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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR OSCILLOSCOPE, AN/USM-117 (OS-106) AND AN/USM-117C (OS-106C) WITH PLUG-IN UNITS, MX-2995/USM-117, MX-2996/USM-117, AND MX-2996C/USM-117C

Headquarters, Department of the Army, Washington, DC
17 November 1980

♦REPORTING OF ERRORS♦

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*This bulletin supersedes TB 9-6625-342-35, 27 May 1971, including all changes.

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SECTION I
IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Oscilloscope AN/USM-117 (OS-106) and AN/USM-117C (OS-106C) with Plug-In Units MX-2995/USM-117, MX-2996/USM-117, and MX-2996C/USM-117C. TM 11-6625-640-15, NAVSHIPS 0969-092-0010, and NAVSHIPS 95712 were used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. Model variations are described within the text.

b. Time and Technique. The time required for the calibration is approximately 4 hours, using the dc and low-frequency technique.

2. DA Form 2416 (Calibration Data Card)

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25-1. DA Form 2416 must be annotated in accordance with TB 750-25-1 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 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 thin; calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Oscilloscopes	
Power input requirements	115 V ac, ±10%; 50 to 60 Hz, ±5% ; or 400 Hz, ±10%; 25 W (approx.)
Horizontal amplifier	
Sensitivity	0.5, 1.0, and 2.5 V/div. Variable control extends 2.5 V/div range beyond 5 V/div
Input impedance[1]	100 kohms shunted by 30 pF max (capacity typically less than 20 pF)
Sweep generator	
Sweep range	0.1 µs/div to 0.1 sec/div ± 3% in 19 ranges with 1, 2, 5, sequence. Variable control provides continuous adjustment between ranges.
Sweep magnifier	Sweep may be expanded 5 times with accuracy within ± 3% for sweep time of 0.1 µs/div or slower.
Trigger requirements	
Source	Internal, external, or line; positive or negative slope
Sensitivity	At least one-half div deflection on graticule (internal), or at least 5.0 V p-p (external)
Vertical post amplifier	
Bandwidth	Dc to 5 MHz (dc coupled), or 2 Hz to 5 MHz (ac coupled) within ± 3 dB
Input impedance[1]	1 megohm shunted by 47 pF max.
Input isolation[1]	50 dB min. between input channels
Calibrator	
Waveform	1 kHz ±10%, square wave
Risetime	1.5 µs max
Voltage amplitude	0.04 and 0.4 V p-p
Plug-In Units[2]	
Bandwidth[1]	Dc to 5 MHz (dc coupled) and 2 Hz to 5 MHz (ac coupled) within 3%
Risetime	70 ns or less
Sensitivity	0.05 (0.01) to 20 V/div ±5% in 9 (11) ranges with 1, 2, 5 sequence. Variable control extends range to at least 50 V/div
Input impedance[1]	1 megohm shunted by 30 (47) pF max.

[1]This specification is for information only and is not necessarily verified in this bulletin.
[2]Specifications in parenthesis are for MX-2996/USM-117 and MX-2996C/USM-117C.

SECTION II
EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specified equipment used in this calibration procedure. This equipment is issued with the Secondary Transfer Standards Calibration Set AN/GSM-256 and AN/GSM-286 and is to be used in performing this procedure. 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 listed in table 2 provides a four-to-one ratio between the standard and TI.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are In be 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)	
			AN/GSM-286	AN/GSM-256
A1	AUTOTRANSFORMER	Range: 105 to 125 V ac Accuracy: ±1%	General Radio, Model W10MT3AS3 (7910809)	Same as AN/GSM-286
A2	OSCILLOSCOPE	Must be furnished with and be compatible with plug-ins MX-2995/USM-117 and MX-2996/USM-117	AN/USM-117 or AN/USM-177C	Same as AN/GSM-286
A3	OSCILLOSCOPE CALIBRATOR	Voltage range: 0.038 to 105 V p-p at 1 kHz Frequency range:1 kHz to 1 MHz Time range: 1 ms to 0.1 µs Risetime: 70 ns or less Accuracy: ±0.75%	Ballantine, Model 6126M (MIS-28714)	Hewlett-Packard, Model 211B (211B) Tektronix, Type 2901 (2901)
A4	VOLTAGE CALIBRATOR	Range: 0.038 to 84 V p-p at 1 kHz Accuracy: ±0.75%	N/A	Ballantine, Model 421AS2 (421AS2)
A5	VOLTMETER	Range: -590 to +20.5 V dc Accuracy: ±0.375%	Tektronix, Type DM501 (P/O A3)	Hewlett-Packard, Model 3490AOPTION060 (3490AOPTION060)

Table 3. Accessories Required

Item	Common name (official nomenclature)	Description (part number)
B1	ADAPTER[1]	Single banana jack to alligator clip (black) (7907560)
B2	ADAPTER (ADAPTER, CONNECTOR)	BNC T type, 2 jacks, 1 plug (MS35173-274C)
B3	ADAPTER (ADAPTER, CONNECTOR)	BNC jack to UHF plug (10519439)
B4	ADAPTER (ADAPTER, CONNECTOR)	UHF jack to BNC plug (10054847)
B5	CABLE[1] (CABLE ASSEMBLY, RADIO FREQUENCY)	30-in., RG-58/U; BNC plug terminations (7907467)
B6	CABLE[1] (CABLE ASSEMBLY, RADIO FREQUENCY)	36-in., RG-58/U; BNC plug to double banana plug terminations (7907471)
B7	CABLE (CABLE ASSEMBLY, RADIO FREQUENCY)	36-in., RG-58/U; BNC plug with two alligator clips (7909410)
B8	EXTENSION (EXTENSION, PLUG-IN)	Tektronix, Type 013-0055-00 (7912632)
B9	LEAD (LEAD, ELECTRICAL)	24-in., No. 18 AWG; single banana plug terminations (black) (7907497)
B10	STANDARDIZER (CAPACITANCE STANDARD)	5 to 80 pF; UHF plug to UHF jack (7916146)
B11	TERMINATION	Hewlett-Packard, Model 11048B (7911587)
B12	TEST PROBE	Test hook to single banana plug terminations (7916122)

[1]Two required.

SECTION III
CALIBRATION PROCESS FOR OSCILLOSCOPES, AN/USM-117 (OS-106) AND AN/USM-117C (OS-106C) WITH PLUG-IN UNITS MX-2996/USM-117 AND MX-2996C/USM-117C

6. Preliminary Instructions

a. The instructions outlined in paragraphs **6** and **7** are preparatory to the calibration process. Personnel should become familiar with sections I through III 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.

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

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 instructions are contained in TM 11-6625-640-15, NAVSHIPS 0969-092-0010, and NAVSHIPS 95712 for this TI.

NOTE

When indications specified in paragraphs **8** through **22** are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs **8** through **22**. Do not perform power supply check if all other parameters are within tolerance.

