

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR
SPECTRUM ANALYZER
TEKTRONIX, TYPE 7L5 (PL-1391/U)
W/PLUG-IN L1 AND L3

Headquarters, Department of the Army, Washington, DC
16 June 1988

Approved for public release; distribution is unlimited.

REPORTING OF ERRORS

You can help improve this publication by calling attention to errors and by recommending improvements and stating your reasons for the recommendations. Your letter or DA Form 2028, Recommended Changes to Publications, should be mailed directly to Commander, U.S. Army TMDE Support Group, ATTN: AMXTM-LPP, Redstone Arsenal, AL 35898-5400. A reply will be furnished directly to you.

SECTION		Paragraph	Page
I.	IDENTIFICATION AND DESCRIPTION		
	Test instrument identification	1	2
	Forms, records, and reports.....	2	2
	Calibration description.....	3	2
II.	EQUIPMENT REQUIREMENTS		
	Equipment required.....	4	3
	Accessories required.....	5	3
III.	CALIBRATION PROCESS		
	Preliminary instructions	6	5
	Equipment setup.....	7	6
	Readout verification (L3 plug-in only).....	8	7
	Calibrator frequency and amplitude.....	9	7
	Sweep triggering.....	10	10
	Dot frequency range and accuracy.....	11	11
	Display dynamic range	12	13
	Display flatness	13	16
	Frequency span accuracy and linearity.....	14	18
	Reference level accuracy (for L3 plug-in only).....	15	19
	Sweep rate accuracy.....	16	21
Displayed frequency stability	17	22	
Final procedure.....	18	23	

*This bulletin supersedes TB 9-6625-2005-35, 24 April 1981, including all changes.

SECTION I

IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Spectrum Analyzer, Tektronix, Type 7L5 (PL-1391/U) w/Plug-in L1 and L3. The manufacturer's manual was used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. None.

b. Time and Technique. The time required for this calibration is approximately 6 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
Calibrator	Frequency range: 500 kHz \pm 1 Hz Output voltage: - 40 dBV \pm .15 dB
Display	Dynamic range: Log 2 dB/DIV = 16 dB (\pm .15 dB/dB to 1 dB (max)) Accuracy: Log 10 dB/DIV = 80 dB (\pm .08 dB/dB to 2 dB (max))
Frequency span/div	Range: 50 Hz to 500 kHz Accuracy: \pm 5%
Sweep timing	Range: 0.01 ms to 10 s Accuracy: $\pm \geq$ 5%
Dot frequency	0 Hz to 4999.75 kHz (0° to 50°C \pm 20 Hz + 10 ⁻⁵ dot readout)
Display flatness	Frequency range: 20 Hz to 5 MHz Accuracy: \pm 0.7 dB (\pm 0.8 dB for L3 plug-in)

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications		
Frequency span	Range: 50Hz to 500 kHz/DIV Linearity: within 5% Accuracy: $\pm 5\%$		
Sweep rate	Range: 0.1 ms to 10 s Accuracy: within 5% of rate selected		
Sweep triggering	Range: 30Hz to 500 kHz Level: -1.5 div		
Reference level	Range	L1	L3
	Log 2 dB/DIV	-128 dBm to +21 dBm	-128 dBm to +21 dBm (50 Ω)
			-139 dBm to +10 dBm (600 Ω)
			-141 dBV to +8 dB V (Hi z)
	Log 10 dB/DIV	-70 dBm to +21 dBm	-70 dBm to +21 dBm (50 Ω)
			-81 dBm to +10 dBm (600 Ω)
			-83 dBV to +8 dBV (Hi Z)
Incremental accuracy	When calibrated at -40 dBV in log mode L1 and L3: Within 0.2 dB/dB with cumulative error of 0.25 dB/10 dB		

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-287. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The

equipment must meet or exceed the minimum use specifications listed in table 2.

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

Table 2. Minimum Specifications of Equipment Required

Item	Common name	Minimum use specifications	Manufacturer and model (part number)
A1	AC VOLTMETER	Frequency range: 500 kHz Accuracy: 1%	Hewlett-Packard, Model 400EL (7915906)
A2	ATTENUATOR	Range: 0 to 90 dB in 10 dB steps Accuracy: $\pm 0.25\%$	Hewlett-Packard, Model 355D (355D)
A3	ATTENUATOR	Range: 0 to 12 dB in 1 dB steps Accuracy: ± 0.25 dB	Hewlett-Packard Model 355C (79108075)
A4	AUTOTRANSFORMER	Range: 105 to 125 V ac Accuracy: $\pm 1\%$	General Radio, Model W10MT3AS3 or Ridge, Model 9020F (7910809)
A5	DIGITAL VOLTMETER	Voltage range: 0 to 20 V dc Accuracy: $\pm 1\%$	Hewlett-Packard, Model 3490AOPT060 (3490AOPT060) Dana, Model 5000, or Dana, Model 5000, w/641
A6	FREQUENCY COUNTER	Range: 499.9995 to 500.005 kHz Accuracy: 10^{-6}	Hewlett-Packard, Model 5345 (MIS- 28754/1 Type 1) w/5355A
A7	OSCILLOSCOPE	Must be compatible with TI	Tektronix, 7000 series (to be provided by customer)
A8	OSCILLOSCOPE CALIBRATOR	Markers out: 10 ms to 10 s	Ballantine, Model 6126M (MIS-28714 Type 1)
A9	TEST OSCILLATOR	Frequency: 10 Hz to 5 MHz Level accuracy: 1%	Hewlett-Packard, Model 652A (MIS- 10224)
A10	VERTICAL AMPLIFIER	Must be compatible with 7000 series oscilloscope	Tektronix, Types 7A15, 7A16, 7A18, etc.
A11	VARIABLE ATTENUATOR	Range: 0 to 69 dB Accuracy: From test report	Weinschel, Model AF117A-69-34 (AF117A-69-34)

Table 3. Accessories Required

Item	Common name (official nomenclature)	Description (part number)
B1	ADAPTER	BNC T-type, 2 jacks, 1 plug (MS35173-274C)
B2	ADAPTER	BNC plug terminations (MS35176-491B)
B3	ADAPTER ¹	N plug to BNC jack (10519457) (UG201A/U)
B4	ADAPTER	BNC plug to double banana jacks (7909401) (7907592)
B5	ADAPTER ¹	Single banana jack to alligator clip (7907560)
B6	CABLE	30-in., RG-58/U; double banana plug terminations (7907470)
B7	CABLE ¹	24-in., RG-58/U; BNC plug terminations (10519141)
B8	EXTENDER ¹	Tektronix, Model 067-0616-00 (067-0616-00)
B9	LEAD	32-in., single banana plug to test hook (red) (7915941-1)
B10	PROBE (TEST LEAD)	36-in., BNC plug to X10 probe, Tektronix, Type P6106 (11513202-1)
B11	TERMINATION (DUMMY LOAD)	50-Ω feed-through; BNC plug to BNC jack (11048B or 11048C)
B12	TEST LEAD	Single banana plug to test hook (SKC-4850-14 or 7916122)

¹Two required.

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 and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

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

d. 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.

