

*TB 9-6625-2407-24

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR TRANSPONDER TEST SET, TEL INSTRUMENT, MODELS T-47G, T-47NH, T-47S AND T-47SH

Headquarters, Department of the Army, Washington, DC
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REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

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

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**SECTION I
IDENTIFICATION AND DESCRIPTION**

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Transponder Test Set, Tel Instrument, Models T-47G, T-47NH, T-47S and T-47SH. The manufacturers' manuals were used as the prime data sources in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. T-47NH and T-47SH contain a handheld antenna.

b. Time and Technique. The time required for this calibration is approximately 4 hours using microwave 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. 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

Transponder mode	
Test instrument parameters	Performance specifications
Transmitter ¹	Frequency: 1030 MHz and 1090 MHz Accuracy: ±10 kHz Power: 7 dBm, -2 dBm, -42 dBm ¹ Accuracy: ± 2dBm
Receiver ¹	Frequency range: 1029.7 to 1093.5 Mhz ¹ Accuracy: ± 200kHz Power: 47 to 64 dBm Accuracy: ± 2dB ³ , ± 3dB ² Sensitivity range: -50 to -87 dBm Accuracy: ± 2dB ³ , ± 3dB ² Reply efficiency range: 0 to 100% Accuracy: 1% ³
TACAN and DME mode	
Transmitter	Frequency: 962 MHz to 1213 MHz Accuracy: ±10 kHz Power: 0 dBm Accuracy: ± 2dBm ² Power: -50 dBm Accuracy: ± 2dBm ⁴ Range accuracy: ± 0.5 nmi typical, ± 1.0 nmi max Velocity accuracy: ± 3.0%

¹Transponder, Interrogator, and TCAS modes only.

²At antenna SUM connector.

³Transponder mode.

⁴At Direct Connect connector.

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, AN/GSM-705, and Secondary Reference Calibration Standards Set NSN 4931-00-621-7878. 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-one ratio between the standard and TI. Where the four-to-one ratio cannot be met, the actual accuracy of the equipment selected is shown in parenthesis.

5. Accessories Required. The accessories required for this calibration are common usage accessories, issued as indicated in paragraph 4 above, and are not listed in this calibration procedure. The following peculiar accessory is also required for this calibration: SEMICONDUCTOR DEVICE (COAXIAL CRYSTAL DETECTOR) Hewlett Packard, Model 423AOPT03.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacture and model (part number)
OSCILLOSCOPE	Sweep: 100 ns/div Vertical gain: 10 mV/div Vertical gain accuracy: $\pm 1.00\%$	(OS303/G)
POWER SPLITTER	Frequency range: 1-2 GHz Output tracking: ± 0.15 dB	Weinschel, Model 1870A, (7916839)
PULSE GENERATOR	Period range: 20.3 μ s Pulse width: 450.0 ns Pulse delay: 12 μ s Accuracy: $\pm 0.5\%$	LeCroy, Model 9210MOD200 (9210MOD200) w/ plug-ins, LeCroy, Models 9211 (9211) and 9215 (9215) (MIS45839) or Agilent Model 81150A
SPECTRUM ANALYZER	Absolute amplitude accuracy: $< \pm 0.34$ dB	(AN/USM-677)
SYNTHESIZED SIGNAL GENERATOR	Frequency range: 10 MHz to 18 GHz Accuracy: $< \pm 5$ parts in 10^{-10}	Wiltron, Model 68347M (68347M)
VARIABLE ATTENUATOR	Frequency range: 10 MHz to 18 GHz Accuracy: See test report	Weinschel, Model AF117A69-34 (AF117A69-34)

SECTION III CALIBRATION PROCESS

6. Preliminary Instructions

NOTE

If any out of tolerance condition is found during performance of Section III, perform Section IV and at completion of Section IV, redo Section III.

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 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 manufacturer’s manual.

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. REDUCE OUTPUT(S) to minimum after each step within the performance check where applicable.

a. Set TI function and rotary switches to settings in table 3 for model T-47G, T-47S and T-47SH, or table 4 for Model T-47NH.

Table 3. Initial Settings - Models T-47G, T-47S and T-47SH

ROTARY/FUNCTION switch	Position
UUT FUNCTION (rotary switch)	XPDR
CODE/ALT, CHN, ATTEN (toggle switch)	CHN (Centered)
UP – DOWN (toggle switch)	Centered
VALID – INVALID (toggle switch)	VALID
IDENT – DEL 135/EMERGENCY (toggle switch)	Centered
TO/FROM – START/STOP (toggle switch)	Centered
BEARING RANGE (rotary switch)	2
VALID, CODE, INVALID (toggle switch)	VALID
AUTO, TEST, MANUAL (toggle switch)	TEST(Centered)
MOM, BACKLIGHT, ON (toggle switch)	BACKLIGHT(Centered)
ON, OFF PWR/CHG (toggle switch)	OFF PWR/CHG
ON, OFF TEST SET (toggle switch)	OFF TEST SET
DIRECT CONNECT (port)	Termination cap installed
ANTENNA SUM – DIFF (ports)	Termination cap installed

Table 4. Initial Settings - Model T-47NH

ROTARY/FUNCTION switch	Position
UUT FUNCTION (rotary switch)	XPDR
G/A, A/A, A/A BCN (toggle switch)	G/A
CODE/ALT, CHN, ATTEN (toggle switch)	CHN (Centered)
UP – DOWN (toggle switch)	Centered
X – Y (toggle switch)	X
IDENT – DEL 135/EMERGENCY (toggle switch)	Centered
TO/FROM – START/STOP (toggle switch)	Centered
BEARING RANGE (rotary switch)	2
VALID, CODE, INVALID (toggle switch)	VALID
AUTO, TEST, MANUAL (toggle switch)	TEST(Centered)

Table 4. Initial Settings - Model T-47NH - Continued

ROTARY/FUNCTION switch	Position
MOM, BACKLIGHT, ON (toggle switch)	BACKLIGHT (Centered)
ON, OFF PWR/CHG (toggle switch)	OFF PWR/CHG
ON, OFF TEST SET (toggle switch)	OFF TEST SET
DIRECT CONNECT (port)	Termination cap installed
ANTENNA SUM – DIFF (ports)	Termination cap installed

- b. Connect TI to a 115 V ac source.
- c. Set TI **ON OFF PWR/CHG** switch to **ON** and ensure the green LED illuminates.
- d. Set TI **ON OFF TEST SET** switch to **ON** and ensure the green LED illuminates.
- e. TI will display the following:

Self Test
Testing . . .