NOTE

Unless otherwise specified, all controls and control settings called out in this bulletin refer to the TI.

7. Equipment Setup

a. Remove protective cover from TI.

b. Install plug-in unit MX-2996/USM-117 or MX-2996C/USM-117C (part of TI) into TI.

c. Connect TI to autotransformer (A1) and connect autotransformer to a 115-V ac source. Adjust controls for a 115-V output.

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

(1) INTENSITY control fully ccw.

(2) TIME/DIV switch to .1 MILLISEC and VARIABLE control to CAL.

(3) STABILITY control to FREE RUN.

(4) TRIGGER SLOPE switch to +INT.

(5) LEVEL control to 0 (zero).

(6) HORIZ MODE switch to SWEEP.

(7) HORIZ GAIN control fully cw.

(8) CALIBRATOR switch to OFF.

(9) VOLTS/DIV switch to .1 and VARIABLE control to CAL.

(10) INPUT SELECTOR switch to INPUT A, AC.

e. Set POWER switch to ON and allow 15 minutes for equipment to warm up**.**

f. Adjust SCALE control for optimum graticule display.

g. Adjust INTENSITY, FOCUS, and ASTIG controls for a clear, sharp trace of optimum brilliance.

NOTE

Adjust horizontal POSITION, and plug-in unit vertical POSITION controls as necessary for convenient viewing. Repeat as necessary throughout this procedure.

h. Alternately set VOLTS/DIV switch between .1 and .2 positions and adjust E.F. BAL (front panel) control until no vertical shift of TI trace is observed.

i. Rotate VOLTS/DIV control throughout its range and adjust D.C. BAL control until no vertical shift of trace is observed.

j. Repeat **h** and **i** above until no further adjustments are required.

8. Crt Alignment and Geometry

a. Performance Check

(1) Adjust vertical POSITION control to align trace on horizontal graticule centerline. If trace is not parallel with horizontal graticule centerline, perform **b**(1) below.

(2) Connect oscilloscope calibrator (A3) MARKER OUT to INPUT A, using cable and termination (B5 and B11).

(3) Set oscilloscope calibrator to .1 mS (millisecond) markers.

(4) Adjust LEVEL control for stable output

(5) Adjust VOLTS/DIV switch and VARIABLE control for an 8-division vertical display.

(6) Adjust horizontal POSITION control to align time-markers with vertical graticule lines. If time-markers are not parallel with vertical graticule lines, and if bowing or tilting is indicated, perform **b**(2) below.

b. Adjustments

(1) Loosen mounting strap at base of crt (cathode ray tube) and rotate crt until trace is parallel with horizontal graticule centerline. Tighten mounting strap.

(2) Adjust R316 (fig. 1) until time-markers are parallel with vertical graticule lines.

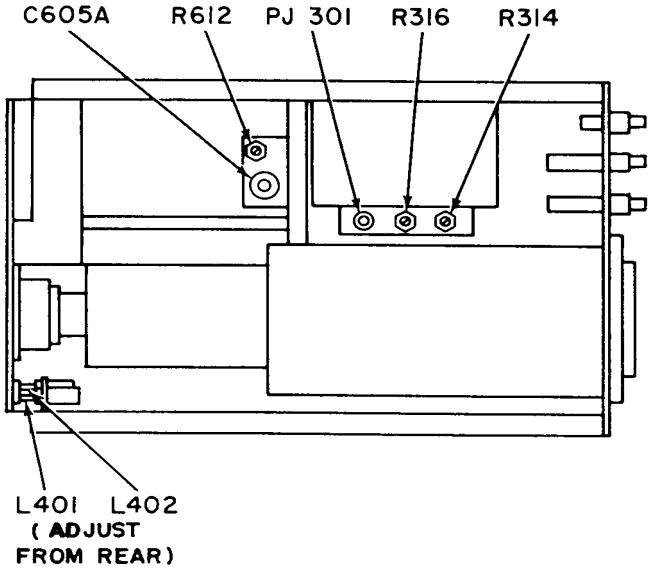

Figure 1. Oscilloscope-top view.

9. Focus

a. Performance Check. Adjust FOCUS and ASTIG controls for greatest clarity and line resolution at center of display. If focus and resolution is not uniform throughout all portions of display, perform **b** below.

b. Adjustments

(1) Set POWER switch to OFF and remove protective cap from rear of crt socket.

(2) Connect voltmeter (A5) between pin 9 of crt socket and chassis ground, using two test probes (Bl2).

(3) Set POWER switch to ON and allow 5 minutes for warm-up.

(4) Adjust R314 (fig. 1) until voltmeter indicates -25 V dc.

(5) Adjust FOCUS and ASTIG control and, if necessary, R314 for optimum overall resolution and focus of display.

(6) Set POWER switch to OFF and replace protective cap on crt socket.

(7) Set POWER switch to ON and allow 5 minutes for warmup.

10. Horizontal Amplifier Zero

a. Performance Check

(1) Set HORIZ MODE switch to X1 and adjust horizontal POSITION control to center spot on crt graticule.

(2) Connect voltmeter (A5) to HORIZ INPUT, using cable (B6). If voltmeter does not indicate 0.0 V dc, perform **b** below.

(3) Set HORIZ MODE switch to X2 and observe that voltmeter indicates 0.0 V dc.

(4) Set HORIZ MODE switch to X5 and observe that voltmeter indicates 0.0 V dc.

b. Adjustments. Adjust R408 (fig. 2) until voltmeter indicates 0.0 V dc.

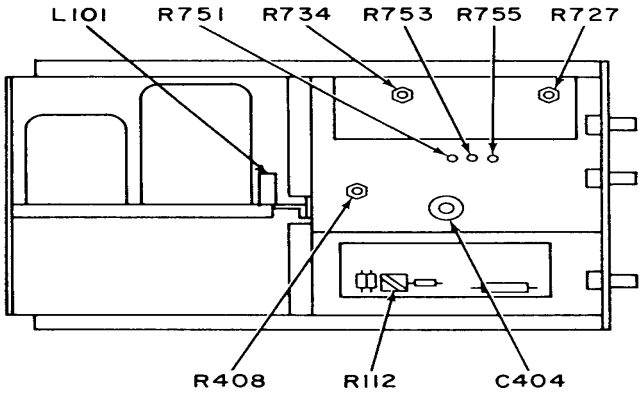

Figure 2. Oscilloscope-bottom view.

11. Horizontal Amplifier Sensitivity

a. Performance Check

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

(a) TIME/DIV switch to 20 µSEC.

(b) HORIZ MODE switch to X1.

(c) STABILITY control to FREE RUN.

NOTE

Use (2) through (8) below for AN/GSM-286.

(2) Connect oscilloscope calibrator (A3) VOLTS OUT to HORIZ INPUT, using cable (B5).