NOTE

L3 plug-in switch positions are in parenthesis.

a. Install TI into center compartments of a 4-compartment or right two compartments of a 3-compartment oscilloscope (A7).

b. Select proper oscilloscope controls to correspond with plug-in compartments occupied by TI.

c. Connect autotransformer (A4) to oscilloscope.

d. Connect autotransformer to a 115-V ac power source and adjust controls for a 115-V ac output.

e. Set oscilloscope power switch to on and allow sufficient time for warmup and stabilization.

f. Position controls as listed in (1) through (15) below:

(1) **DOT MKR** control fully cw (detent position).

(2) **FREQUENCY SPAN/DIV** switch to **MAX.**

(3) **RESOLUTION (Hz)** switch to **COUPLED.**

(4) **REFERENCE LEVEL VAR** control fully cw (detent position).

(5) **BASELINE CLIPPER** control fully cw.

(6) **REFERENCE LEVEL LOG 10 dB/DIV** pushbutton on.

(7) **REFERENCE LEVEL** switch to **-40 dBV.**

(8) **REFERENCE LEVEL INPUT BUFFER** pushbutton off.

(9) **TRIGGERING SOURCE FREE RUN** pushbutton on.

(10) **TRIGGERING MODE NORM** pushbutton on.

(11) **DIGITAL STORAGE SAVE A** pushbutton to off.

(12) **DIGITAL STORAGE MAX HOLD** pushbutton off.

(13) **dBm/dBV** switch to **dBV** (plugin module switch).

(14) **INPUT TERMZ** switch to **50Q** (L3 plug-in only).

(15) **TIME/DIV** switch to **AUTO.**

g. Connect **CALIBRATOR** to plug-in **INPUT** using cable (B7).

h. Only perform i through l below if L3 plug-in is being used.

i. Position controls as listed in (1) through (8) below:

(1) **LOG 2 dB/DIV** pushbutton on.

(2) **FREQUENCY SPAN/DIV** control to **2 kHz.**

(3) **RESOLUTION (Hz)** control to **3 kHz.**

(4) **TIME/DIV** control to **0.2 s.**

(5) **DIGITAL STORAGE DISPLAY A and B** pushbuttons on.

(6) **VERT POSITION** control adjusted to place display on the bottom horizontal graticule line.

(7) **DOT FREQUENCY** control to 500.00 kHz.

(8) **LOG 10 dB/DIV** pushbutton on.

j. Adjust **LOG CAL** control for a full screen (8 division) display.

k. Push **LOG 2 dB/DIV** pushbutton to on and adjust **AMPL CAL** control (L3) for a full screen display.

l. Repeat i(8) through k above until displayed waveform is 8 vertical divisions.

NOTE

Perform m below if L1 plug-in is being used.

m. Position controls as listed in (1) through (10) below:

(1) **SWP CAL** and **HORIZ POSITION** controls adjusted until second and tenth vertical signals are aligned with second and tenth vertical graticule lines (counted from left edge).

(2) **FREQUENCY SPAN/DIV** control to **2 kHz**.

(3) **TIME/DIV** control to **0.2 s**.

(4) **DIGITAL STORAGE DISPLAY A** and **B** pushbuttons on.

(5) **VERT POSITION** control adjusted to place display baseline on bottom horizontal graticule line.

(6) **RESOLUTION (Hz)** control to **3K**.

(7) **DOT FREQUENCY CONTROL** to 500.00 kHz.

(8) **LOG CAL** control for a fullscreen display.

(9) **REFERENCE LEVEL LOG 2 dB/DIV** pushbutton on.

(10) **AMPL CAL** control for a full screen display.

8. Readout Verification (L3 Plug-in Only)

a. Performance Check

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

(a) **INPUT REF** switch to **dBm/50W**.

(b) **INPUT TERMNZ** switch to **50W**.

(c) **REFERENCE LEVEL** control for

+21 dBm.

(2) Position **INPUT REF** switch to **dBV** and observe art readout for a +8 dBV indication displayed.

(3) Position **INPUT REF** switch to **dBm/600W** and observe crt readout for a +10 dBm indication displayed.

NOTE

The **INPUT** connector is a three-conductor BNC connector with the outer ring used to detect the presence of a 10X probe.

(4) Short **INPUT** outer ring using adapter and lead (B4 and B12) and observe crt readout for a 20 dB increase.

b. **Adjustments** No adjustments can be made.

9. Calibrator Frequency and Amplitude

a. Performance Check

(1) Connect equipment as shown in figure 1.

(2) Observe frequency counter (A6) indication. If frequency counter does not indicate between 499.999 to 500.001 kHz, perform b(1) and (2) below.

(3) Observe digital voltmeter (A5) indication. If digital voltmeter does not indicate between .3579 to .3746 V dc, perform b(1) and (3) through (19) below.

b. Adjustments

(1) Remove T1 from oscilloscope and reconnect to oscilloscope using two extenders (B8).

(2) Adjust Y390 (fig. 2) for a frequency counter indication of 500.000 kHz.

(3) Remove plug-in module from T1 and place insulating tape (e.g., scotch tape) over pins A13, B13, A14, B14, A15, and B15 of interface connection (fig. 3).

(4) Reinsert plug-in module in T1.

(5) Connect test oscillator (A9) output (without the termination) to ac voltmeter (A1), using cable (B7).

(6) Adjust test oscillator controls for an output frequency of 500 kHz and 10 mV indication on ac voltmeter.

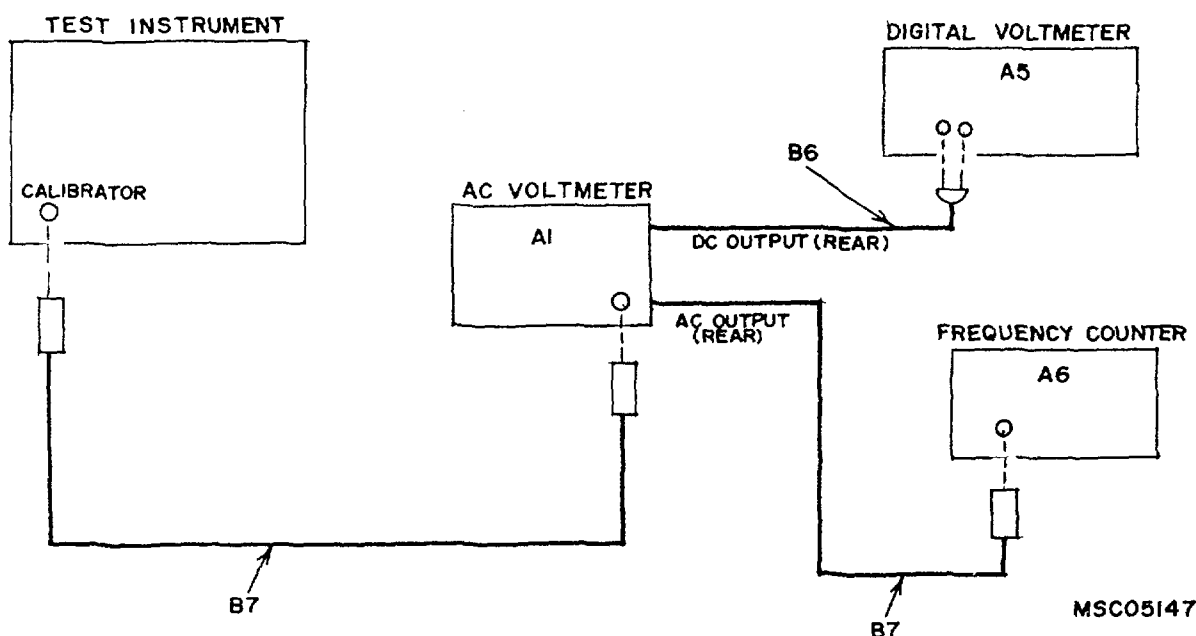


Figure 1. Calibrator accuracy - equipment setup.