Self Test
PASS

Tel-Instrument	T-47X
REV X.XX	XXXXX hrs

- f. TI will briefly indicate current software version and total hours then display the following:

ANTENNA Connections
Missing or reversed

- g. Toggle and hold TI **MOM BACKLIGHT ON** switch to **ON** and verify backlighting remains lit. Release switch and backlighting extinguishes.
- h. Toggle and release TI **MOM BACKLIGHT ON** switch to **MOM** and verify backlighting illuminates briefly and then extinguishes.
- i. Set TI **ON OFF TEST SET** switch to **OFF** and disconnect AC power cord.
- j. Set TI **ON OFF TEST SET** switch to **ON** and ensure TI turns off after approximately 15 minutes of inactivity.
- k. Reconnect TI AC power cord, remove TI **SUM** cap and set TI **ON OFF TEST SET** switch to **ON**.
- l. Ensure TI displays the following:

**ANTENNA Connections
Missing or reversed**

- m. Set **TI ON OFF TEST SET** switch to **OFF**, remove **TI DIRECT CONNECT** cap.
- n. Set **TI ON OFF TEST SET** switch to **ON**. TI will display the following:

**Direct Connection
Press AUTO to cont**

- o. Reconnect **TI DIRECT CONNECT** cap and ensure TI returns to previous displayed screen.
- p. Set **TI ON OFF TEST SET** switch to **OFF**.

8. Transponder Transmitter Frequency

a. Performance Check

- (1) Set TI function and rotary switches to settings in table 3 for models T-47G, T-47S and T-47SH, or table 4 for Model T-47NH.
- (2) Connect spectrum analyzer to **TI SUM** port.

NOTE

Any time test are conducted using **TI SUM** and **DIFF** ports and TI is turned **ON**, a message indicating “ANTENNA Connections Missing or reversed” is displayed. To bypass this, short the center pin of **TI DIFF** connector to advance.

- (3) Set **TI UUT FUNCTION** switch to **XPDR**, hold **TI AUTO TEST MANUAL** switch in **AUTO** position and toggle **TI ON OFF TEST SET** switch to **ON**.
- (4) Toggle **TI TO/START FROM/STOP** switch to set TI antenna gain to 0 dB.
- (5) Set **TI UUT FUNCTION** switch to **TCAS** and toggle **TI TO/START FROM/STOP** switch to set TI antenna gain to 0 dB.
- (6) Set **TI UUT FUNCTION** switch to **XPDR** and toggle **TI AUTO TEST MANUAL** switch to **AUTO**.
- (7) At “ANT Hand Held” screen, select **YES** by toggling **TI TO/START FROM/STOP** switch.
- (8) Toggle **TI AUTO TEST MANUAL** switch to **AUTO** and verify TI passes Self Test.
- (9) Utilize **TI TO/START FROM/STOP** switch to set TI distance to “**Set Distance: 25 ft**” and toggle **AUTO TEST MANUAL** switch to **AUTO**.
- (10) Turn TI **OFF**. Hold down **TI SLEW UP DOWN** and **TO/START FROM/STOP** switches and turn TI back **ON**. This will disable TI LED power and “**ANTENNA LED IS OFF**” will be briefly displayed.
- (11) Toggle **AUTO TEST MANUAL** switch to **AUTO** until TI display indicates the following:

TRANSPONER Test
Press AUTO/MANUAL

(12) Toggle **AUTO TEST MANUAL** switch to **MANUAL** until TI display indicates the following:

M 3A
No reply

(13) Set spectrum analyzer center frequency to 1030 MHz, amplitude reference level to 10 dBm, span to 0 MHz, resolution BW to 3 MHz, video BW to 3 MHz and sweep time to 500 ms.

(14) Spectrum analyzer, accounting for cable loss, will indicate $7 \text{ dB} \pm 2 \text{ dB}$ at 1030 MHz (record reading). If not, perform Section IV below.

(15) Set TI **UUT FUNCTION** switch to **MODE S** and toggle TI **AUTO TEST MANUAL** switch to **AUTO** then **MANUAL** until TI display indicates the following:

M 3A
No reply

(16) Spectrum analyzer, accounting for cable loss, will indicate $7 \text{ dB} \pm 2 \text{ dB}$. If not, perform Section IV below.

(17) Set TI **UUT FUNCTION** switch to **XPDR** position.

(18) Toggle **AUTO TEST MANUAL** switch to **AUTO** until TI display indicates the following:

TRANSPONER Test
Press AUTO/MANUAL

(19) Toggle **AUTO TEST MANUAL** switch to **MANUAL** until TI display indicates the following:

M 3A
No reply

(20) Move spectrum analyzer connection from **ANTENNA SUM** connector to **ANTENNA DIFF** connector.

(21) Spectrum analyzer will indicate at least 20 dB lower than indication in step (14) above. If not, perform Section IV below.

(22) Toggle **SLEW UP/DOWN** switch **UP** and utilizing the **TO/START - FROM/STOP** switch to change “**Set Distance: 25 ft.**” to “**Set Distance: 35 ft.**”

(23) Toggle **AUTO TEST MANUAL** switch to **AUTO** one time to return TI to **M 3A** display.

(24) Spectrum analyzer will indicate between $9 \text{ dB} \pm 2 \text{ dB}$ lower than indication in step (14) above. If not, perform Section IV below.