(3) Position oscilloscope calibrator controls as listed in (a) through (d) below:

(a) DEVIATION switch to VOLTS ±10%.

(b) OUTPUT MODE switch to 1 kHz.

(c) MULTIPLIER switch to X3.

(d) VOLTS/DIV switch to 1 V.

(4) Adjust oscilloscope calibrator VOLTS/DIV variable control for a 6-division horizontal TI display. If DEVIATION readout does not indicate within ±3 percent, perform **b**(1) and (2) below.

(5) Set HORIZ MODE switch to X2.

(6) Set oscilloscope calibrator VOLTS/DIV MULTIPLIER switch to X6 and repeat (4) above except, if necessary, perform **b**(3) below.

(7) Set HORIZ MODE switch to X5.

(8) Set VOLT/DIV switch to 5 V and MULTIPLIER to X3 and repeat (4) above.

NOTE

Use (9) through (14) below for AN/GSM-256.

(9) Connect voltage calibrator (A4) to HORIZ INPUT, using cable (B6).

(10) Adjust voltage calibrator for a 6-division horizontal display at 1 kHz. If voltage calibrator does not indicate between 2.91 and 3.09 V p-p, perform **b**(1) and (2) below.

(11) Set HORIZ MODE switch to X2.

(12) Repeat (10) above. If voltage calibrator does not indicate between 5.82 and 6.18 V p-p, perform **b**(3) below.

(13) Set HORIZ MODE switch to X5.

(14) Repeat (10) above. If voltage calibrator does not indicate between 14.55 and 15.45 V p-p, perform **b**(3) below.

b. Adjustments

(1) Adjust oscilloscope calibrator VOLTS/DIV variable until DEVIATION readout indicates +0.00 percent (for AN/GSM-256, adjust voltage calibrator output for 3.0 V p-p).

(2) Adjust R425 (fig. 3) for a 6-division horizontal display.

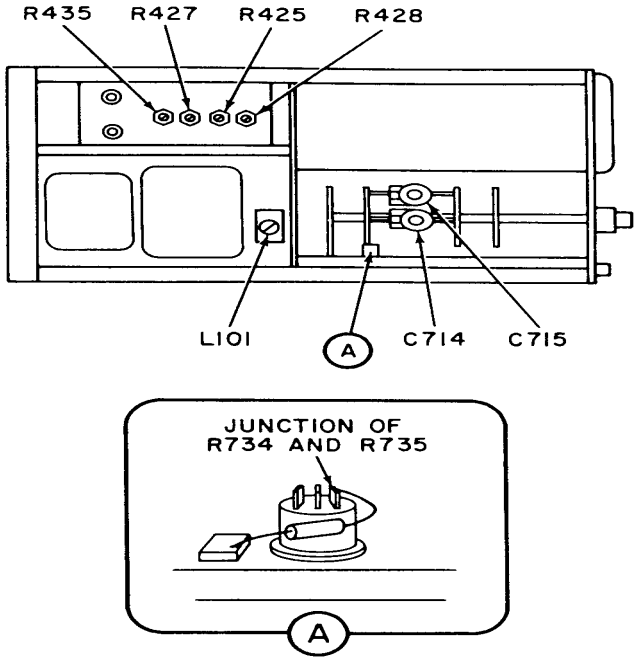

Figure 3. Oscilloscope-left t-side view.

(3) If necessary, repeat **a**(1) and (3) above, and **b**(1) and (2) above until voltages at X1, X2, and X5 positions are within tolerance.

12. Horizontal Amplifier Frequency Response

a. Performance Check

(1) Set TRIGGER SLOPE switch to +AC.

(2) Connect oscilloscope calibrator (A3) HI AMPL OUTPUT (for AN/GSM-256, use H-P Model 211B 50Ω OUTPUT) to HORIZ INPUT, using cable and termination (B5 and B11).

(3) Connect oscilloscope calibrator MARKER OUT (for AN/GSM-256, use TRIGGER OUTPUT) to EXT TRIGGER INPUT, using another cable (B5).

(4) Connect INPUT A to junction of R734 and R735 (fig. 3), using cable (B7)

(5) Set oscilloscope calibrator TRIGGER PULSE PERIOD switch to 100 µS and TIME/DIV switch to .1 mS (for AN/GSM-256, adjust frequency for 10 kHz) and amplitude control for a convenient horizontal display.

(6) Adjust VOLTS/DIV switch and VARIABLE control until vertical deflection displays at least 2 cycles of square wave (vertical time base) If overshoot or rounding is observed on left and right side of square wave display, perform **b**(1) below.

(7) Set oscilloscope calibrator TRIGGER PULSE PERIOD switch to 10 µS and TIME/DIV switch to 10 µS (for AN/GSM-256, adjust frequency for 100 kHz) and amplitude control for a convenient horizontal display.

(8) Set TIME/DIV switch to 2 µSEC and repeat (6) above, except, if necessary, perform **b**(2) below.

b. Adjustments

(1) Adjust C404 (fig. 2) for minimum overshoot and/or rounding of square-wave display

(2) Alternately adjust L401 and L402 (fig. 1) in small increments for minimum overshoot and/or rounding of square-wave display (R).

13. Preset Stability

a. Performance Check

(1) Connect oscilloscope calibrator (A3) VOLTS OUT (for AN/GSM-256, use voltage calibrator (A4) OUTPUT) to INPUT A and EXT. TRIGGER INPUT, using two cables and adapters (B5 and B2) (for AN/GSM-256, use two cables (B6)).

(2) Set oscilloscope calibrator OUTPUT MODE switch to 1 kHz (for AN/GSM-256, set MODE switch to 1 KC p-p).

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

(a) HORIZ MODE switch to SWEEP.

(b) TIME/DIV switch to 1 MILLISEC.

(c) VOLTS/DIV switch to 1 and VARIABLE control to CAL.

(d) STABILITY control to PRESET.

(4) Adjust oscilloscope calibrator VOLTS/DIV switch (for AN/GSM-256, use voltage calibrator output) and LEVEL control until sweep triggers and remains stable. If oscilloscope calibrator (voltage calibrator) does not indicate 0.5 V (p-p) or less, perform **b** below.

(5) Turn TRIGGER SLOPE switch to +INT and repeat (4) above

b. Adjustments

(1) Adjust oscilloscope calibrator (voltage calibrator) output to 0.5 V (p-p).

(2) Turn R727 (fig. 2) ccw until waveform disappears, then turn slowly cw until sweep trigger and remains stable.

14. Sweep Generator Amplifier Bias and Sweep Length

a. Performance Check

(1) Connect oscilloscope calibrator (A3) MARKER OUT to INPUT A and +1 V FAST RISE OUTPUT (for AN/GSM-256, use MARKER OUT and TRIGGER OUT) to EXT. TRIGGER INPUT, using two cables (B5).

