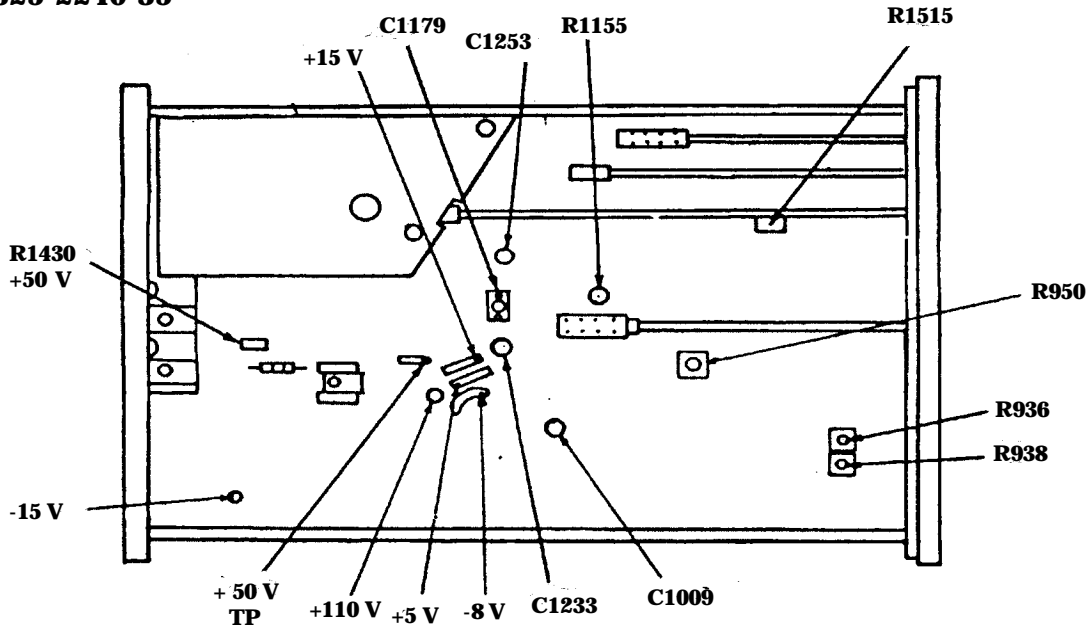


Figure 3. Adjustments locations - bottom view.

- (6) Perform steps (a) through (d) below:
 - (a) Set TI **A COUPLING** switch to **LF REJ**.
 - (b) Set TI **A SOURCE** switch to **CH1**.
 - (c) Press TI **X10 MAG** pushbutton to on (in).
 - (d) Press **TRIG MODE NORM** pushbutton to (in).

NOTE

You may need to adjust **A TRIGGER SLOPE LEVEL** for a stable display in step (8) below.

- (7) Set oscilloscope calibrator output and TI to settings listed in table 7.
- (8) Adjust horizontal **POSITION** control to align 1 marker per division. TI will indicate as listed in table 7 .1 marker per division. Perform adjustments listed in table 7 if required.

Table 7. Delay Time and Differential Measurement

Test instrument VOLTS/DIV switch settings	Test instrument TIME/DIV switch settings		Oscilloscope calibrator MARKER output	Test instrument indications 1 per division ± minor divisions	Test instrument adjustments
	A	B			
.5 V	.05 μs	.05 μs	5 ns	2	b(2)

- (9) Set **A SOURCE** switch to **NORM**, and **A COUPLING** switch to **AC**.
- (10) Press **X10 MAG (IN)** pushbutton to off (out).

(11) Use technique of (12) and (13) below for TI **TIME/DIV** switch settings and oscilloscope calibrator **MARKER** settings listed in table 8. Perform adjustments as needed listed in table 8.

(12) Adjust horizontal **POSITION** control to align 1st time marker with 1st graticule line.

(13) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to obtain 1 marker per division on TI. Oscilloscope calibrator **err** display will indicate within limits specified in table 8.

b. Adjustments

(1) Set oscilloscope calibrator **MARKER** output to **1 ms**. Press oscilloscope calibrator **OPR/STBY** pushbutton for **OPR** indication on oscilloscope calibrator display and adjust R1155 (fig. 3) for 1 marker per division (R).

NOTE

Interaction exists between C1233, C1253, and C1179 (fig. 3).
Adjust for best in-tolerance condition.

(2) Adjust C1233 and C1253 (fig. 3) in equal amounts until TI displays 1 marker per division (R).