(25) Repeat technique of steps (22) and (23) above to change “**Set Distance: 35 ft.**” to “**Set Distance: 75 ft.**”

(26) Spectrum analyzer will indicate $5 \text{ dB} \pm 2$ lower than indication in step (14) above. If not, perform Section IV below.

(27) Move spectrum analyzer connection from **ANTENNA DIFF** connector to **ANTENNA SUM** connector.

(28) Set **TI ON OFF TEST SET** switch to **OFF** and then back **ON**.

(29) Toggle **AUTO TEST MANUAL** switch to **AUTO** until TI display indicates the following:

<p>TRANSPONER Test Press AUTO/MANUAL</p>
--

(30) Toggle **AUTO TEST MANUAL** switch to **MANUAL** until TI display indicates the following:

<p>M 3A No reply</p>
--

(31) Set spectrum analyzer center frequency to 1030 MHz, amplitude reference level to 10 dBm, span to 25 MHz, resolution BW to 5 MHz, video BW to 3 MHz and sweep time to 1 Sec.

(32) Spectrum analyzer will indicate $1030 \text{ MHz} \pm 0.2 \text{ MHz}$. If not, perform Section IV below.

(33) Set **TI ON OFF TEST SET** switch to **OFF**.

b. Adjustments. See Section IV.

9. Interrogator/TCAS Frequency and Power

a. Performance Check

(1) Set pulse generator for double pulses, frequency to 100 Hz, dbl delay to 8 μs , pulse width to 800 ns, leading and trailing edge to 5 ns, amplitude to +3 volts Hi / +0 volts Low, input impedance 50 Ω .

(2) Connect output of pulse generator to the pulse in connector of the synthesized signal generator.

- (3) Set synthesized signal generator frequency to 1030 MHz, external pulse modulation, and +0 dBm output (account for cable loss).
- (4) Connect synthesized signal generator output to TI ANTENNA SUM connector.
- (5) Set TI UUT FUNCTION switch to INTERR position and ON OFF TEST SET switch to ON.
- (6) Toggle AUTO TEST MANUAL switch to AUTO until TI display indicates the following:

Set Distance: XX ft.
TO/FROM Cont: AUTO

- (7) Toggle TI TO/START – FROM/STOP switch to change “Set Distance: 25 ft.”
- (8) Toggle AUTO TEST MANUAL switch to AUTO.

NOTE

In the following tests, there may be some variance in pulse width measurements.

- (9) Repeatedly toggle AUTO TEST MANUAL switch to MANUAL until TI display indicates approximately the following:

M3A PASS - ?? dB
0.80 → 08.05 → 0.80

- (10) TI will indicate PASS. If not, perform Section IV below.
- (11) Toggle TI AUTO TEST MANUAL switch to MANUAL once. TI should indicate the following:

M C TIMG
No Interrogations

- (12) Change pulse generator dbl delay to 21 μs. TI will indicate approximately the following:

M C PASS - ?? dB
0.80 → 21.00 → 0.80

- (13) TI will indicate PASS. If not, perform Section IV below.
- (14) Set TI ON OFF TEST SET switch to OFF.

(15) Set synthesized signal generator output to off and disconnect synthesized signal generator from TI ANTENNA SUM connector.

(16) Connect a BNC "T" connector to TI ANTENNA SUM connector. Reconnect synthesized signal generator output to one end of BNC "T" and spectrum analyzer to the other end of BNC "T".

(17) Set spectrum analyzer center frequency to 1090 MHz, amplitude reference level to 0 dBm, span to zero span, resolution BW to 5 MHz, video BW to 3 MHz and sweep time to 1 Sec.

(18) Set synthesized signal generator output to on and set TI ON OFF TEST SET switch to ON.

(19) Toggle AUTO TEST MANUAL switch repeatedly to AUTO until TI advances to Automatic Sequence of Interrogator Tests.

(20) Verify TI displays a reply. Spectrum analyzer, accounting for cable and connector loss, will indicate $-4 \text{ dBm} \pm 2 \text{ dB}$ ($-2 \text{ dBm} \pm 2 \text{ dB}$ for models T-47G and T-47S). If not, perform Section IV below.

(21) Set TI ON OFF TEST SET switch to OFF.

b. Adjustments. See Section IV.

10. DME/TACAN Frequency and Power

a. Performance Check

(1) Connect equipment as shown in figure 1.