(2) Set oscilloscope calibrator TIME/DIV switch to .1 μS and TRIGGER PULSE PERIOD switch to 100 nS (for AN/GSM-256, set to .1 μS time-markers and 10 μS triggers).

(3) Set TIME DIV switch to .1 μSEC and TRIGGER SLOPE switch to AC+.

(4) Adjust VOLTS/DIV switch and VARIABLE control for a convenient vertical display. Adjust STABILITY and LEVEL controls as required for stable display. If waveform does not indicate uniform spacing, perform **b**(1) below If sweep length is not 10.5 divisions, perform **b**(2) below.

b. Adjustments

(1) Adjust R435 (fig. 3) for optimum linearity on display.

(2) Adjust R734 (fig. 2) until sweep length is 10.5 divisions.

15. Basic Timing

a. Performance Check

(1) Set TIME/DIV switch to .1 SEC.

(2) Set oscilloscope calibrator (A3) TIME/DIV switch to .1 S and TRIGGER PULSE PERIOD switch to 100 mS. (For AN/GSM-256, set to .1 S time-markers and .1 S triggers.)

(3) Adjust VOLTS/DIV switch and VARIABLE control for a convenient vertical deflection.

(4) Adjust horizontal POSITION control to align second time-marker on second vertical graticule line. If 10th time-marker is not within ±1.5 minor divisions of 10th vertical graticule line, perform **b** below.

b. Adjustments. Adjust R427 (fig. 3) until 10th time-marker is within +1.5 minor divisions of 10th vertical graticule line (R).

16. Sweep Time Accuracy

a. Performance Check

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

(2) Set oscilloscope calibrator (A3) TIME/DIV switch to .1 mS and TRIGGER PULSE PERIOD switch to 100 μS. (For AN/GSM-256, set to .1 mS time-markers and .1 mS triggers.)

(3) Adjust horizontal POSITION control to align second time-marker on second vertical graticule line.

(4) Adjust oscilloscope calibrator TIME/DIV variable control to align one time-marker for each vertical graticule between second and 10th lines. If oscilloscope calibrator does not indicate .1 mS within ±3 percent (for AN/GSM-256, if 10th time-marker is not aligned with 10th vertical graticule line or there is not a time-marker within ±1.5 minor divisions of each vertical graticule between second and 10th lines), perform **b** below.

(5) Repeat technique of (1) through (4) above for oscilloscope calibrator output and TIME/DIV switch setting listed in table 4. At each setting, if oscilloscope calibrator does not indicate within ±3 percent, perform appropriate adjustments listed in table 4. (For AN/GSM-256, at each setting, adjust horizontal POSITION control to align second time-marker (1/div) or third time-marker (2/div) with second vertical graticule line. At each setting, if either 10th (1/div) or 19th (2/div) time-marker is not within ±1.5 minor divisions of each vertical graticule between second and 10th lines, perform appropriate adjustments listed in table 4.)

b. Adjustments. Set oscilloscope calibrator for .1 ms and adjust R755 (fig. 2) for one time marker per division between second and 10th vertical graticule line (R).

Table 4. Sweep Time Accuracy

Oscilloscope calibrator outputs		Test instrument		
Time-marker[1] out	**TRIGGER PULSE PERIOD** (trigger)	**TIME/DIV** switch settings	Time-markers per division[1]	Adjustments (R)
0.2 ms (0.1 ms)	1 ms	.2 MILLISEC	1 (2)	R753 (fig. 2)
0.5 ms	1 ms	.5 MILLISEC	1	R751 (fig. 2)
1 ms	1 ms	1 MILLISEC	1	- - -
2 ms (1 ms)	10 ms	2 MILLISEC	1 (2)	- - -
5 ms	10 ms	5 MILLISEC	1	- - -
10 ms	10 ms	10 MILLISEC	1	- - -
20 ms (10 ms)	10 ms	20 MILLISEC	1 (2)	- - -
50 ms	0.1 S	50 MILLISEC	1	- - -
50 µS	0.1 ms	50 µSEC	1	- - -
20 µS (10 µS)	0.1 ms	20 µSEC	1 (2)	- - -
10 µS	10 µS	10 µSEC	1	- - -
5 µS	10 µS	5 µSEC	1	C714[2]
2 µS (1 µS)	10 µS	2 µSEC	1 (2)	C714
1 µS	1 µS	1 µSEC	1	C714
0.5 µS	1 µS	.5 µSEC	1	C715
0.2 µS(0.1 µS)[3]	1 µS	.2 µSEC	1 (2)	C715
0.1 µS[3]	1 µS	.1 µSEC	1	C715

[1]( ) for AN/GSM-256 time-marker, trigger outputs, and time-markers per division.
[2]When adjusting C714 or C715 (fig. 3), make compromise adjustments as necessary for optimum display.
[3]Use termination (B11).

17. Sweep 5X Magnifier

a. Performance Check

(1) Set TIME/DIV switch to 5 µSEC and HORIZ MODE switch to 5X MAG.

(2) Set oscilloscope calibrator (A3) TIME/ DIV switch to 1 µS and TRIGGER PULSE PERIOD switch to 1 µS. (For AN/GSM-256, set to 1 µS time-markers and 1 µS triggers.)

(3) Adjust horizontal POSITION control to align second time-marker on second vertical graticule lines.

(4) Adjust oscilloscope calibrator output to align a time-marker for each TI vertical graticule between second and 10th line. If oscilloscope calibrator does not indicate 1 µs within ±3 percent (for AN/GSM-256, if 10th time-marker is not aligned with 10th vertical graticule line or there is not a time-marker within ±1.5 minor divisions of each vertical graticule between second and 10th lines), perform **b** below.

b. Adjustments. Adjust R428 (fig. 3) until 10th time-marker aligns on 10th vertical graticule line and display has a time-marker within ±1.5 minor divisions of each vertical graticule between second and 10th lines (R).

18. Vertical Sensitivity

NOTE
Use (1) through (4) below for AN/GSM-286.

a. Performance Check

(1) Connect oscilloscope calibrator (A3) VOLTS OUT to INPUT A, using cable (B5).

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

(a) TIME/DIV switch to 1 MILLISEC.

(b) TRIGGER SLOPE switch to +INT.

(c) VOLTS/DIV switch to .01 and VARIABLE control to CAL.

(3) Set oscilloscope calibrator OUTPUT MODE switch to 1 kHz. Adjust VOLTS/DIV switch and variable control for a 4-division vertical display. If DEVIATION readout does not indicate within ±5 percent, perform **b** below.

(4) Repeat technique of (2) (c) and (3) above for VOLTS/DIV settings listed in table 5. Oscilloscope calibrator DEVIATION readout will indicate within ±5 percent of each VOLTS/DIV switch setting.