(3) Set oscilloscope calibrator **MARKER** output to **20 ns**. Adjust C1179 (fig. 3) for 1 marker per division (R).

Table 8. Sweep Timing Accuracy

Test instrument TIME/DIV switch settings	Oscilloscope calibrator MARKER output settings	Oscilloscope calibrator err display limits (±%)	Test instrument adjustments
.02 μs	.02 μs	1	b(3)
.01 μs	10 ns	1	
.05 μs	50 ns	1	
.2 μs	.2 μs	1	
.5 μs	.5 μs	1	
1 μs	1 μs	1	
2 μs	2 μs	1	
5 μs	5 μs	1	
20 μs	20 μs	1	
50 μs	50 μs	1	
.1 ms	.1 ms	1	
.2 ms	.2 ms	1	
.5 ms	.5 ms	1	
1 ms	1 ms	1	
2 ms	2 ms	1	
5 ms	5 ms	1	

Table 8. Sweep Timing Accuracy - Continued

Test instrument TIME/DIV switch settings	Oscilloscope calibrator MARKER output settings	Oscilloscope calibrator err display limits (± %)	Test instrument adjustments
10 ms	10 ms	2	
20 ms	20 ms	2	
50 ms	50 ms	2	
.1 s	.1 s	2	
.2 s	.2 s	2	
.5 s	.5 s	2	

10. Delay Time and Differential Time Measurement

a. Performance Check

- (1) Position controls as listed in (a) through (g) below:
 - (a) **HORIZ DISPLAY A INTEN** pushbutton pressed (in).
 - (b) **DELAY TIME POSITION** dial to **1.00**.
 - (c) Press **TRIG MODE AUTO** pushbutton to (in).
 - (d) Press **X10 MAG (IN)** pushbutton to (in).
 - (e) Ensure oscilloscope calibrator **CHAN 1** is connected to TI **CH1** through 50Ω feedthrough termination.
 - (f) Set TI **VOLTS/DIV**, **TIME/DIV** switch settings and oscilloscope calibrator **MARKER** output as listed in table 9.
 - (g) Adjust **A TRIGGER SLOPE LEVEL** as needed for a stable trace on crt.

NOTE

For Tektronix, Type 475, SN B250000, and above, and Tektronix, Type 475A, perform (3) below then proceed to (4). For all other models, proceed to (4) below.

- (2) Adjust horizontal **POSITION** control to align 1st time marker with 1st graticule line. Rotate oscilloscope calibrator knob located below **EDIT FIELD** output to obtain **1** marker per division on TI. Oscilloscope calibrator **err** display will be within limits specified in table 9. Perform adjustments, if required, listed in table 9.

Table 9. Delay Time and Differential Measurement

Test instrument VOLTS/DIV switch settings	Test instrument TIME/DIV switch settings		Oscilloscope calibrator MARKER output	Oscilloscope calibrator err display limits (±%)	Test instrument adjustments
	A	B			
.5	1 μs	10 μs	1 μs	2	b(1)

- (3) Press **HORIZ DISPLAY B DLY'D** pushbutton (in).
- (4) Press **X10 MAG (IN)** pushbutton to (out).
- (5) Set TI **VOLTS/DIV, TIME/DIV** switch settings and oscilloscope calibrator output as listed in table 10.
- (6) Adjust horizontal **POSITION** control to align start of sweep with center vertical graticule line. Leading edge of displayed time marker will be aligned with the center vertical graticule line; if not, perform adjustment listed in table 10.

Table 10. Delay Time and Differential Measurement

Test instrument VOLTS/DIV switch settings	Test instrument TIME/DIV switch settings		Oscilloscope calibrator MARKER output settings	Test instrument adjustment
	A	B		
.5	10 μ s	0.1 μ s	10 μ s	b(2)

- (7) Set TI **VOLTS/DIV, TIME/DIV** switch and oscilloscope calibrator output as listed in table 11.
- (8) Rotate **DELAY TIME POSITION** dial to **9.00**. Leading edge of displayed time marker will be aligned with center vertical graticule line; if not, perform adjustment listed in table 11.