(7) Disconnect cable from ac voltmeter input and reconnect to TI input.

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

- (a) **DOT FREQUENCY** control for **500 kHz**.
- (b) **FREQUENCY SPAN/DIV** control for **2 kHz**.
- (c) **RESOLUTION (Hz)** control to **30 k**.
- (d) **LOG 2 dB/DIV** pushbutton on.

(9) Adjust **REFERENCE LEVEL** control to display signal at center of crt and note signal position (reference).

(10) Disconnect cable from input and connect **CALIBRATOR** output to input, using cable (B7).

(11) Adjust R892 (fig. 2) for a **CALIBRATOR** output amplitude as noted in (9) above.

(12) Connect test oscillator output to ac voltmeter input, using cable (B7) and termination (B11).

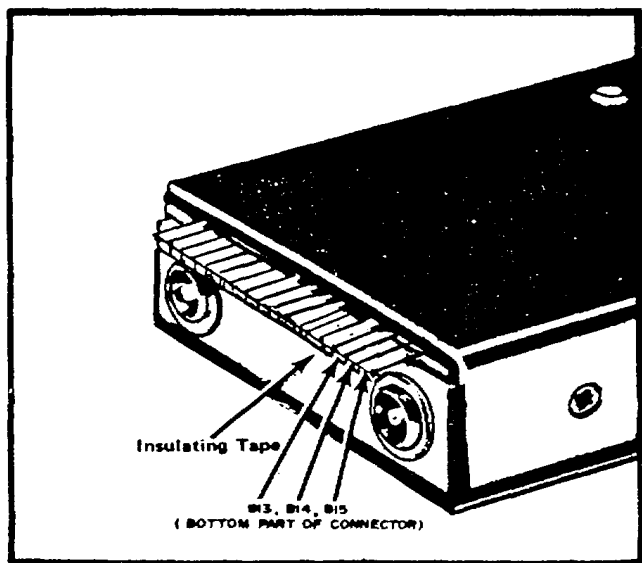
(13) Adjust test oscillator controls for an output frequency of 500 kHz and 10 mV indication on ac voltmeter.

(14) Disconnect termination from ac voltmeter and reconnect test oscillator output without termination to T1 plug-in input.

(15) Adjust **REFERENCE LEVEL** control to display signal at center of crt and note signal position (reference).

(16) Remove screws to swing down IF module assembly so pin 13 is accessible (fig. 4).

(17) Using lead and adapter (B12 and B5) short pin (B13) (fig. 4) to chassis ground.



MSC05149

Figure 2. Adjustment locations.

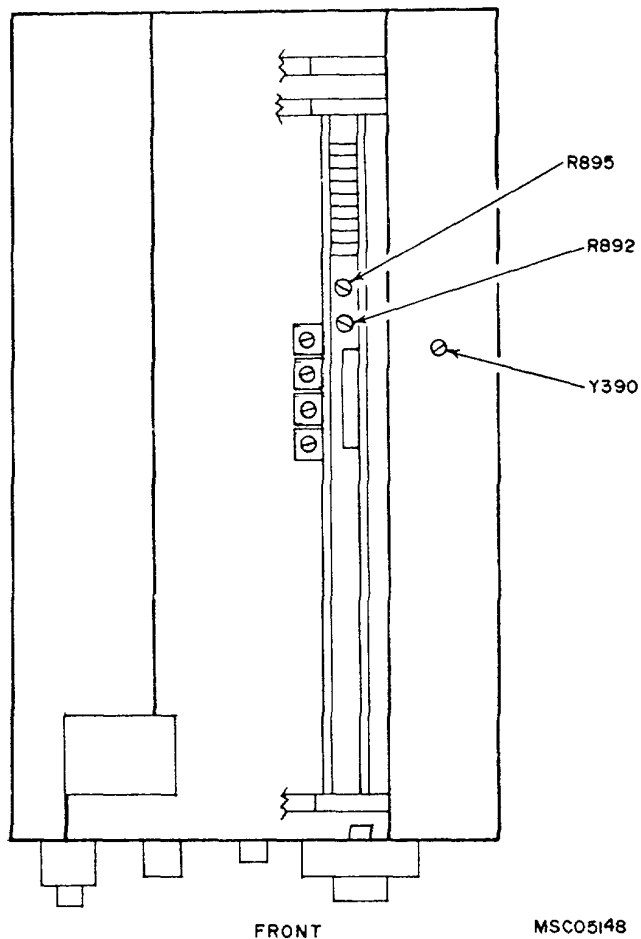
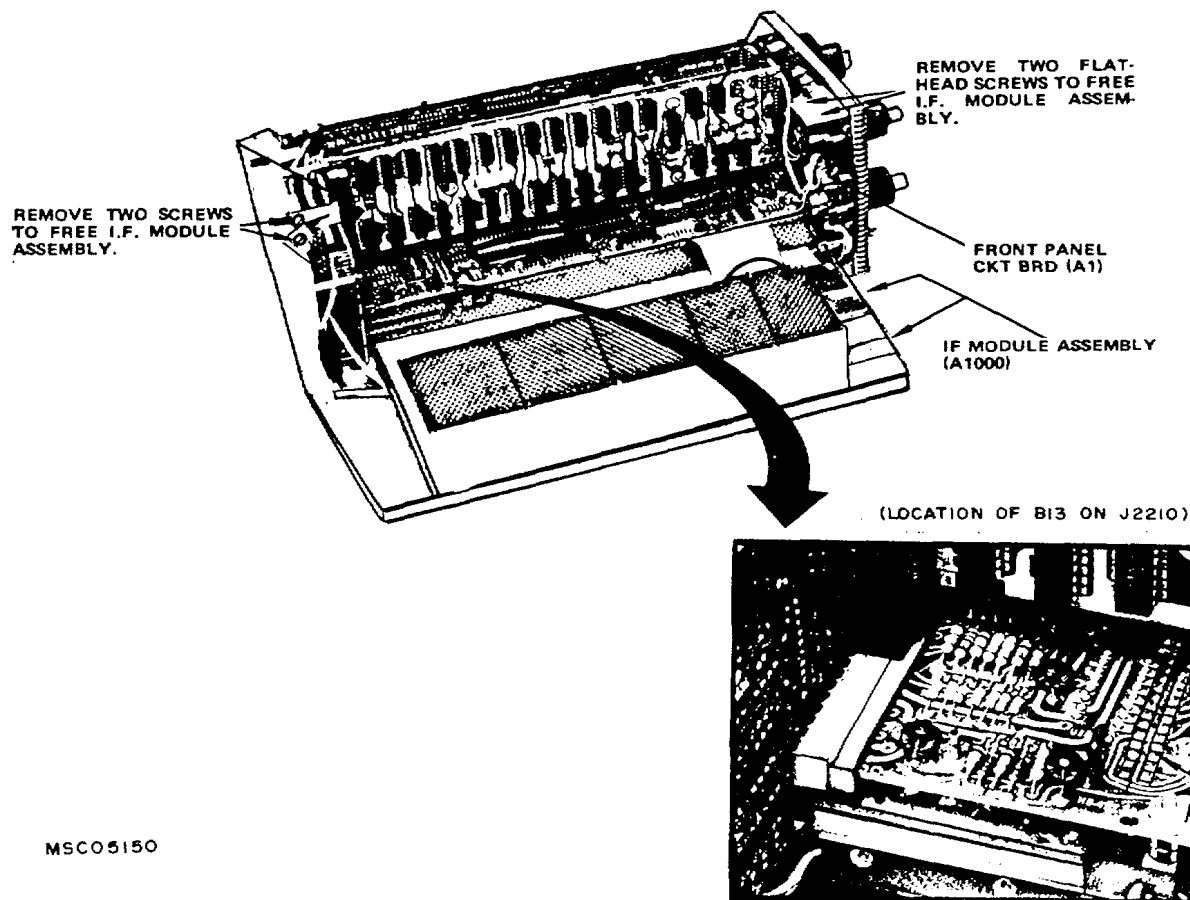


Figure 3. Plug-in module rear connector locations.