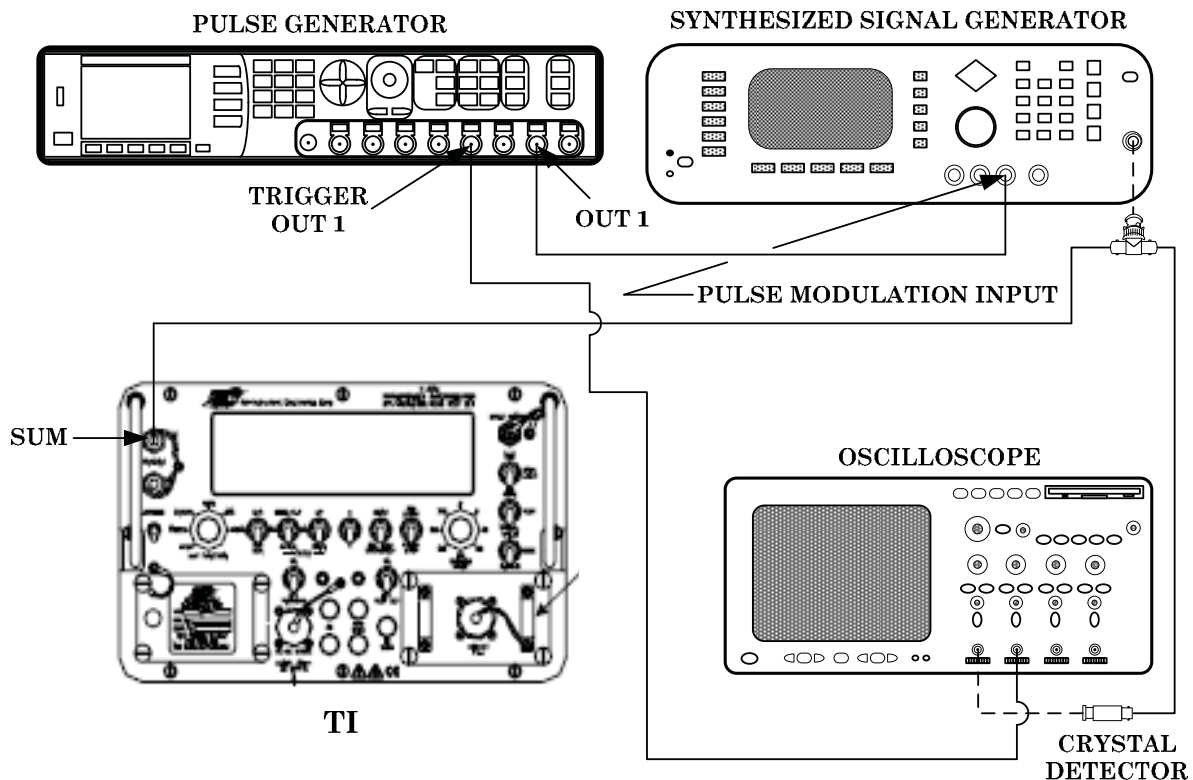


Figure 1. Equipment connection.

(2) Set pulse generator for double pulses, frequency to 100 Hz, delay to 12 μ s, pulse width to 3.5 μ s, leading edge rise to 5 ns, amplitude to +3 volts Hi / +0 volts Low, input impedance 50 Ω .

(3) Set TI **UUT FUNCTION** switch to **DME** and set TI **X-Y** switch to **X** with 2 nmi **BEARING RANGE**.

(4) Hold down TI **TO/START FROM/STOP** and **SLEW UP DOWN** switches and set TI **ON OFF TEST SET** switch to **ON**. If necessary, use **SLEW UP/DOWN** switch to set TI to channel **17X**.

(5) Set synthesized signal generator frequency to 1041 MHz, external pulse modulation, and +0 dBm output.

NOTE

Interrogation pulse width is set on pulse generator and width displayed on oscilloscope may be affected by crystal detector.

(6) Observe interrogation and reply pulses on oscilloscope. Interrogation pulse width will be 3.5 μ s \pm 0.5 μ s, reply pulse spacing will be 12 μ s \pm 0.25 μ s. If not, perform Section IV below.

NOTE

Reply pulses are approximately 75 μ s after interrogation pulses.

(7) Set TI to channel **17Y** using **X-Y** switch with 2 nmi **BEARING RANGE** and set pulse generator delay to 36 μ s. Reply pulse spacing will be 30 μ s \pm 0.25 μ s as observed on oscilloscope. If not, perform Section IV below.

(8) Set TI to channel **17X** using **X-Y** switch with 2 nmi **BEARING RANGE** and set pulse generator delay to 12 μ s.

(9) Activate oscilloscope markers. Place marker “A” at 50% rise point of first interrogation pulse and marker “B” at 50% rise point of first reply pulse.

(10) Measure distance between markers. If distance is not within limits specified in first row of table 5, perform Section IV below.

(11) Repeat technique of (8) through (10) above using TI and pulse generator settings listed in table 5. If distance measured is not within limits specified in table 5, perform Section IV below.

Table 5. DME Range Verification

Test instrument		Pulse generator	Oscilloscope indication	
Channel	Bearing range (nmi)	Delay (μ s)	Limits (μ s)	
			Min	Max
17X	2	12	68.54	80.90
17X	130	12	1650.48	1662.84
17X	300	12	3751.52	3763.88
17Y	2	36	74.54	86.90
17Y	130	36	1656.48	1668.84
17Y	300	36	3757.52	3769.88

(12) Set TI **ON OFF TEST SET** switch to **OFF** and disconnect equipment setup.

(13) Connect spectrum analyzer to TI **ANTENNA SUM** connector.

(14) Hold down TI **TO/START FROM/STOP** and **SLEW UP DOWN** and set TI **ON OFF TEST SET** switch to **ON**.

(15) Set TI to channel **17X** using **X-Y** switch.

(16) Set spectrum analyzer center frequency to 978 MHz, amplitude reference level to 0 dBm, span to 10 MHz, resolution BW to 10 kHz, video BW to **AUTO** and averaging to **OFF**.

(17) Spectrum analyzer will indicate a center frequency within limits specified in first row of table 6. If not, perform Section IV below.

(18) Repeat technique of (15) through (17) above using TI and spectrum analyzer settings listed in table 6. If spectrum analyzer center frequency indications are not within limits specified in table 6, perform Section IV below.

Table 6. DME Center Frequency

Test instrument	Spectrum analyzer		
	Center frequency (MHz)	Indication limits (MHz)	
Channel			Min
17X	978	977.5	978.5
73X	1160	1159.5	1160.5
122X	1209	1208.5	1209.5
17Y	1104	1103.5	1104.5
73Y	1034	1033.5	1034.5
122Y	1083	1082.5	1083.5

(19) Set spectrum analyzer center frequency to 978 MHz, amplitude reference level to 5 dBm, span to zero span, resolution BW to 3 MHz, video BW to **AUTO**, scale/div to 1 dB and averaging to **OFF**.

(20) Set TI to channel 17X and utilizing spectrum analyzer marker feature measure TI power out. If spectrum analyzer indication is not 1 dBm ± 3 dB (0 dBm ± 2 dB, model T-47G), perform Section IV below.

(21) Set TI **UUT FUNCTION** switch to **TACAN** and set TI to channel 17X.