Table 11. Delay Time and Differential Measurement

Test instrument VOLTS/DIV switch settings	Test instrument TIME/DIV switch settings		Oscilloscope calibrator MARKER output settings	Test instrument DELAY TIME POSITION dial limits (\pm)	Test instrument adjustment
	A	B			
.5	10 μ s	0.1 μ s	10 μ s	.05	b(3)

- (9) Rotate **DELAY TIME POSITION** dial to **1.00**.
- (10) Set TI **VOLTS/DIV, TIME/DIV** switch settings and oscilloscope calibrator output as listed in table 12.
- (11) Adjust horizontal **POSITION** control to align 1st marker with center vertical graticule line using test instrument settings and oscilloscope calibrator **MARKER** output setting listed in table 12.
- (12) Rotate **DELAY TIME POSITION** dial to align 9th time marker with center vertical graticule line. **DELAY TIME POSITION** dial will indicate as listed in table 12. If not, perform test instrument adjustments listed in table 12.

Table 12. Delay Time and Differential Measurement

Test instrument VOLTS/DIV switch setting	Test instrument TIME/DIV switch setting		Oscilloscope calibrator MARKER output setting	Test instrument DELAY TIME POSITION dial limits		Test instrument adjustments
	A	B		Min	Max	
.5	10 μ s	10 μ s	10 μ s	8.95	9.05	b(4) through (7)

NOTE

You may need to adjust **A TRIGGER SLOPE LEVEL** for a stable display.

(13) Set TI **VOLTS/DIV**, **TIME/DIV** switch settings and oscilloscope calibrator output as listed in table 13.

(14) Rotate **DELAY TIME POSITION** dial to **1.00**.

(15) Set TI **VOLTS/DIV**, **TIME/DIV** switch settings and oscilloscope calibrator output as listed in table 13.

(16) Adjust horizontal **POSITION** control to align **1st** marker with center vertical graticule line using test instrument settings and oscilloscope calibrator **MARKER** output setting listed in table 13.

(17) Rotate **DELAT TIME POSITION** dial to align **9th** time marker with center vertical graticule line. **DELAY TIME POSITION** dial will indicate between 8.95 and 9.05; if not, perform adjustments listed in table 13.

(18) Rotate **DELAY TIME POSITION** knob to **0.0** .

Table 13. Delay Time and Differential Measurement

Test instrument VOLTS/DIV switch settings	Test instrument TIME/DIV switch settings		Oscilloscope calibrator MARKER output settings	Test instrument DELAY TIME POSITION dial limits		Test instrument adjustments
	A	B		Min	Max	
.5	0.1 μ s	0.1 μ s	0.1 μ s	8.95	9.05	b(8) through (11)

b. Adjustments

(1) Adjust R950 (fig. 3) for 1 time marker per division (R).

(2) Adjust R938 (fig. 3) until start of sweep is aligned with the leading edge of the displayed time marker (R).

NOTE

Interaction occurs between R936 and R938 (fig. 3). Readjust as necessary for best in-tolerance condition.

(3) Adjust R936 (fig. 3) until start of sweep is aligned with the leading edge of the displayed time marker (R).

- (4) Set **DELAY TIME POSITION** dial to **1.00**.
- (5) Adjust C1023 (fig. 2) to align time marker with center vertical graticule line (R).
- (6) Set **DELAY TIME POSITION** dial to **9.00**.
- (7) Readjust C1023 (fig. 2) for best in-tolerance condition between **DELAY TIME POSITION** dial readings of **1.00** and **9.00** to align time marker with center vertical graticule line (R).
- (8) Set **DELAY TIME POSITION** dial to **1.00**.
- (9) Adjust C1025 (fig. 2) to align time marker with center vertical graticule line (R).
- (10) Set **DELAY TIME POSITION** dial to **9.00**.
- (11) Readjust C1025 (fig. 2) for best in-tolerance condition between **DELAY TIME POSITION** dial readings of **1.00** and **9.00** to align time marker with center vertical graticule line (R).

11. Risettime and Bandwidth

a. Performance Check

- (1) Press **HORIZONTAL DISPLAY A (A LOCKS KNOBS** for SN B250000 and above) pushbutton (in). Connect oscilloscope calibrator **CHAN 1** to TI **CH1** through **10x** attenuator and **50W** termination.
- (2) Press and release **20 MHz BW/TRIG VIEW** pushbutton to full bandwidth and press **VERT MODE CH1** pushbutton (in).
- (3) Set TI **VOLTS/DIV CH1** switch to **5m (10m** for Tektronix, Type 475A).
- (4) Use technique of step 5 below for TI settings and oscilloscope calibrator output settings listed in table 14.
- (5) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to adjust amplitude for 5 divisions of vertical deflection on TI. Square wave will have aberrations not more than those listed in table 14; if not, perform adjustment as listed in table 14.