Table 5. Vertical Sensitivity

Test instrument		Oscilloscope calibrator **VOLTS/DIV** switch settings (V)
VOLTS/DIV switch settings	Vertical deflection (div)	
.02	5	.1
.05	4	.2
.1	5	.5
.2	5	1
.5	4	2
1	5	5
2	5	10
5	4	20
10	5	5[1]
20	5	10[1]

[1]Set MULTIPLIER switch to X10.

NOTE
Use (5) through (7) for AN/GSM-256.

(5) Connect voltage calibrator (A4) to INPUT A, using cable (B6) and repeat (2) above.

(6) Adjust voltage calibrator for a 4-division vertical display. If voltage calibrator does not indicate between 0.038 and 0.042 p-p, perform **b** below.

(7) Repeat technique of (6) above for VOLTS/DIV settings listed in table 6. Voltage calibrator will indicate within limits specified.

b. Adjustments

(1) Adjust oscilloscope calibrator (voltage calibrator) output for 0.040 V p-p.

(2) Set R612 (fig. 1) to midrange and adjust R829 (fig. 4) until vertical display is 4 divisions (R).

Table 6. Vertical Sensitivity

Test instrument VOLTS/DIV switch settings	Voltage calibrator indications (V p-p)	
	Min	Max
.02	0.076	0.084
.05	0.19	0.21
.1	0.38	0.42
.2	0.76	0.84
.5	1.9	2.1
1	3.8	4.2
2	7.6	8.4
5	19.0	21.0
10	38.0	42.0
20	76.0	84.0

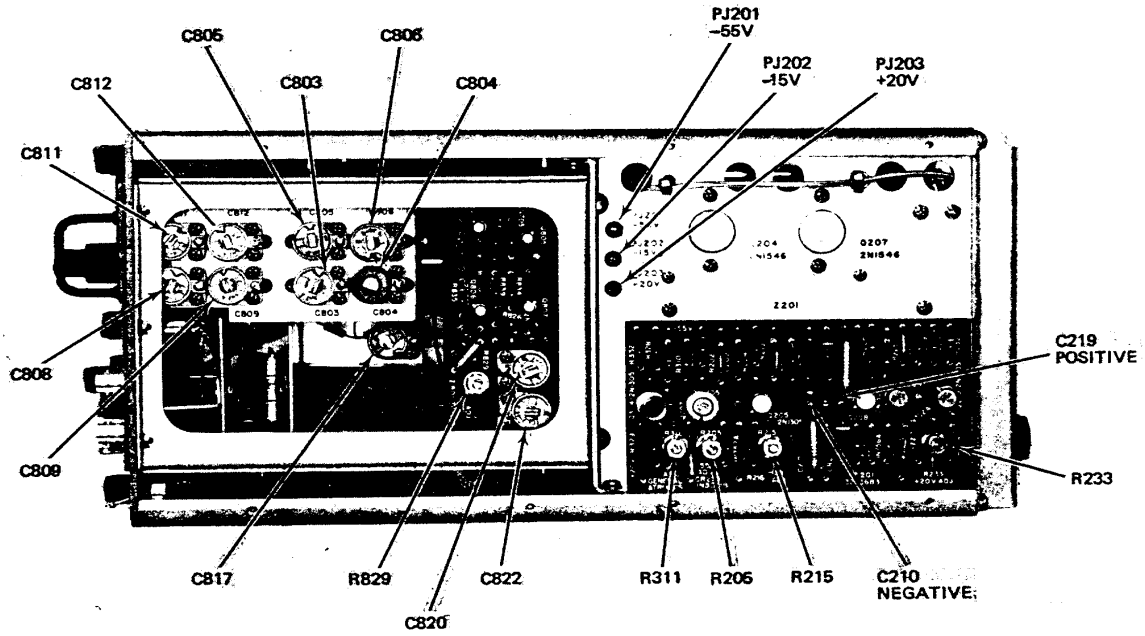

Figure 4. Plug-in unit MX-2996/USM-117 - right side view.

19. Vertical High Frequency Compensation

a. Performance Check

(1) Connect oscilloscope calibrator (A3) +1 V FAST RISE OUTPUT (for AN/GSM-256, use H-P Model 211B 50Ω OUTPUT) to INPUT A, using cable and termination (B5 and B11).

(2) Set TIME/DIV switch to 50 µSEC and VOLTS/DIV switch to .01.

NOTE

Adjust STABILITY and LEVEL controls as required.

(3) Set oscilloscope calibrator TRIGGER PULSE PERIOD switch to 100 µS (for AN/GSM-256, adjust frequency for 10 kHz) and amplitude control for a convenient square-wave display. If square-wave display has overshoot or rounding, perform **b**(1) below.

(4) Set TIME,/DIV switch to 1 µSEC.

(5) Set oscilloscope calibrator TRIGGER PULSE PERIOD switch to 10 µS (for AN/GSM-256, adjust frequency for 100 kHz). If square-wave display has overshoot or rounding, perform **b**(2) below.

(6) Set VOLTS/DIV VARIABLE control fully ccw.

(7) Adjust oscilloscope calibrator amplitude control for a convenient square-wave display. If square-wave display has overshoot or rounding, perform **b**(3) through (6) below.

b. Adjustments

(1) Adjust C817 (fig. 4) for optimum square-wave display.

(2) Adjust C820 (fig. 4) and C605A (fig. 1) for Optimum square-wave display.

(3) Adjust C822 (fig. 4) for optimum square-wave display.

(4) Set VOLTS/DIV VARIABLE control to CAL.

(5) Adjust oscilloscope calibrator amplitude control for a convenient square-wave display.

(6) Repeat **a**(5) through (7) above and corresponding adjustments until no further adjustments are required.

20. Vertical Attenuator Input Capacitance

a. Performance Check

(1) Connect oscilloscope calibrator (A3) HI AMPL OUTPUT (for AN/GSM-256, use H-P Model 211B 50Ω OUTPUT) to INPUT A, using adapters, cable, standardizer and termination (B3, B4, B5, B10, and B11).

(2) Set oscilloscope calibrator TRIGGER PULSE PERIOD switch to 1 mS (for AN/GSM-256, adjust H-P Model 211B frequency for 1 kHz).

(3) Set TIME/DIV switch to .1 MILLISEC.

(4) Adjust oscilloscope calibrator amplitude control for a convenient square-wave display.

(5) Adjust standardizer for optimum TI square-wave display.

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

(7) Repeat technique of (6) above for TI VOLTS/DIV switch settings and adjustments listed in table 7.

Table 7. Vertical Attenuator Input Capacitance

Test instrument **VOLTS/DIV** switch settings	Adjustments (fig. 4)
.05	C806
.1	C814 and C815 (fig. 5)
.2	C803
.5	C805
1	C808 and C809
10	C811 and C812

b. Adjustments. Adjust C804 (fig. 4) until TI square-wave display has optimum flat top, and minimum overshoot and rounding.