(22) Set spectrum analyzer center frequency to 978 MHz, amplitude reference level to -25 dBm, span to 5 MHz, resolution BW to 100 kHz, video BW to 100 kHz, scale/div to 10 dB and sweep to 10 ms.

(23) Acquire signal and then decrease spectrum analyzer amplitude setting to view TI un-modulated signal as shown in figure 2 below. If spectrum analyzer center frequency indication is not within limits specified in first row of table 7, perform Section IV below.

(24) Repeat technique of (21) through (23) above using TI and spectrum analyzer settings listed in table 7. If spectrum analyzer center frequency indications are not within limits specified in table 7, perform Section IV below.

Table 7. TACAN Center Frequency

Test instrument	Spectrum analyzer		
	Center frequency (MHz)	Indication limits (MHz)	
Channel			Min
17X	978	977.5	978.5
2X	963	962.5	963.5
73X	1160	1159.5	1160.5
122Y	1083	1082.5	1083.5

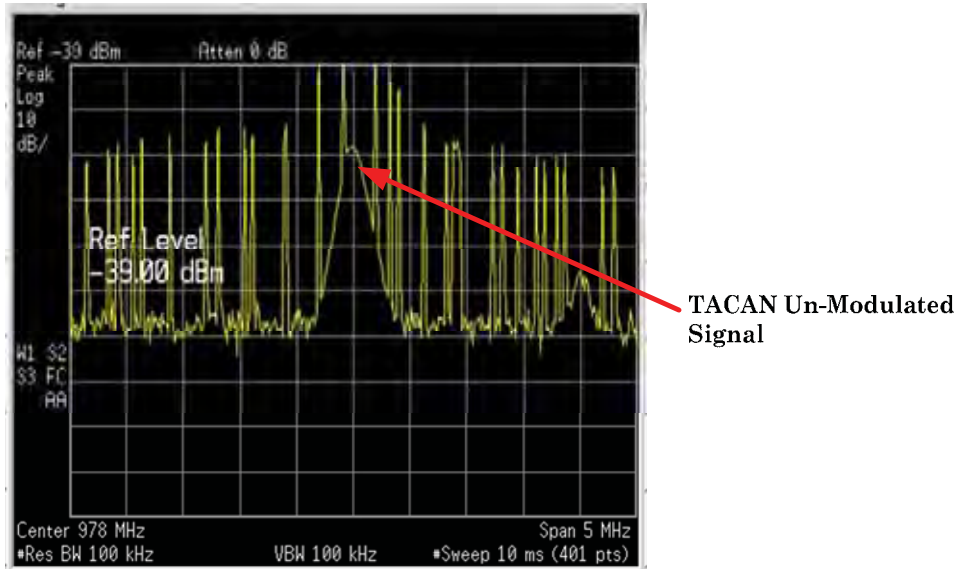


Figure 2. TACAN un-modulated signal.

11. Final Procedure

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

SECTION IV ADJUSTMENT PROCESS

12. Preliminary Instructions

- a. Set TI switches IAW table 3 or table 4, depending on model.
- b. Remove the TI from the case by loosening the eight (8) or ten (10) lock bolts located on the front panel. Do not remove the bolts as they are a captive type. Only loosen enough to release grip on the anchor nuts.
- c. Grasp the TI handles and slowly remove TI assembly from case. Ensure force is not used to pull the TI from the case; slightly angle the TI to allow for free movement of the assembly, attached hardware and cables then place on flat non-conductive surface.
- d. Gain access to the Digital PCB (directly under rear facing cover secured by screws); locate U17.
- e. Set position 1 of the dip switch to “ON” (for T-47S set position 1 and 2 of the dip switch to “ON”). Set the remaining dip switch positions to “OFF”.
- f. Replace cover of Digital PCB with four (4) screws.
- g. Remove screws securing the Digital PCB/RF PCB assembly to mainframe. Ensure that all attaching cables and connectors remain attached and undue stress is not put on them.
- h. Remove termination from the **DIRECT CONNECT** connector.
- i. Disconnect the ATT connector from the attenuator assembly.

- j. Connect oscilloscope, crystal detector and adapters to ATT connector.
- k. Set oscilloscope sweep to 2 $\mu\text{s}/\text{div}$, vertical gain to 10 mV/div and input impedance to 50 Ω .
- l. Remove cover from RF PCB.
- m. Externally trigger oscilloscope using TP3 on RF PCB shown in figure 3.

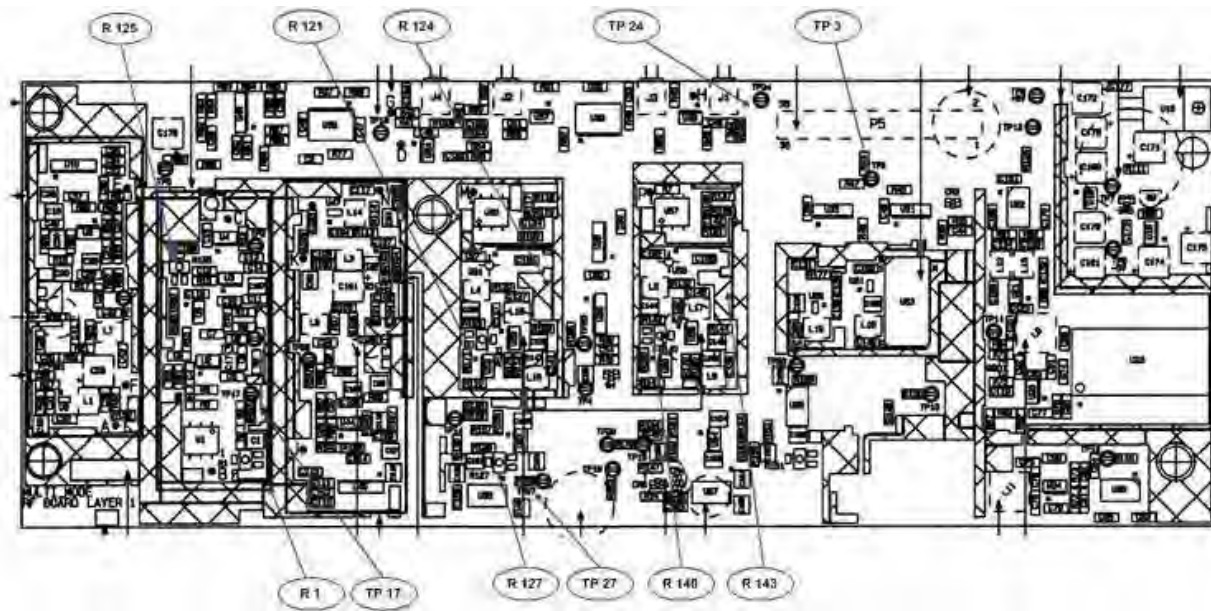


Figure 3. RF PCB.