(18) Adjust R895 (fig. 2) for a **CALIBRATOR** output amplitude as noted in (15) above.

(19) Disconnect equipment setup, short, and tape from pins.



MSC05150

Figure 4. IF module swung down to expose internal locations.

10. Sweep Triggering

a. Performance Check

(1) Turn **POWER** switch of oscilloscope (A7) to off and install vertical amplifier (A10) in the left compartment.

(2) Turn **POWER** switch to on and press **VERT MODE LEFT** pushbutton in.

(3) Press **TRIG SOURCE LEFT** pushbutton in and connect test oscillator (A9) output to vertical amplifier CH1 input, using cable and termination (B7 and B11).

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

(a) **DIGITAL STORAGE** pushbuttons off.

(b) **FREQUENCY SPAN/DIV** control for 0.

(c) **TRIGGERING SOURCE NORM** pushbutton on.

(d) **TRIGGERING FREE RUN** pushbutton on.

(e) **TIME/DIV** control to 10 ms.

(5) Adjust test oscillator frequency control for 30 Hz and an amplitude level of 1.5 divisions.

(6) Press **TRIGGERING SOURCE INT** pushbutton on and adjust **LEVEL/SLOPE** control for a stable triggered display.

(7) Adjust test oscillator frequency control for 500 kHz output and repeat technique of (6) above.

(8) Press **TRIGGERING SOURCE FREE RUN** pushbutton on.

(9) Press **TRIGGERING MODE SGL SWP** pushbutton and observe that a sweep is initiated on crt.

(10) Press **TRIGGERING MODE MNL SWP** pushbutton on and adjust **MNL SWP** control to move trace over approximately the same range as the normal sweep.

b. Adjustments. No adjustments can be made.

11. Dot Frequency Range and Accuracy

a. Performance Check

(1) Disconnect test oscillator (A9) output from vertical amplifier (A10) and connect test oscillator to INPUT, using cable and adapter (B7 and B1).

(2) Connect **INPUT** to frequency counter (A6) input A, using cable (B7).

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

(a) **TRIGGERING SOURCE FREE RUN** pushbutton on.

(b) **TRIGGERING MODE NORM** pushbutton on.

(c) **DOT FREQUENCY** control to 500 kHz.

(d) **RESOLUTION** (Hz) control for COUPLED.

(e) **FREQUENCY SPAN/DIV** control for 50 (z).

(f) **TIME/DIV** control to **AUTO**.

(g) **LOG 2 dB/DIV** pushbutton on.

(h) **REFERENCE LEVEL** control for -20 dBm.

(4) Adjust test oscillator frequency controls for a 500 kHz signal with 6 divisions of amplitude on the crt.

(5) Adjust test oscillator frequency controls to place the displayed signal under frequency dot. If frequency counter does not indicate between 499,994 to 500,006 Hz perform b below.

(6) Repeat technique of (4) above, using settings listed in table 4. If frequency counter does not indicate within limits specified, perform b below.

b. Adjustments

(1) Remove TI from mainframe and reconnect, using two plug-in extenders (B8).

Table 4. Dot Frequency Range and Accuracy

Test instrument Crt frequency indication (kHz)	Frequency counter indications (Hz)	
	Min	Max
1000.00	999,993	1000,007
1500.00	1499,992	1500,008
2000.00	1999,991	2009,009
2500.00	2499,990	2500,010
3000.00	2999,989	3000,011
3500.00	3499,988	3500,012
4000.00	3999,987	4000,013
4500.00	4499,986	4500,014
4999.75	4999,735	4999,765

(2) Remove rf screen cover (on right side of T1) over honeycomb assembly and turn power on.

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

(a) **FREQUENCY SPMNIDIN** control for 0.

(b) **DOT FREQUENCY** control to 2500.00 kHz.

(c) **DOT MKR** control fully ccw (detent position).

(4) Connect digital voltmeter (A5) to base of Q365 (fig. 5) and chassis ground, using test leads (B9). Adjust R365 (fig. 5) for digital voltmeter indication of 11.00 V.

(5) Disconnect lead from base of Q365 and connect to pin 7 of U340 (fig. 5). Digital voltmeter will indicate 4.00 V.

(6) Disconnect lead from pin 7 of U340 and reconnect to pin 7 of U325 (fig. 5). Digital voltmeter will indicate 4.00 V.

(7) Disconnect digital voltmeter test leads from T1.

(8) Position **FREQUENCY SPAN/DIV** control for 5 kHz and adjust **HORIZ POSITION** control to center marker dot on center graticule line.

(9) Position **FREQUENCY SPAN/DIV** control to MAX and adjust R655 (fig. 6) to center dot marker on center graticule line (if necessary).

(10) Adjust **DOT FREQUENCY** control for 00.00 kHz indication on the crt and connect digital voltmeter positive lead to pin MH (fig. 5) and negative lead to chassis ground, using leads (B9). Record digital voltmeter indication.

(11) Adjust **DOT FREQUENCY** control for 4999.75 on crt and record new digital voltmeter indication.

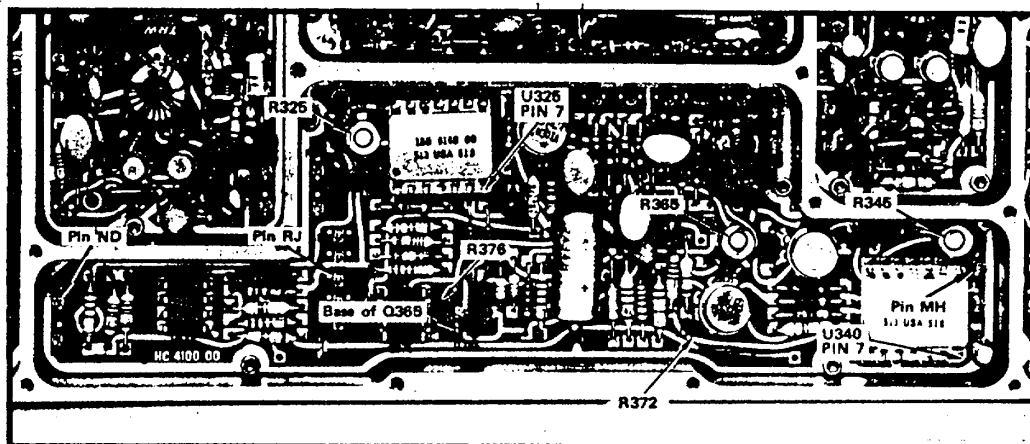
(12) Subtract digital voltmeter value recorded in (10) above from value recorded in (11) above. If the difference between the two values is not between 16.60 to 16.70, adjust R345 (fig. 5) for a digital voltmeter indication of 16.654.