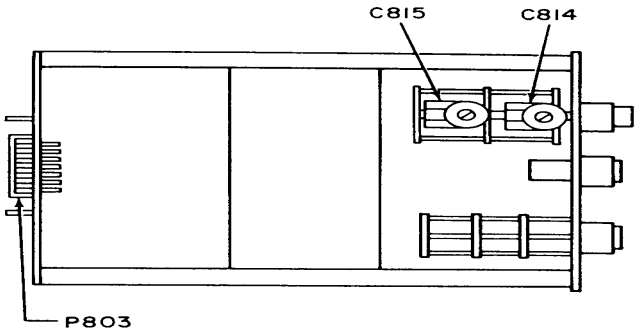

Figure 5. Plug-in unit MS-2996/USM-117 - left-side view.

21. Vertical Risetime

a. Performance Check

(1) Connect oscilloscope calibrator (A3) +1 V FAST RISE OUTPUT (for AN/GSM-256, use H-P Model 211B 50Ω OUTPUT) to INPUT A, using cable and termination (B5 and B11).

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

(a) VOLTS/DIV switch to .1.

(b) TIME/DIV switch to .1 μSEC.

(c) HORIZ MODE switch to 5X MAG.

(3) Set oscilloscope calibrator TRIGGER PULSE PERIOD switch to 1 μS (for AN/GSM256, adjust frequency for 1 MHz) and amplitude control for a convenient display.

(4) Measure risetime, using standard risetime techniques. Risetime will be 70 ns or less.

b. Adjustments. No adjustments can be made.

22. Calibrator

a. Performance Check

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

(a) HORIZ MODE switch to SWEEP.

(b) CALIBRATOR switch to .4.

(c) TIME/DIV switch to .1 MILLISEC.

(d) INPUT SELECTOR switch to A, DC.

(2) Connect CALIBRATOR OUTPUT to vertical A INPUT, using cable (B5). If crt does not display 1 cycle of waveform 10 divisions in length, perform **b**(1) below.

(3) Measure and record amplitude of vertical deflection.

(4) Connect oscilloscope calibrator (A3) VOLTS OUT to INPUT B, using cable (B5). (For AN/GSM-256, connect voltage calibrator (A4) to INPUT B, using cable (B6).)

(5) Set INPUT SELECTOR switch to INPUT B, DC.

(6) Adjust oscilloscope calibrator (voltage calibrator) amplitude control to value recorded in (3) above. If oscilloscope calibrator DEVIATION readout does not indicate within ±2 percent (.4 V), (for AN/GSM-256 if voltage calibrator does not indicate between 0.392 and 0.408 V p-p), perform **b**(2) through (4) below.

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

(a) CALIBRATOR switch to .04.

(b) VOLTS/DIV switch to .01.

(c) INPUT SELECTOR switch to INPUT A, AC.

(8) Measure and record amplitude of TI vertical deflection.

(9) Set INPUT SELECTOR switch to B, AC.

(10) Adjust oscilloscope calibrator (voltage calibrator) amplitude control to value recorded in (8) above. Oscilloscope calibrator DEVIATION readout will indicate within ±2 percent (.04 V) (For AN/GSM-256, voltage calibrator will indicate between 0.0392 and 0.0408 V p-p.)

(11) Adjust autotransformer (A1) from 105 and 125 V ac. Repeat (10) above.

(12) Adjust autotransformer for 115 V ac.

b. Adjustments

(1) Adjust L101 (fig. 3) until 1 cycle of waveform is 10 divisions in length (not on Model MX-2996C/USM-117C) (R).

(2) Adjust oscilloscope calibrator (voltage calibrator) amplitude control for 0.40 V p-p and record amplitude of vertical deflection.

(3) Set INPUT SELECTOR switch to A, DC.

(4) Adjust R112 (fig. 2) until vertical deflection is same as recorded in (2) above (not on Model MX-2996/USM-117) (R).

23. Power Supply

NOTE

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

a. Performance Check

(1) Connect voltmeter (A5) between test points listed in table 8 and chassis ground, using two test probes (B12). If voltmeter does not indicate within limits specified, perform adjustments listed in table 8.

Table 8. Power Supply Check

Test instrument test points (fig. 4)	Voltmeter indications (V dc)		Adjustments (fig. 4) (R)
	Min	Max	
PJ203	+19.5	+20.5	R233
PJ202	-14.5	-15.5	R215
PJ201	-53.5	-56.5	R205
C210 (negative)	-4.5	-5.5	- - -
C219 (positive)	+4.5	+5.5	- - -

(2) Deenergize TI and connect positive test probe to test point PJ301 (fig. 1).

(3) Energize TI. If voltmeter does not indicate between -570 and -590 V dc, perform **b** below.

(4) Rotate INTENSITY control throughout its range while observing that voltmeter does not vary by more than 10 V dc.

b. Adjustments. Adjust R311 (fig. 4) until voltmeter indicates -580 V dc (R).

24. Final Procedure

a. Deenergize and disconnect all equipment and reinstall protective cover on TI.

b. When all parameters are within tolerance, annotate and affix DA Label 80 (US Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (US Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, repair the TI in accordance with the maintenance manual. When repair is delayed for any reason or the TI cannot be repaired with local resources, annotate and affix DA Form 2417 (US Army Calibration System Rejected Instrument) and inform the owner/user accordingly in accordance with TB 750-25-1.

SECTION IV
CALIBRATION PROCESS FOR PLUG-IN UNIT MX-2995/USM-117

25. Preliminary Instructions

a. The instructions outlined in paragraph and 26 are preparatory to the calibration process. Personnel should become familiar with sections I, II, and IV 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.

NOTE

Unless otherwise specified, verify the results 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 references listed in section 1, paragraph 1.

NOTE

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

26. Equipment Setup

a. Connect TI to oscilloscope (A2), using extension (B8).

b. Position controls as listed in (1) through (3) below:

(1) MODE switch to A-ONLY.

(2) Channels A and B VOLTS,, DIV switches to .05 and VERNIER controls to CAL.

(3) Channels A and B POLARITY switches to +AC.

c. Position oscilloscope controls as listed in (1) through (7) below:

(1) INTENSITY control fully ccw.

(2) TIME/DIV switch to .5 MILLISEC and VARIABLE control to CAL.

(3) STABILITY control to FREE RUN.

(4) TRIGGER SLOPE switch to +INT.

(5) LEVEL control to 0 (zero).

(6) HORIZ MODE switch to SWEEP.

(7) HORIZ GAIN control fully cw.

d. Set oscilloscope POWER switch to ON and allow 15 minutes for warmup.

e. Adjust SCALE, INTENSITY, FOCUS, AND ASTIG controls for optimum viewing.