Table 14. High Frequency Compensation Adjustments

Oscilloscope calibrator EDGE settings		Test instrument			
Amplitude	Frequency	TIME/DIV switch settings (μ s)	Aberration limits minor division or minor division pk-pk ($<$)	CH1 adjustments (R)	Portion of waveform affected
200 mVpp	1 MHz	0.1	1	C175, R175 (fig. 1)	10 ns from leading edge 2 ns from leading edges Front corner
		0.05		C133, R133 (fig. 1)	
				C112, R112 (fig. 1)	
200 mVpp	100 kHz	.5 μ s	1	C471, C477 ³ (fig. 2)	Top and corner

See footnotes at end of table.

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Table 14. High Frequency Compensation Adjustments - Continued

Oscilloscope calibrator EDGE settings		Test instrument			
AMPLITUDE	FREQUENCY	TIME/DIV switch settings (μ s)	Aberration limits minor division or minor division pk-pk ($<$)	CH1 adjustments (R)	Portion of waveform affected
200 mVpp	10 kHz	20	1	R109 (fig. 1) ¹	Top and corner
		10		R139 (fig. 1)	
		5		R475 (fig. 2) ^{2,3}	
		1		R494 (fig. 2) ³	

¹Test instrument with SN B250000 and above.

²Optional on some test instruments.

³Affect both **CH1** and **CH2**. Readjust as necessary.

(6) Remove TI connection from **CH1** and connect to **CH2** and press **VERT MODE CH2** pushbutton (in).

(7) Set TI **VOLTS/DIV CH2** switch to **5m (10m** for Tektronix, Type 475A).

(8) Use technique of step 9 below for TI settings and oscilloscope calibrator output listed in table 15.

(9) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to adjust amplitude for 5 divisions of vertical deflection on TI. Square wave will have aberrations not more than those listed in table 15, if not perform adjustment listed in table 15.

Table 15. High Frequency Compensation Adjustments

Oscilloscope calibrator EDGE settings		Test instrument			
AMPLITUDE	FREQUENCY	TIME/DIV switch settings (μ S)	Abberation limits minor division or minor division pk- pk ($<$)	CH2 adjustments (R)	Portion of waveform affected
200 mVpp	1 MHz	0.1	1	C275, R275 (fig. 1)	10 ns from leading edge 2 ns from leading edges Front corner
		0.05		C233, R233 (fig. 1)	
200 mVpp	100 kHz	0.5	1	C471, C477 ³ (fig. 2)	
200 mVpp	10 kHz	20	1	R209 (fig. 1) ¹	Top and corner
		10		R239 (fig. 1)	
		5		R475 (fig. 2) ^{2,3}	
		1		R494 (fig. 2) ³	

¹Test instrument with SN B250000 and above.

²Optional on some test instruments.

³Affect both **CH1** and **CH2**. Readjust as necessary.

(10) Connect oscilloscope calibrator **CHAN 1** to TI **CH1** through 10x attenuator, 50Ω feedthrough termination, and 5 - 80 pF standardizer.

(11) Pull **20 MHz /TRIGVIEW** pushbutton out to **20 MHz**.

(12) Set TI **TIME/DIV** switch to **.2 ms**

(13) Oscilloscope calibrator output to **500 mV** at **1 kHz**.

(14) Set **CH1 VOLTS/DIV** switch to **5 m (10 m** for Tektronix, Type 475A) and press **VERT MODE CH1** pushbutton (in).

(15) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to adjust amplitude for **5** divisions of vertical deflection on TI. Adjust standardizer for optimum square wave presentation. If optimum square wave presentation cannot be obtained, perform adjustments listed in table 16.

(16) Repeat technique of (15) above for remaining TI **VOLTS/DIV** switch settings listed in table 16 (do not readjust standardizer). If optimum square wave presentation cannot be obtained, perform adjustments listed in table 16.

Table 16. Voltage Compensation

Oscilloscope calibrator EDGE settings	Test instrument VOLTS/DIV settings	Test instrument CH1 and CH 2 adjustments (fig. 1) (R)			
		Tektronix, Type 475		Tektronix, Type 475A	
		Square corner	Flat top	Square corner	Flat top
500 mV pp	5 m	---	C10 (CH1) ¹ C50 (CH2) ¹	---	---
1 V pp	10 m	C36	C37	---	C10 (CH1) ¹ C50 (CH2) ²
1 V pp	20 m ²	C34	C35	C36	C37
250 mV pp	50 m ³	C32	C33	C34	C35
500 mV pp	.1	---	---	C32	C33
1.25 V pp ⁴	.5	C30	C31	---	---
1.25 V pp ^{4,5}	1	---	---	C30	C31

¹Adjust for optimum results between square corners and flat tops.