(13) Adjust **DOT FREQUENCY** control for 99.75 kHz indication on the crt.

(14) Disconnect digital voltmeter positive lead from pin MH and reconnect to pin ND (fig. 5). Record digital voltmeter value.

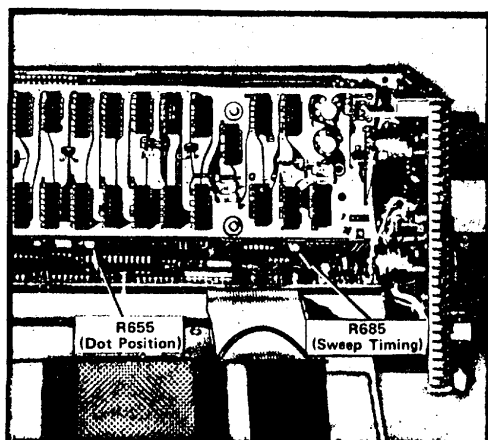
(15) Adjust **DOT FREQUENCY** control for 100.000 kHz indication on the crt. Record digital voltmeter new value.

(16) Subtract digital voltmeter value recorded in (14) above from value recorded in (15) above. If difference between the two values is not 18.0 V, adjust R325 (fig. 5) for a digital voltmeter indication of 18.00 V (difference).



MSC05151

Figure 5. A and B oscillator test point and adjustment location.



MSC05152

Figure 6. Sweep timing and dot position adjustment locations.

(17) Adjust **FREQUENCY SPAN/DIV** control to **2 kHz** and **RESOLUTION (kHz)** control to **50 (Hz)**.

(18) Connect **TI CALIBRATOR** output to **TI INPUT**, using cable (B7) and adjust **REFERENCE LEVEL** control -30 dBm (approximately).

(19) Observe span accuracy for 100 kHz on crt. Span accuracy will not exceed ± 4 percent.

(20) Adjust **DOT FREQUENCY** control for 99.75 kHz indication on the crt. Observe span accuracy for 99.75 kHz on crt. Span accuracy will not exceed ± 4 percent.

(21) Disconnect **CALIBRATOR** output from **INPUT**.

(22) Position **FREQUENCY SPAN/DIV** control to any setting other than **MAX** and adjust **HORIZ POSITION** control (front panel) to center marker dot on crt.

(23) Position **FREQUENCY SPAN/DIV** control to **MAX** and adjust **DOT FREQUENCY** control for 2500.00 kHz display indication.

(24) Connect **CALIBRATOR** output to **INPUT**, using cable (B7) and adjust **RESOLUTION (kHz)** control to **30 k**.

(25) Adjust **HORIZ POSITION** control to center 2500.00 kHz marker on center graticule line of crt.

(26) Adjust **SWP CAL** (front panel) adjustment for optimum span accuracy from 2500.00 to **500.00 kHz**.

(27) Disconnect **CALIBRATOR** output from **TI** plug-in **INPUT**.

12. Display Dynamic Range

a. Performance Check

(1) Connect equipment as shown in figure 7.

(2) Position controls as listed in (a) through

(g) below:

(a) **RESOLUTION (Hz)** control to **COUPLED**.

(b) **FREQUENCY SPAN/DIV** control for 1 kHz.

(c) **TIME/DIV** switch to **AUTO**.

(d) **LOG 10 dB/DIV** pushbutton on.

(e) **INPUT REF** switch to **dBm**.

(f) **DOT FREQUENCY** control for 500.00 kHz.

(g) **REFERENCE LEVEL** control for -40 dBm.

(3) Position attenuators (A2 and A3) to 0 dB and adjust **REFERENCE LEVEL VAR** control for full screen indication.

NOTE

It may be necessary to adjust reference after every 10 dB step.

(4) Increase attenuator in 10 dB steps to 70 dB, ensuring displayed signal will decrease between 9.5 and 10.5 dB at each 10 dB step.

(5) Increase attenuator to 8 dB (78 dB total), ensuring displayed signal will be attenuated between 76 to 80 dB.

- (6) Adjust both attenuator controls to 0 dB.
- (7) Position controls as listed in (a) through (c) below:

- (a) **FREQUENCY SPAN/DIV** control for 50 Hz.

- (b) **RESOLUTION (Hz)** control for 30 k.

- (c) **LOG 2dB/DIV** pushbutton on.

(8) Repeat technique of (3) above and add 15 dB of attenuation in 2 and 1 dB steps, ensuring displayed signal will decrease by 1 division for every 2 dB of attenuation.

(9) Total attenuation error of (8) above will not exceed ± 1 dB.

(10) Repeat technique of (3) above with **REFERENCE LEVEL LIN** pushbutton on and reference level adjusted for a 500 pV indication on the crt.

(11) Adjust attenuators for 10 dB and adjust **REFERENCE LEVEL VAR** control for an 8 division amplitude indication on crt.

(12) Increase attenuators 6 dB, ensuring displayed signal will decrease to 4 ± 0.2 divisions.

(13) Increase attenuators 8 dB, ensuring displayed signal will decrease to 2 ± 0.1 divisions.

(14) Adjust attenuators to 10 dB and adjust **REFERENCE LEVEL VAR** control fully cw.

(15) Adjust **REFERENCE LEVEL** control until displayed signal is at a reference point near full scale and record signal position on crt.

(16) Adjust **REFERENCE LEVEL VAR** control fully ccw (detent position). Displayed signal will decrease at least 4 divisions.

(17) Adjust attenuators until displayed signal is at reference point established in (15) above. Change in attenuation will be 8 dB or more.

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

- (a) **dBm/dBV** switch to **dBm**.

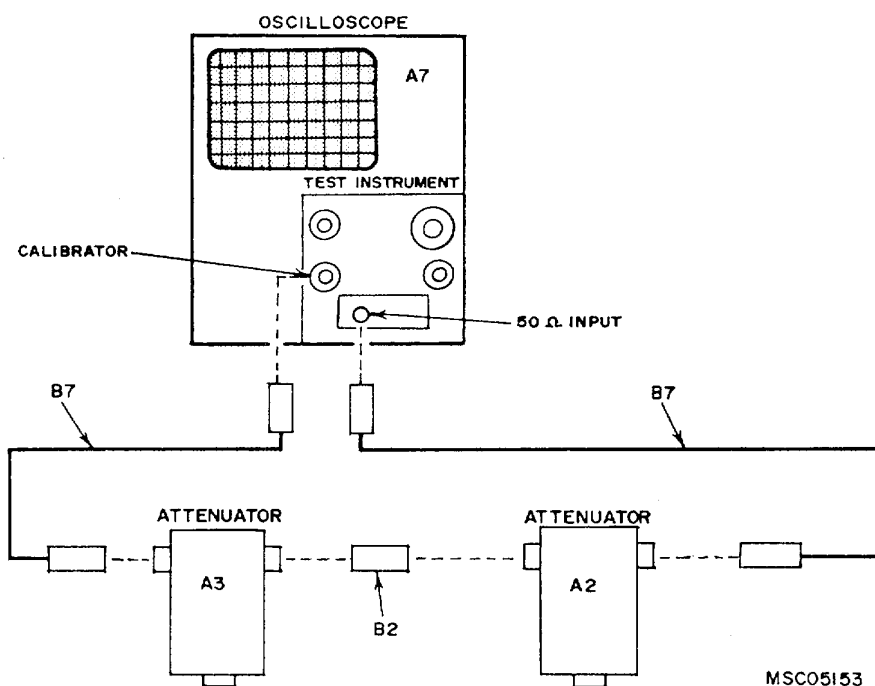


Figure 7. Display low accuracy - equipment setup

- (b) **LOG 2 dB/DIV pushbutton ON.**
- (c) **REFERENCE LEVEL** control for -29 dBm.
- (d) **RESOLUTION (Hz)** control for 3 kHz.
- (e) **FREQUENCY SPAN/DIV** control for 1 kHz.