NOTE

Adjust POSITION controls as necessary for suitable viewing throughout the calibration.

f. Alternately set channel A VOLTS/DIV switch between .05 and .1 positions while adjusting A DC BAL (front panel) control for no vertical deflection of oscilloscope trace.

g. Set channel A VOLTS/DIV switch to .05 and rotate VERNIER control throughout its range. If vertical deflection of trace is observed, adjust R105 (fig. 6) for no vertical deflection.

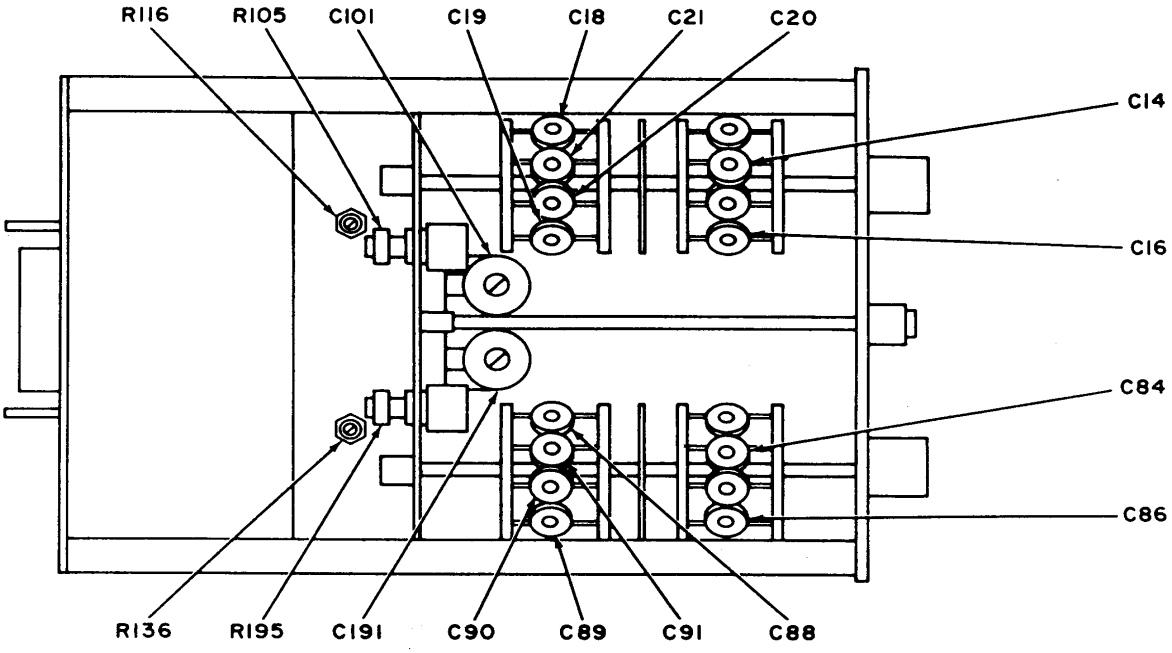

Figure 6. Plug-in unit MX-2995/USM-117 - left-side view.

h. Set channel A VOLTS/DIV VERNIER control to CAL and MODE switch to B-ONLY.

i. Repeat **f** through **h** above, using channel B controls, substituting adjustment R195 (fig. 6) for R105.

j. Set oscilloscope STABILITY control to PRESET.

27. Vertical Sensitivity

a. Performance Check

NOTE

Use (1) through (7) below for AN/GSM-286.

(1) Connect oscilloscope calibrator (A3) VOLTS OUT to A INPUT, using cable (B5).

(2) Set MODE switch to A-ONLY.

(3) Adjust oscilloscope calibrator VOLTS/DIV variable control for a 4-division oscilloscope (A2) display at 1 kHz. If DEVIATION readout does not indicate within ±5 percent (0.2 V), perform **b**(1) and (2) below.

(4) Repeat technique of (3) above for VOLTS/DIV settings listed in table 9. Oscilloscope calibrator DEVIATION readout will indicate within ±5 percent of each VOLTS/DIV switch setting.

Table 9. Vertical Sensitivity

Test instrument		Oscilloscope calibrator **VOLTS/DIV** switch settings(V)
VOLTS/DIV switch settings	Vertical deflection (div)	
.1	5	.5
.2	5	1
.5	4	2
1	5	5
2	5	10
5	4	20
10	5	5[1]
20	5	10[1]

[1]Set MULTIPLIER switch to X10.

(5) Disconnect cable from A INPUT and connect to B INPUT.

(6) Set MODE switch to B-ONLY.

(7) Repeat (3) and (4) above for channel B, except perform **b**(3) and (4) below.

NOTE

Use (8) through (14) below for AN/GSM-256.

(8) Connect voltage calibrator (A4) to A INPUT, using cable (B6).

(9) Set MODE switch to A-ONLY.

(10) Adjust voltage calibrator frequency for 1 kHz p-p and amplitude for a 4-division vertical display on oscilloscope. If voltage calibrator does not indicate between 0.19 and 0.21 V p-p, perform **b**(1) and (2) below.

(11) Repeat technique of (10) above for TI channel A VOLTS/DIV switch settings and voltage calibrator indications as listed in table 10.

Table 10. Vertical Sensitivity

Test instrument **VOLTS/DIV** switch settings	Voltage calibrator indications V (p-p)	
	Min	Max
.1	0.38	0.42
.2	0.76	0.84
.5	1.9	2.1
1	3.8	4.2
2	7.6	8.4
5	19.0	21.0
10	38.0	42.0
20	76.0	84.0

(12) Set MODE switch to B-ONLY.

(13) Disconnect cable from A INPUT and connect to B INPUT.

(14) Repeat technique of (10) and (11) above for channel B, except perform **b**(3) and (4) below.

b. Adjustments

(1) Adjust oscilloscope calibrator (voltage calibrator) output for 0.2 V p-p.

(2) Adjust R116 (fig. 6) for a 4-division oscilloscope vertical display (R).

(3) Repeat (1) above.

(4) Adjust R136 (fig. 6) for a 4-division oscilloscope vertical display (R).

28. Vertical High Frequency Compensation

a. Performance Check

(1) Connect oscilloscope calibrator (A3) +1 V FAST RISE OUTPUT (for AN/GSM-256, use H-P Model 211B 50Ω OUTPUT) to B INPUT, using cable and termination (B5 and B11).

(2) Set channel A and B VOLTS/DIV switches to .05.

(3) Set oscilloscope (A2) TIME/DIV switch to 20 μSEC.

(4) Set oscilloscope calibrator TRIGGER PULSE PERIOD switch to 100 μS (for AN/GSM256, adjust frequency for 10 kHz) and amplitude control for a convenient oscilloscope square-wave display. If oscilloscope square-wave display has overshoot or rounding, perform **b**(1) through (5) below.

(5) Disconnect cable from B INPUT and connect to A INPUT.