13. Mode S Surveillance ID Test

a. Performance Check

- (1) Set TI UUT FUNCTION switch to **MODE S** position.
- (2) Turn on TI.
- (3) Toggle **TEST** switch to **AUTO** until TI display indicates the following:

M S Surv Id
No reply

- (4) Toggle **TEST** switch to **MANUAL** to observe pulses.
- (5) Observe pulses on the oscilloscope (for T-47N only, check pulses that are between 8 μs and 13 μs after the trigger). The pulse amplitude should not vary more than ± 2 mV. If not, perform **b** (1) below.
- (6) Turn off TI.
- (7) Remove oscilloscope and crystal detector from **ATT** cable.
- (8) Set spectrum analyzer center frequency to 1030 MHz, amplitude reference level to +10 dBm, span to 0 MHz, resolution BW to 3 MHz, and sweep time to 2 seconds.
- (9) Connect spectrum analyzer to **ATT** cable using adapters and cable.

- (10) Set TI **UUT FUNCTION** switch to **XPDR** position.
- (11) Turn on TI and set cable loss variable to 3.0 dB.
- (12) Toggle **TEST** switch to **AUTO** until TI display indicates the following:

TRANSPONER Test
Press AUTO/MANUAL

- (13) Toggle **TEST** switch to **MANUAL** until TI display indicates the following:

M 3A
No reply

(14) Spectrum analyzer, accounting for cable loss, will indicate between 7.8 and 8.2 dB at 1030 MHz. If not, perform **b** (2) below.

- (15) Turn off TI and remove spectrum analyzer from ATT connector.

(16) Install **DIRECT CONNECT** termination and connect spectrum analyzer to the **ANTENNA SUM** connector. Terminate the **ANTENNA DIFF** connector with a 50 Ω termination.

(17) Turn on TI while holding the **SLEW UP DOWN** and **TO/START – FROM/STOP** switches in the down position.

- (18) Toggle **TEST** switch to **AUTO** until TI display indicates the following:

TRANSPONDER Test
Press AUTO/MANUAL

- (19) Toggle **TEST** switch to **MANUAL** until TI display indicates the following:

M 3A
No reply

(20) Spectrum analyzer, accounting for cable loss, will indicate between 6 and 8 dB at 1030 MHz. Record indication as reference level.

(21) Swap spectrum analyzer and 50 Ω termination from **ANTENNA SUM** connector and **ANTENNA DIFF** connectors.

- (22) Spectrum analyzer will indicate at least 20 dB lower than indication in step (20) above.

(23) Toggle **SLEW UP DOWN** switch up and utilizing the **TO/START – FROM/STOP** switch to change “**Set Distance: 25 ft.**” to “**Set Distance: 35 ft.**”

- (24) Toggle **TEST** switch to **AUTO** one time.

(25) Spectrum analyzer will indicate between $9 \text{ dB} \pm 2 \text{ dB}$ lower than indication in step (20) above.

(26) Repeat technique of steps (23) and (24) to change “**Set Distance: 35 ft**” to “**Set Distance: 75 ft.**”

(27) Spectrum analyzer will indicate $5 \text{ dB} \pm 2$ lower than indication in step (20) above.

(28) Turn TI off.

b. Adjustments

(1) Adjust R1 (fig. 1) for $0 \pm 2 \text{ mV}$ (R).

(2) Adjust R125 (fig. 1) for $8 \text{ dB} \pm 0.2 \text{ dB}$ (R).

14. DAC Table (Transmit)

a. Performance Check

(1) Remove termination from the **DIRECT CONNECT** connector.

(2) Connect spectrum analyzer to ATT cable using adapter and cable. (Refer to step **12 g** above).

(3) Set TI **UUT FUNCTION** switch to **TCAS** position.

(4) Turn on TI while holding the **TEST MANUAL** switch in the down position. TI display indicates the following:

**TEST FUNCTIONS:
Calibrate TX POWER**

(5) Toggle **TEST** switch to **AUTO** one time. TI display indicates the following:

**POWER CALIBRATION:
-00 dB DAC=0000h**

NOTE

DAC= can be a different value.

(6) Set spectrum analyzer center frequency to 1030 MHz, amplitude to approximately 10 dBm, span to 0 MHz, resolution BW to 3 MHz, sweep time to 50 ms, scale per division to 1 dB.

(7) Observe a straight line power measurement on spectrum analyzer.

(8) Adjust spectrum analyzer so the measured pulse is even on any line. This will be the same reference line used for each measurement which ensures linear adjustments are made to the DAC table. After each adjustment, using spectrum analyzer controls, reposition the signal back to this same line before making another adjustment.

(9) Toggle the **SLEW UP DOWN** switch down to change -00 dB display by -02 dB. The spectrum analyzer display will decrease by approximately -2 dB.

(10) Use the **IDENT/EMERG** switch for coarse adjustment and the **TO/FROM** switch for fine adjustment to place the spectrum analyzer measurement -2 dB from the reference.

(11) Readjust the spectrum analyzer to set the measured pulse back on the reference line as set up in step (8) above.