- (19) Adjust attenuator for 2 dB attenuation.
- (20) Adjust **VERT POSITION** control as necessary to establish a graticule reference at signal peak and record position of signal on crt.
- (21) Set **REFERENCE LEVEL** switch to -30 dbm.
- (22) Increase attenuator to 3 dB, ensuring displayed signal will remain within ± 0.2 dB of signal level established in (20) above.
- (23) Set **REFERENCE LEVEL** control to -31 dBm.
- (24) Increase attenuator to 4 dB, ensuring displayed signal will remain within ± 0.25 dB of signal level established in (20) above.

- (25) Adjust **VERT POSITION** control as necessary to establish a new reference point. Record reference.
- (26) Pull **REFERENCE LEVEL 10 dB/STEP** control and adjust for a -41 dBm readout.
- (27) Increase attenuator to 24 dB, ensuring displayed signal will remain within ± 0.25 dB of signal level established in (25) above.
- (28) Repeat technique of (26) and (27) above, using settings and indications listed in table 5.
- (29) Decrease attenuators to 0 dB.
- (30) Press **REFERENCE LEVEL LIN** pushbutton on and adjust **REFERENCE LEVEL** control to 10 mV. Displayed signal amplitude will be 1 division ± 5 percent.
- (31) Repeat technique of (29) and (30) above, using settings and indications listed in table 6. Signal amplitude will be within limits specified.

b. Adjustments. No adjustments can be made.

Table 5. Attenuation

Test instrument REFERENCE LEVEL settings	Attenuator settings (dB)	Allowable error (dB)
-51	34	0.50
-61	44	0.75
-71	54	1.00
-81	64	1.25
-91	74	1.50
-101	84	1.75
-111	94	2.00
-121	104	2.25

Table 6. Linearity Accuracy

Test instrument REFERENCE LEVEL switch settings	Attenuator settings (dB)	Signal amplitude in divisions ± 5 percent
5 mV	0	2
2 mV	0	5
1 mV	6	5
0.5 mV	12	5
0.2 mV	20	5
0.1 mV	26	5
50 μ V	32	5
20 μ V	40	5
10 μ V	46	5
5 μ V	52	5
2 μ V	60	5
1 μ V	66	5
500 nV	72	5
200 nV	80	5
100 nV	86	5
50 nV	92	5
20 nV	100	5

13. Display Flatness**a. Performance Check**

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

(a) **DOT FREQUENCY** control for 500.000 kHz.

(b) **RESOLUTION (Hz)** control for **COUPLED**.

(c) **FREQUENCY SPAN/DIV** control for 100 kHz.

(d) **TIME/DIV** control to **AUTO**.

(e) **LOG 2 dB/DIV** pushbutton on.

(f) **REFERENCE LEVEL** control for -20 dBm indication.

(g) **DIGITAL STORAGE** pushbuttons

off.

(2) Connect test oscillator output to **INPUT**, using cable and termination (B7 and B11).

(3) Adjust test oscillator frequency controls for 500 kHz and an output level control of 6 divisions of amplitude on the crt. Record test oscillator output level monitor meter indication.

(4) Adjust test oscillator frequency controls to sweep display on crt while maintaining output level at level recorded in (3) above to 1 MHz. If display signal amplitude does not remain within .7 dB (.8 dB for L3 plug-in) from 6 division reference, perform b below.

(5) Repeat technique of (3) and (4) above with DOT FREQUENCY control set to 150.000 kHz, 2500.00 kHz, 3500.00 kHz, and 4500.00 kHz.

b. Adjustments

NOTE

No adjustments can be made for plug-ins L1 through L3, so verify if T1 is out of tolerance or plug-in before performing adjustments.

(1) Connect CALIBRATOR output to plug-in **INPUT** using cable (B7).

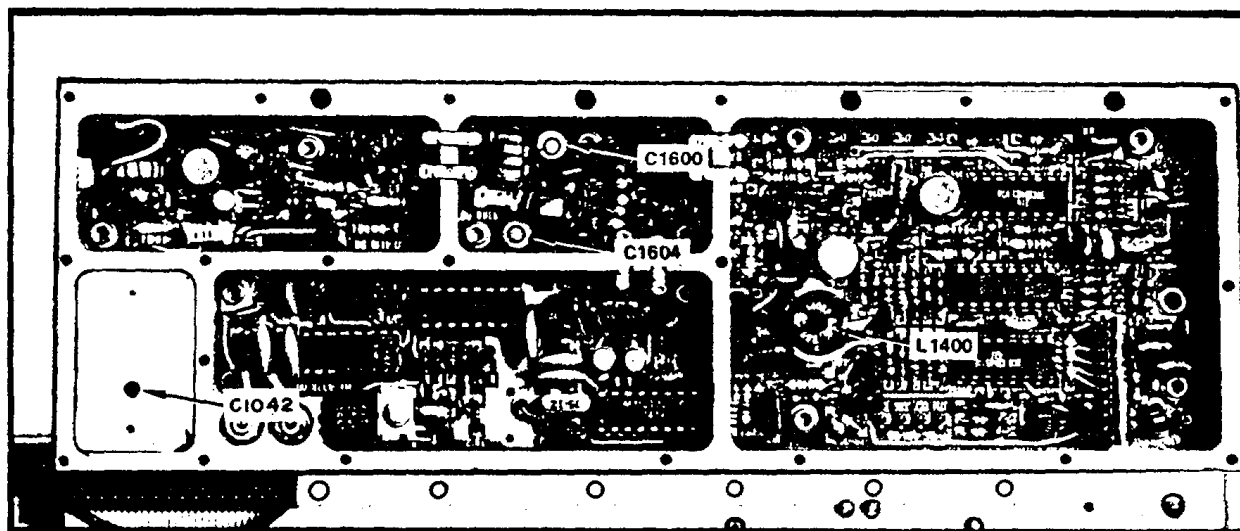
(2) Position controls as listed in (a) through (f) below:
 (a) **DOT FREQUENCY** control for 500 kHz.

- (b) **LOG 2 dB/DIV** pushbutton on.
- (c) **DIGITAL STORAGE** pushbuttons
- (d) **FREQUENCY SPAN/DIV** control for 0.
- (e) **RESOLUTION (Hz)** control for 30 kHz.
- (f) **TIME/DIV** control to 2 ms.

NOTE

It may be necessary to adjust **REFERENCE LEVEL** controls to position signal on crt.

(3) Observe oscilloscope display for a signal amplitude of >-30 dBm and adjust L1220 (fig. 8), L1400, C1604, C1600, and C1042 (fig. 8) for a maximum signal response (500 kHz) on oscilloscope crt.



MSC05154

Figure 8. 250 kHz IF amplifier, 10.8 MHz input filter and 2d mixer - adjustment and test point locations.