²Remove termination from setup.

³Attenuators from setup.

⁴Maximum amplitude for oscilloscope calibrator. Make adjustments as best as possible.

⁵Adjust **A TRIGGER** for stable display if required.

(17) Connect oscilloscope calibrator **CHAN 1** to TI **CH2** through 10x attenuator, 50Ω feedthrough termination, and **5 - 80 pF** standardizer.

(18) Set TI **TIME/DIV** switches to **.2 ms**.

(19) Set oscilloscope calibrator output to **500 mV** at **1 kHz**.

(20) Set **CH2 VOLTS/DIV** switch to **5 m (10 m** for Tektronix, Type 475A) and press **VERT MODE CH2** pushbutton (in).

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(21) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to adjust amplitude for 5 divisions of vertical deflection on TI. Adjust standardizer for optimum square wave presentation. If optimum square wave presentation cannot be obtained, perform adjustments listed in table 17.

(22) Repeat technique of (21) above for remaining TI **VOLTS/DIV** switch settings listed in table 17 (do not readjust standardizer). If optimum square wave presentation cannot be obtained, perform adjustments listed in table 17

Table 17. Voltage Compensation

Oscilloscope calibrator EDGE settings	Test instrument VOLTS/DIV settings	Test instrument CH1 and CH 2 adjustments (fig. 1) (R)			
		Tektronix, Type 475		Tektronix, Type 475A	
		Square corner	Flat top	Square corner	Flat top
500 mV pp	5 m	---	C10 (CH1) ¹ C50 (CH2) ¹	---	---
1 V pp	10 m	C36	C37	---	C10 (CH1) ¹ C50 (CH2) ²
1 V pp	20 m ²	C34	C35	C36	C37
250 mV pp	50 m ³	C32	C33	C34	C35
500 mV pp	.1	---	---	C32	C33
1.25 V pp ⁴	.5	C30	C31	---	---
1.25 V pp ^{4,5}	1	---	---	C30	C31

¹ Adjust for optimum results between square corners and flat tops.

² Remove termination from setup.

³ Attenuators from setup.

⁴ Maxium amplitude for oscilloscope calibrator. Make adjustments as best as possible.

⁵ Adjust **A TRIGGER** for a stable display if required.

(23) Connect oscilloscope calibrator **CHAN 1** to TI **CH1** through **50W** feedthrough termination.

NOTE

Ensure **50W** feedthrough termination, wattage, and frequency ratings are adequate for test below.

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

- (a) **TRIG MODE AUTO** pushbutton pressed (in).
- (b) **X10 MAG** pushbutton pressed to on (in).
- (c) Press and release **20 MHz BW/TRIG VIEW** pushbutton to full bandwidth.
- (d) **VERT MODE CH1** pushbutton pressed (in).

NOTE

Ensure oscilloscope calibrator **FASTEDG** and **TDPULSE** are off when performing steps below.

(25) Perform steps (a) through (c) below:

(a) Ensure oscilloscope calibrator **EDGE** pushbutton green **LED** is illuminated.

(b) Set TI **VOLTS/DIV**, **TIME/DIV** switch settings and oscilloscope calibrator **EDGE** output to settings listed in table 18. Use technique of step (c) below for TI switch settings and oscilloscope calibrator **EDGE** output settings listed in table 18.

(c) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to adjust amplitude for 5 divisions on TI crt and measure risetime using standard risetime technique. Risetime limits are listed in table 18.

Table 18. Channel 1 Risetime Measurement

Test instrument switch settings		Oscilloscope calibrator EDGE output settings		Test instrument risetime limits (\leq)
VOLTS/DIV	TIME/DIV	Amplitude	Frequency	
5 m	0.01 μ s	25 mVpp	10 MHz	1.75 ns
10 m (Tektronix, Type 475A)	0.01 μ s	25 mVpp	10 MHz	1.4 ns

(26) Move connection on TI to **CH2** and press **VERT MODE CH2** pushbutton (in).

NOTE

Ensure **CH2 VOLTS/DIV AC CND DC** switch is set to **DC** for steps below.

(27) Set TI **VOLTS/DIV**, **TIME/DIV** settings and oscilloscope calibrator **EDGE** output to settings listed in table 19. Use technique of step (28) below for TI switch settings and oscilloscope calibrator **EDGE** output settings listed in table 19.