(12) Repeat technique of steps (9) through (11) above for -2 dB steps to -42 dB.

(13) Toggle **TEST** switch to **AUTO** one time to save DAC table to TI RAM.

(14) Turn TI off.

(15) Disconnect spectrum analyzer from the ATT connector cable.

b. Adjustments. None

15. RX Gain Calibration

a. Performance Check

(1) Connect Ext Trigger of pulse generator to TP3 on RF PCB shown in figure 3.

(2) Set pulse generator period to 20.3 μ s, delay to 12 μ s, pulse width to 450.0 ns, leading and trailing edge to 5 ns, amplitude to +4 volts Hi / +0 volts Low, input impedance 50 Ω , external trigger, trigger mode to Burst, trigger level to Auto Level.

(3) Connect output of pulse generator to the pulse in connector of the synthesized signal generator. Do not disconnect unless instructed to do so.

(4) Set synthesized signal generator frequency to 1090 MHz, pulse modulation, and +0 dBm output (account for cable loss).

(5) Connect synthesized signal generator output to the **ATT** connector cable using adapter and cable.

(6) Set TI **UUT FUNCTION** switch to **XPDR** position.

(7) Turn on TI while holding down the **DEL 135/EMERGENCY** switch.

(8) Toggle **TEST** switch to **AUTO** until TI display indicates the following:

<p>TRANSPONDER Test Press AUTO/MANUAL</p>

(9) Toggle **TEST** switch to **MANUAL** until TI display indicates the following:

M 3A	SLS	
0000	100%	FAIL

NOTE

SLS, FAIL, and EMERG may be seen, but have no effect on the calibration.

- (10) Verify a 100% reply is observed on the TI display.
- (11) Turn TI off.
- (12) Set TI **UUT FUNCTION** switch to **INTERR** position.
- (13) Turn on TI while holding the **TEST** switch in the **MANUAL** down position. TI display indicates the following:

TEST FUNCTIONS: Calibrate RX GAIN
--

- (14) Toggle **TEST** switch to **AUTO**. TI display indicates the following:

Calibrate RX GAIN SUM: XXX DIFF: YYY
--

- (15) **SUM** display will indicate 210 ± 1 . If not, perform **b** (1) below.
- (16) Change synthesized signal generator output to -25 dBm (account for cable loss).
- (17) **SUM** display will indicate 145 ± 1 . If not, perform **b** (2) through (4) below.
- (18) Change synthesized signal generator output to +5 dBm (account for cable loss).
- (19) **SUM** display will indicate 222 ± 2 .
- (20) Turn TI off.
- (21) Set **UUT FUNCTION** switch to **XPDR**.
- (22) Turn on TI and set cable loss variable to 3.0 dB.
- (23) Toggle **TEST** switch to **AUTO** until TI display indicates the following:

TRANSPONDER Test Press AUTO/MANUAL

- (24) Toggle **TEST** switch to **MANUAL** until TI display indicates the following:

POWER	FREQUENCY
58 dB	1090.0 P

NOTE

Frequency and Power measurements may slightly differ; ensure that a “**P**” is indicated.

- (25) Change synthesized signal generator output to 0 dBm (account for cable loss).
- (26) TI display **POWER** will indicate $53 \text{ dB} \pm 2$ and an “**F**” will replace “**P**” under **FREQUENCY**.

POWER	FREQUENCY
53 dB	1090.0 F

- (27) Vary the output of synthesized signal generator from +10 dBm to -30 dBm and verify the display **POWER** tracks accordingly ± 1 dB at each 1 dB step.
- (28) Turn TI off and remove synthesized signal generator, adapter and cable.
- (29) Reconnect the **ATT** connector to the TI attenuator assembly.
- (30) Connect spectrum analyzer to the **DIRECT CONNECT** port.
- (31) Turn TI on and toggle **TEST** switch to **AUTO** until TI display indicates the following:

TRANSPONDER Test
Press AUTO/MANUAL

TRANSPONDER Test
Press AUTO/MANUAL

- (32) Toggle **TEST** switch to **MANUAL** until TI display indicates the following:

M 3A
No reply

- (33) Set spectrum analyzer span to 0 MHz, resolution bandwidth to 3 MHz, center frequency to 1030 MHz and sweep time to 2 seconds.
- (34) Spectrum analyzer will indicate between -41 and -43 dB, taking into account cable loss.
- (35) Disconnect spectrum analyzer from **DIRECT CONNECT** port and connect the TI termination.
- (36) Connect TI supplied antenna to **ANTENNA DIFF** connector (if antenna is not available, a 50 Ω termination can be substituted).
- (37) Turn TI off and then back on while holding down the **DEL 135/EMERGENCY** switch. This step enables a 4 ms read cycle to ensure correct reply timing.
- (38) Toggle **TEST** switch to **AUTO** until TI display indicates the following:

TRANSPONDER Test
Press AUTO/MANUAL

(39) Toggle **TEST** switch to **MANUAL** until TI display indicates the following:

M 3A
No reply

(40) Set the synthesized signal generator for 1090 MHz and amplitude at 0.0 ± 0.1 dBm into 50Ω termination and cables as measured from both ends of the splitter, one at a time, using spectrum analyzer. Annotate synthesized signal generator output power setting.

(41) Turn off TI and connect equipment as shown in figure 4 without variable attenuator installed in setup.