14. Frequency Span Accuracy and Linearity

a. Performance Check

(1) Disconnect test oscillator (A9) output from input and connect **CALIBRATOR** output to **INPUT** using cable (B7).

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

(a) **DOT FREQUENCY** control for 0.00 kHz.

(b) **RESOLUTION (Hz)** control for 30 kHz.

(c) **FREQUENCY SPAN/DIV** control for **MAX.**

(d) **TIME/DIV** control to **AUTO.**

(e) **REFERENCE LEVEL** control for **-30 dBm.**

(f) **LOG 10 dB/DIV** pushbutton on.

(3) Aline second marker with second graticule line and verify that each marker right from the second graticule line is coincident with each graticule line. If 8th marker is not within 5 percent (± 5 division), perform **b** below.

(4) Disconnect **CALIBRATOR** output from **INPUT** and connect oscilloscope calibrator (A8) marker output to **INPUT**, using cable (B7).

(5) Position oscilloscope calibrator controls for an output of 5 μ s.

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

(a) **DOT FREQUENCY** control for **4000.00 kHz.**

(b) **FREQUENCY SPAN/DIV** control for **200 kHz.**

(c) **RESOLUTION (Hz)** control for **10 kHz.**

(d) **REFERENCE LEVEL** control for **+10 dBm** or as required.

(e) **DOT MKR** control to **MAX CW** (dot to left edge of graticule lines.

(7) Repeat technique of (3) above and verify 8th marker coincident within +.4 division.

(8) Position **FREQUENCY SPAN/DIV** control to **100 kHz** and position oscilloscope calibrator controls for an output of 10 ps. Set **FREQUENCY SPAN/DIV** control to **100 kHz.**

(9) Repeat technique of (3) above and verify 8th marker coincident within ± 5 division.

(10) Repeat technique of (3) above for settings in table 7.

NOTE

Adjust RESOLUTION (Hz) control as required to optimize signal amplitude.

b. Adjustments

(1) Connect oscilloscope calibrator (A8) marker output to vertical amplifier (A10) input (CH1), using cable (B7).

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

(a) **TIME DIV** control to **10 ms.**

(b) **FREQUENCY SPAN/DIV** control **0.**

(c) **DIGITAL STORAGE** pushbuttons

OFF.

(d) **TRIGGERING SOURCE INT** pushbutton **ON.**

(e) **MODE NORM** pushbutton **ON.**

(3) Adjust oscilloscope calibrator controls for 10 ms markers output.

(4) Adjust triggering **LEVEL** control for a triggered display on crt.

(5) Adjust **HORIZ POSITION** control and R685 (fig. 6) to position one marker per division.

(6) Repeat technique of (4) and (5) above for remaining **TIME/DIV** settings while adjusting oscilloscope calibrator controls for appropriate time marker output. Observe crt time markers will be within ± 5 % of **TIME/DIV** control setting.

Table 7. Frequency Span Accuracy

Test instrument FREQUENCY SPAN/DIV settings	Oscilloscope calibrator control settings	Tolerance within 4%
		Displayed markers/div on the crt
200 kHz	5 μs	1 div
100 kHz	10 μs	1 div
50 kHz	10 μs	2 div
20 kHz	50 μs	1 div
10 kHz	1 μs	1 div
5 kHz	1 μs	2 div
2 kHz	5 μs	1 div
1 kHz	1 ms	1 div
.5 kHz	1 ms	2 div
.2 kHz	5 ms	1 div
.1 kHz	10 ms	1 div
50 Hz	10 ms	2 div

(7) Adjust **TIME/DIV** control to **10 ms**.

(i) **TIME/DIV** control to **AUTO**.

(j) **INPUT TERMNZ** switch to **50**.

15. Reference Level Accuracy (for L3 Plug-in only)

a. Performance Check

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

(a) **DOT FREQUENCY** control for 1 MHz.

(b) **RESOLUTION (Hz)** control to **COUPLED**.

(c) **FREQUENCY SPAN/DIV** control for 10 kHz.

(d) **INPUT REF** switch to dBV.

(e) **REFERENCE LEVEL** control for -45 dBV.

(f) **LOG 2 dB/DIV** pushbutton on.

(g) **TRIGGERING SOURCE FREE** pushbutton on.

(h) **TRIGGERING MODE NORM** pushbutton on.

(2) Connect test oscillator (A9) output to variable attenuator (A11), using cable and adapter (B7 and B3).

(3) Connect variable attenuator output to **INPUT**, using cable and adapter (B7 and B3).

NOTE

Variable attenuator must be used with test report in the following steps.

(4) Adjust variable attenuator controls for 48 dB.

(5) Adjust test oscillator frequency control to 1 MHz with an output amplitude of 7 vertical divisions on crt.

(6) Adjust **REFERENCE LEVEL** control for -37 dBV and variable attenuator controls to 40 dB. If displayed signal amplitude is not 7 divisions ± 0.1 minor division (0.2 dB), perform b below.

(7) Repeat technique of (4) through (6) above increasing **REFERENCE LEVEL** control by 8 dB and decreasing variable attenuator controls by 8 dB until reference level is +3 dBV.

b. Adjustments

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

(a) **DOT FREQUENCY** control for 1000.00 kHz.

(b) **INPUT TERMNZ** switch to **50W**.

(c) **INPUT REF** switch to dBV.

(d) **REFERENCE LEVEL** control for -21 dBV.

(e) **LOG 2 dB/DIV** pushbutton on.

(2) Set variable attenuator controls for 24 dB and adjust test oscillator frequency control to 1 MHz with an output amplitude of 7 divisions on crt.

(3) Adjust **REFERENCE LEVEL** control for -13 dBV and variable attenuator controls to 16 dB.

(4) Adjust C126 (fig. 9) for 7 divisions of amplitude on the crt.

(5) Adjust **REFERENCE LEVEL** control for -5 dBV and variable attenuator controls to 8 dB.

(6) Adjust C136 (fig. 9) for 7 divisions of amplitude on the crt.

(7) Adjust **REFERENCE LEVEL** control for +3 dBV and a variable attenuator controls to 0 dB.

(8) Adjust C135 (fig. 9) for 7 divisions of amplitude on the crt.

(9) Press **INPUT BUFFER** pushbutton on and adjust C132 (fig. 9) for 7 divisions amplitude on the crt.

(10) Press **INPUT BUFFER** pushbutton off and repeat (3) through (9) above making necessary adjustments.

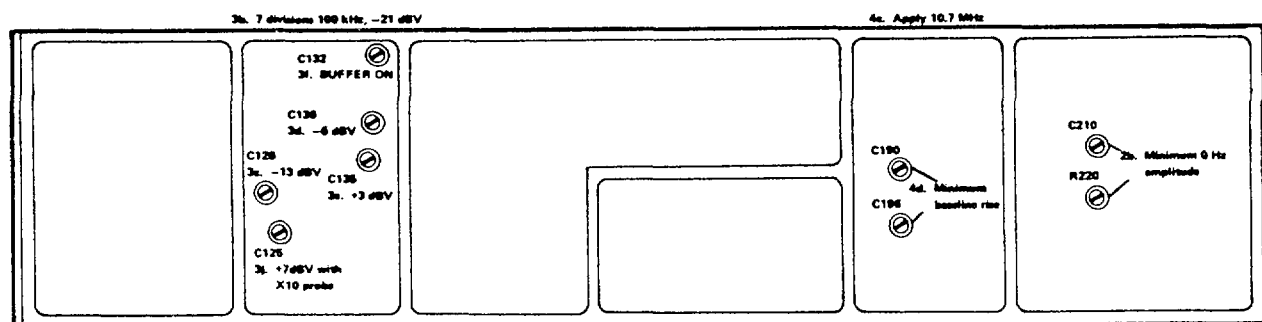
(11) Remove cable between variable attenuator and **INPUT**.