(6) Set MODE switch to A-ONLY and repeat (4) above, except perform **b**(6) through (10) below.

b. Adjustments

(1) Adjust C93 (fig. 7) for optimum oscilloscope square-wave display.

(2) Set oscilloscope POWER switch to OFF and connect two adapters and lead (B1 and B9) across R91 (fig. 7).

(3) Set oscilloscope POWER switch to ON and adjust C191 (fig. 6) for optimum square-wave display

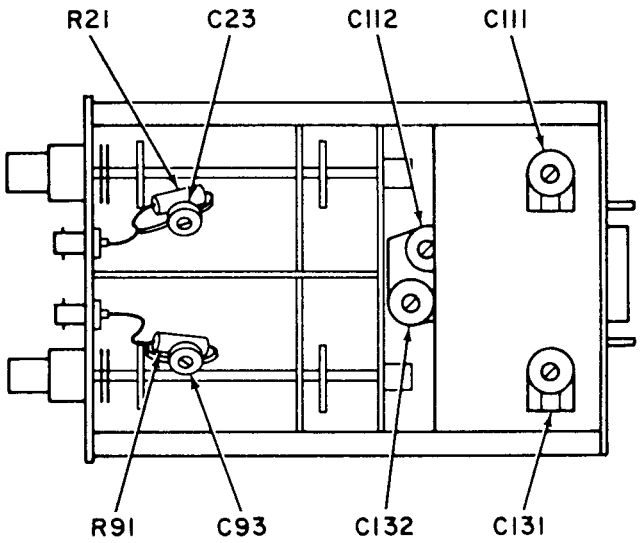

Figure 7. Plug-in unit MX-2995/USM-117 - right-side view.

(4) Set POWER switch to OFF and remove connection made in (3) above.

(5) Set POWER switch to ON and repeat (1) above.

(6) Adjust C23 (fig. 7) for optimum square-wave display.

(7) Set oscilloscope POWER switch to OFF and connect two adapters and lead (B1 and B9) across R21 (fig. 7).

(8) Set POWER switch to ON and adjust C101 (fig. 6) for optimum square-wave display on oscilloscope.

(9) Set POWER switch to OFF and remove connection made in (7) above.

(10) SET POWER switch to ON and repeat (6) above

29. High-Frequency Peaking

a. Performance Check

(1) Set oscilloscope (A2) TIME/DIV switch to 2 μSEC.

(2) Set oscilloscope calibrator (A3) TRIGGER PULSE PERIOD switch to 10 μS (for AN/GSM-256, adjust frequency for 100 kHz) and amplitude control for a convenient oscilloscope square-wave display. If oscilloscope square-wave display has overshoot or rounding, perform **b**(1) below.

(3) Set VOLTS/DIV switch to .2.

(4) Repeat (2) above, except perform **b**(2) and (3) below.

(5) Disconnect cable from A INPUT and connect to B INPUT.

(6) Set MODE switch to B-ONLY and repeat (1) and (2) above, except perform **b**(4) below.

(7) Set channel B VOLTS/DIV switch to .2.

(8) Repeat (2) above, except perform **b**(5) and (6) below.

b. Adjustments

(1) Adjust C112 (fig. 7) for optimum squarewave display.

(2) Adjust C111 (fig. 7) for optimum oscilloscope square-wave display.

(3) Repeat **a**(1) through (4) above and corresponding adjustments until no further adjustments are required.

(4) Adjust C132 (fig. 7) for optimum oscilloscope square-wave display.

(5) Adjust C131 (fig. 7) for optimum oscilloscope square-wave display.

(6) Repeat **a**(6) through (8) above and corresponding adjustments until no further adjustments required.

30. Vertical Attenuator Input Capacitance

a. Performance Check

(1) Connect oscilloscope calibrator (A3) HI AMPL OUTPUT (for AN/GSM-256, use H-P Model 211B 50Ω OUTPUT) to B INPUT, using adapters, cable, standardizer, and termination (B3, B4, B5, B10, and B11).

(2) Set oscilloscope (A2) TIME/DIV switch to.2 MILLISEC.

(3) Set channel B VOLTS/DIV switch to .05.

(4) Set oscilloscope calibrator TRIGGER PULSE PERIOD switch to 1 ms (for AN/GSM256, adjust H-P Model 211B frequency for 1 kHz) and amplitude control for a convenient oscilloscope square-wave display.

(5) Adjust standardizer for optimum oscilloscope square-wave display.

(6) Repeat technique of (4) above for VOLTS/DIV switch settings and adjustments listed in table 11. If oscilloscope square-wave display has overshoot or rounding, perform appropriate adjustments.

Table 11. Attenuator Input Capacitance

Test instrument **VOLTS/DIV** switch settings	Adjustments (fig. 6)	
	Channel A	Channel B
.1	C20	C90
.2	C21	C91
.5	C14	C84
1	C18	C88
2	C19	C89
5	C16	C86

(7) Disconnect cable and accessories from B INPUT and connect to A INPUT.

(8) Set MODE switch to A-ONLY and channel A VOLTS/DIV switch to .1.

(9) Repeat (6) above for channel A VOLTS/DIV switch and adjustments.

b. Adjustments. No further adjustments can be made.

31. Vertical Risetime

a. Performance Check

(1) Connect oscilloscope calibrator (A3) +1 VOLT FAST RISE OUTPUT (for AN/GSM-256, use H-P Model 211B 50Ω OUTPUT), to A INPUT, using cable and termination (B5 and B11).

(2) Connect oscilloscope calibrator MARKER OUT (for AN/GSM-256, use TRIGGER OUTPUT) to oscilloscope (A2) EXT TRIGGER INPUT, using another cable (B5).

(3) Set oscilloscope TIME/DIV switch to .1 µSEC and TRIGGER SLOPE switch to +AC.

(4) Set channel A VOLTS/DIV switch to .1.

(5) Set oscilloscope calibrator TRIGGER PULSE PERIOD and TIME/DIV switches to 1 μS (for AN/GSM-256, adjust frequency for 1 MHz) and amplitude for a convenient oscilloscope square-wave display.

(6) Measure risetime, using standard risetime technique. Risetime will be 70 ns or less.

(7) Disconnect cable and termination from A INPUT and connect to B INPUT.

(8) Set MODE switch to B-ONLY and repeat (4) through (6) above for channel B.

b. Adjustments. No adjustments can be made.

32. Final Procedure

a. Deenergize and disconnect all equipment and reinstall protective cover on TI.

b. When all parameters are within tolerance, annotate and affix DA Label 80 (US Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (US Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, repair the TI in accordance with the maintenance manual. When repair is delayed for any reason or the TI cannot be repaired with local resources, annotate and affix DA Form 2417 (US Army Calibration System Rejected Instrument) and inform the owner/user accordingly in accordance with TB 750-25-1

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