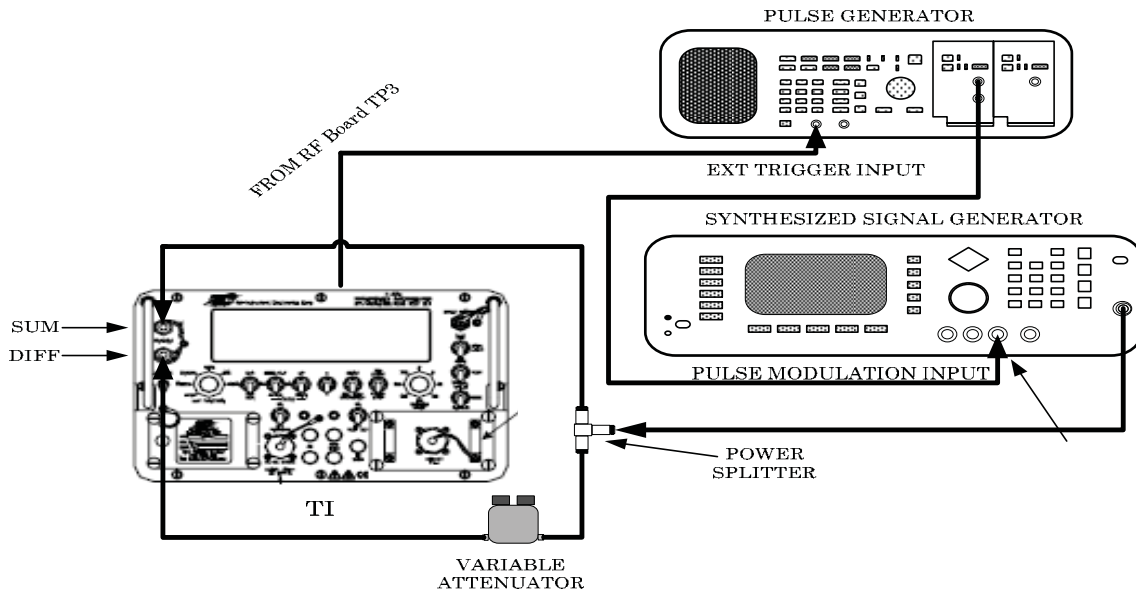


Figure 4. Receiver sum diff setup.

(42) Set **UUT FUNCTION** switch to **INTERR**.

(43) Turn on TI while holding the **TEST** switch in the **MANUAL** down position. TI display indicates the following:

TEST FUNCTIONS:
Calibrate RX GAIN

(44) Toggle **TEST** switch to **AUTO** one time. TI display indicates the following:

Calibrate RX GAIN
SUM: XXX DIFF: YYY

(45) Reduce the synthesized signal generator output until the **SUM: XXX** is 202 ± 2 . **DIFF: YYY** will indicate 240 ± 2 . If not, perform **b** (5) below.

- (46) Reduce the synthesized signal generator output by -25 dB.
- (47) **SUM: XXX** will be 138 ± 2 and **DIFF: YYY** will be 175 ± 2 . If not, perform **b (6)** below.
- (48) Turn TI off.
- (49) Set **UUT FUNCTION** switch to **XPDR**.
- (50) Turn TI on while holding down the **DEL 135/EMERGENCY** switch.
- (51) Toggle **TEST** switch to **AUTO** two (2) times. Display should indicate the following:

Set Distance: 25 ft.
TO/FROM Cont: AUTO

- (52) Toggle the **TO/START - FROM/STOP** switch to change display “**Set Distance: 25 ft.**” to “**Set Distance: 35 ft.**”
- (53) Toggle **TEST** switch to **AUTO** one time.
- (54) Toggle **TEST** switch to **MANUAL** until the TI display indicates the following:

M 3A
No reply

- (55) Set synthesized signal generator output to -15 dBm below setting noted in step (40) above.
- (56) Connect variable attenuator as shown in figure 4.
- (57) Set variable attenuator to 10 ± 0.2 dB.
- (58) The **=TURN=** message will flicker rapidly on and off. If not, perform **b (7)** below.
- (59) Set variable attenuator to 9 ± 0.2 dB.
- (60) The **=TURN=** message will remain on.
- (61) Set variable attenuator to 11 ± 0.2 dB.
- (62) The **=TURN=** message will be off and display 100% reply.

NOTE

SLS, FAIL, Ident, and EMERG may be seen, but have no effect on the calibration.

- (63) Toggle the **SLEW UP/DOWN** switch up to return to the “**Set Distance**” menu.
- (64) Toggle the **TO/START - FROM/STOP** switch to change display “**Set Distance: 35 ft.**” to “**Set Distance: 25 ft.**”.
- (65) Toggle **TEST** switch to **AUTO** switch to return to the previous display.
- (66) The **=TURN=** message will remain on at 4 ± 1 dB.

b. Adjustments

- (1) Adjust R140 (fig. 3) for 210 ± 1 (R).

- (2) Adjust R143 (fig. 3) for 145 ± 1 (R).
- (3) Change synthesized signal generator output to 0 dBm.
- (4) Repeat steps a (14) through (16) above until both measurements can be obtained without adjustment.
- (5) Adjust R121 (fig. 3) for 240 ± 2 (R).
- (6) Adjust R124 (fig. 3) for 138 ± 2 and 175 ± 2 . Repeat steps a (44) through (46) above until no adjustment are necessary (R).
- (7) Adjust R127 until =TURN= message flickers rapidly on and off or as close as possible.

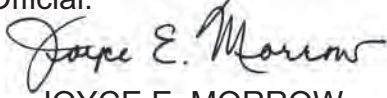
16. Final Procedure

- a. Deenergize and disconnect all equipment.
- b. For T-47NH, T-47S and T-47SH, set all DIP switch U17 positions, found on Digital PCB, to OFF.
- c. For T-47G, set position 3 on dip switch U17 found on Digital PCB, to ON. Set remaining positions to OFF.
- d. Replace cover and screws on the RF PCB and Digital PCB.
- e. Secure the Digital PCB/RF PCB assembly to mainframe. Ensure that all attaching cables and connectors remain attached and undue stress is not put on them.
- f. Reassemble TI in case.
- g. Repeat Section III above.

By Order of the Secretary of the Army:

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

Official:



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

1017409

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To be distributed in accordance with the initial distribution number (IDN) 345052, requirements for calibration procedure TB 9-6625-2407-24.

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

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

Subject: DA Form 2028

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

This is the text for the problem below line 27.

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