(12) Connect termination (B11) to variable attenuator output.

(13) Adjust **REFERENCE LEVEL** control for -21 dBV and variable attenuator controls to 8 dB.

(14) Press **INPUT TERMNZ** switch to 1 M /28 pF and connect probe (B10) to **INPUT** (check that readout changed to -1 dBV).

(15) Connect other end of probe to terminator.



MSC05155

Figure 9. L-3 adjustment locations.

(16) Adjust test oscillator output controls for 7 divisions of amplitude on the crt.

(17) Adjust **REFERENCE LEVEL** controls for +7 dBV and variable attenuator controls to 0 dB.

(18) Adjust C125 (fig. 9) for 7 divisions of amplitude on the crt.

(19) Disconnect equipment setup.

16. Sweep Rate Accuracy

a. Performance Check

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

(a) FREQUENCY SPAN/DIV control for 0.

(b) TIME/DIV control for .1 ms.

(c) TRIGGERING SOURCE INT pushbutton to **ON**.

(d) TRIGGERING SOURCE MODE **NORM** pushbutton to on.

(2) Position oscilloscope calibrator (A8) controls for an output of .1 ms.

NOTE

Adjust VOLTS/DIV control on vertical amplifier (A10) as required for a stable signal on the crt.

(3) Adjust **HORIZ POSITION** control to align one marker for each vertical graticule line and verify markers are within 5 percent of their respective graticule line (with the first marker on the left graticule line and the last marker within 0.5 division of the right graticule line. If not, perform **b** below.

(4) Repeat technique of (3) above for settings listed in table 8.

Table 8. Sweep Rate Accuracy

Test instrument TIME/DIV control setting	Oscilloscope calibrator control setting	Displayed markers/div on crt
.1 ms	.1 ms	1/1
.2 ms	1 ms	1/5
.5 ms	1 ms	1/2
1.0 ms	10 ms	1/5
5.0 ms	10 ms	1/2
10.0 ms	10 ms	1/1
20.0 ms	.1 s	1/5
50.0 ms	.1 s	1/2
.1 s	.1 s	1/1
.2 s	1 s	1/5
.5 s	1 s	1/2
1.0 s	1 s	1/1
2.0 s	1 s	2/1
5.0 s	5 s	1/1
10.0 s	5 s	2/1

(5) Disconnect equipment setup.

b. Adjustments. Perform adjustments in paragraph 11b if not already performed, and repeat paragraph 11a.

17. Displayed Frequency Stability

a. Performance Check

(1) Connect test oscillator (A9) output to **INPUT** using cable, termination, and adapter (B7, B11, and B1).

(2) Connect adapter from **INPUT** to frequency counter (A6) using cable (B7).

(3) Adjust test oscillator controls for a frequency output of 500 kHz and -20 dBm amplitude indication on the Crt.

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

(a) **DOT FREQUENCY** control for 500.00 kHz.

(b) **RESOLUTION** (Hz) control for **100 Hz**.

(c) **FREQUENCY SPAN/DIV** control for **50 (Hz)**.

(d) **TIME/DIV** control to **.1 s**.

(e) **REFERENCE LEVEL** control for **-27 dBm**.

(f) **DIGITAL STORAGE DISPLAY A** pushbutton on.

(g) **DIGITAL STORAGE DISPLAY B** pushbutton on.

(h) **LOG 2 dB/DIV** pushbutton on.

(5) Observe displayed waveform (similar to figure 10) for a 6:1 slope on the linear portion of the waveform (it may be necessary to adjust **REFERENCE LEVEL** control to establish a 6:1 waveform similar to figure 10).

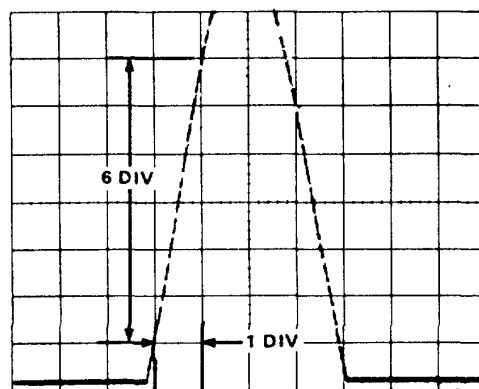
(6) Adjust **DOT MKR** control to establish a center screen reference (trailing edge center on crt vertical and horizontal) on the crt.

(7) Press **DIGITAL STORAGE SAVE A** and **MAX HOLD** pushbuttons to on.

(8) Allow one hour for frequency to stabilize.

(9) Observe crt displayed waveform for a frequency drift of not more than 5 Hz (that is, any change in the displayed waveform indicated by horizontal and vertical separation between "Reference" waveform as in (6) above and frequency stability test waveform in figure 11).

b. Adjustments. No adjustments can be made.



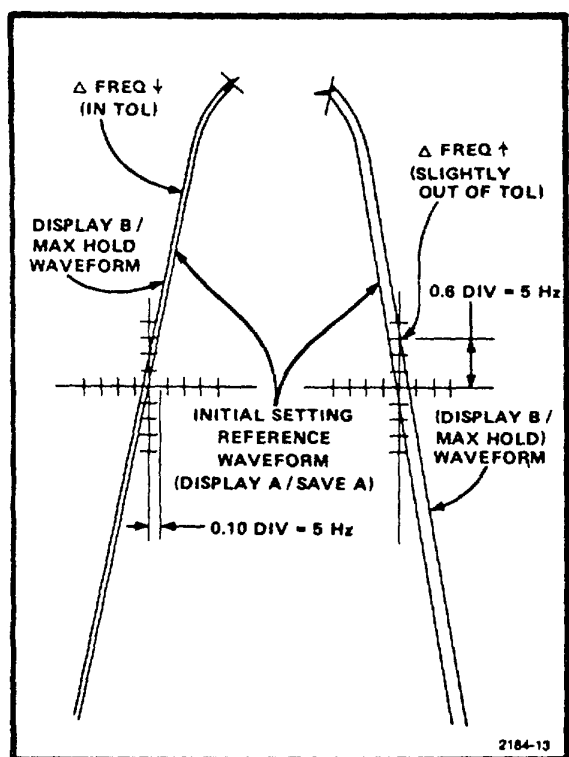
(A) 6:1 Slope

MSC05156

Figure 10. 6:1 reference waveform.

18. Final Procedure

- a. Deenergize and disconnect all equipment.
- b. Annotate and affix DA Label/Form in accordance with TB 750-25.



MSC05157

Figure 11. Frequency stability test waveform interpolation.

By Order of the Secretary of the Army:

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

Official:

R. L. DILWORTH
 Brigadier General, United States Army
 The Adjutant General

Distribution:

To be distributed in accordance with DA Form 12-34C, Block No. 319, requirements for calibration procedures publications.

☆U.S. GOVERNMENT PRINTING OFFICE: 1988-530-022/80070

TB 9-6625-2005-35

PIN NO: 048495-000