(28) Rotate oscilloscope calibrator knob located below **EDIT FIELD** pushbutton to adjust amplitude for 5 divisions on TI crt and measure risetime using standard risetime technique. Risetime limits are listed in table 19.

Table 19. Channel 2 Risetime Measurement

Test instrument switch settings		Oscilloscope calibrator EDGE output settings		Test instrument risetime limits (\leq)
VOLTS/DIV	TIME/DIV	Amplitude	Frequency	
5 m	0.01 μ s	25 mV pp	10 MHz	1.75 ns
10 m (Tektronix, Type 475A)	0.01 μ s	25 mV pp	10 MHz	1.4 ns

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(29) Press **VERT MODE CH1** pushbutton (in), and set **X10 MAG** pushbutton (out).

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

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

(32) Set TI **VOLTS/DIV**, **TIME/DIV** settings and oscilloscope calibrator **LEVEL SINE** output to settings listed in table 20.

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

Table 20. Bandwidth Measurement Setup

Test instrument switch settings		Oscilloscope calibrator LEVEL SINE output settings		Test instrument amplitude limits (divisions) (≥)
VOLTS/DIV	TIME/DIV	Amplitude	Frequency	
5 m	0.1 ms	30 mV pp	50 kHz to 200 MHz	4.2
10 m (Tektronix, Type 475A)	0.1 ms	60 mV pp	50 kHz to 250 MHz	4.2

NOTE

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

(34) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to sweep oscilloscope from **50 KHz** to **200 MHz** while observing displayed waveform amplitude on TI crt. Displayed waveform will be 4.2 divisions or greater in amplitude throughout entire range to **200 MHz** (**250 MHz** for Tektronix, Type 475A).

b. Adjustments. No further adjustments.

12. Calibrator

a. Performance Check

(1) Connect TI **CALIBRATOR** (front panel) to TI **CH1**.

(2) Press **VERT MODE CH1** pushbutton (in).

(3) Press oscilloscope calibrator **VOLTAGE** pushbutton to illuminate green **LED**.

(4) Set **TIME/DIV** to **.2 ms** and **CH1 VOLTS/DIV** switch to **50 m**. Adjust **CH1 VOLTS/DIV VAR** control for 6 divisions of vertical deflection on TI.

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

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(6) Set TI switch settings and oscilloscope calibrator output as listed in table 21.

(7) Rotate oscilloscope calibrator knob below **EDIT FIELD** pushbutton to adjust for 6 divisions of vertical deflection on TI. Oscilloscope calibrator **err** display will indicate as specified in table 21, if not perform **b** below.

Table 21. TI Calibrator Output Check

Test instrument switch settings		Oscilloscope calibrator VOLTAGE output settings		Test instrument Err display limits (±%)
VOLTS/DIV	TIME/DIV	Amplitude	Frequency	
50 m	.2 ms	300 mV pp	1 kHz	1

b. Adjustments

(1) Set oscilloscope calibrator **DEVIATION** switch to **OFF**.

(2) Adjust TI **VOLTS/DIV** controls for 6 divisions of vertical deflection on TI.

(3) Disconnect oscilloscope calibrator from TI and connect TI **CALIBRATOR** (front panel) and (ground) (front panel) to TI **CH1** input.

(4) Adjust R1515 (fig. 3) for 6 divisions of vertical deflection on TI (R).

13. Power Supply

NOTE

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

a. Performance Check

(1) Connect digital multimeter to TI test point +50 V (fig. 3) and chassis ground. Digital multimeter will indicate as listed in table 22 below; if not, perform **b** below.

(2) Repeat technique of (1) above for TI test points and voltage indications listed in table 22. Digital multimeter will indicate within limits specified in table 22.

Table 22. Power Supply Voltage

Test instrument test points (fig. 3)	Digital multimeter indications (V dc)	
	Min	Max
+50 V	+49.75	+50.25
+110 V	+107	+113
+15 V	+14.77	+15.23
+5 V	+4.92	+5.08
-15 V	-14.77	-15.23
-8 V	-7.88	-8.12

b. Adjustments. Adjust R1430 +50 V (fig. 3) for digital multimeter indication of +50 V (R).

14. Final Procedure

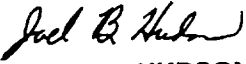
- a.** Deenergize and disconnect all equipment and reinstall protective cover on TI.
- b.** Annotate and affix DA label/form in accordance with TB 750-25.

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By Order of the Secretary of the Army:

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

OFFICIAL:


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0120708

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