

SECTION 4

TEST, CALIBRATION, AND MAINTENANCE

4-1 General

The use of the current generation of electronic components has dramatically increased avionic test customer cost saving changes to traditional industry acceptance-test/annual-calibration procedures. Accordingly, the recommended test, calibration, and maintenance procedures for the T-49 will be as follows:

4 1 1 **Final Assembly Acceptance & Annual Calibration Tests** - these will be performed on an unopened test set by measuring inputs/outputs; if these tests are not within spec, the test set should be opened for alignment (see Appendix A for test report documentation format)

4 1 2 **Sub Assembly Alignment Tests** - opening the test set will make accessible the RF and Digital printed circuit boards, and their test points and alignment controls; if these adjustments do not return the test set to specified function, the unit requires maintenance (see Appendix A for test report documentation format)

4 1 3 **Maintenance** - depending upon customer maintenance policy, the unit is either trouble-shot, using the information from Sections 3, 5, & 6, which will permit a qualified technician to diagnose the fault and make the necessary repair or SRU replacement, or is returned to the manufacturer for repair, it is suggested that this policy be discussed at the time of the initial unit delivery

4-2 Final Assembly Acceptance And Annual Calibration Tests

4 2.1 Equipment Needed

1. Spectrum Analyzer (Hewlett Packard 8558B/182T)
- 2 3' X 3' L Band Antenna Base Plate
3. T-49 Unit & Accessories
- 4 Calibrated Transponder

4 2 2 Procedure

1 Battery Charging

- a Before testing, the T-49 unit should be charged.

Note: The total time of recharging should be at least two times as long as the test set was operated since its last full charge, but a charge time of up to 16 hours will not damage the internal Ni-Cad battery cells

- b Remove the power cord from inside the cover and attach it to the correct AC power receptacle.
- c Be sure the voltage change/fuse cartridge is set for the AC power to be used
- d Connect the power cord to an appropriate AC outlet.
- e Turn the AC power switch to the on position. Verify charging by observing that the Red AC power lamp is lit.
- f Remove AC power cord once finished charging.

2 Display Operation

- a Select the XPDR TEST of the TCAS INTRUDER TYPE mode switch.
- b After proper charging, press the INTERROGATE switch. Check the Data Display window for the following message

**Tel-Instrument
T-49 REV. X.X***

***Note: X.X Represents software revision number. Also, if the UUT displays BATTERY LOW RECHARGE, proceed back to step 1.**

Immediately followed by:

No Reply from XPDR.

- c Hold the light switch to the "LIGHT" position and verify that the display back light is functioning

3 Transmitter Frequency

- a Connect the output of the antenna connector directly to a spectrum analyzer
- b Set the Spectrum Analyzer to the following settings.

Frequency:	1030 MHz
Power Level:	-10 dBm

- c Set the XPDR/TCAS (HIGH/LOW) switch to low.
- d Hold down the INTERROGATE switch on and verify the existence of a pulse modulated signal at a frequency of 1030 MHz +/- 1MHz
- e Connect the output of the antenna connector directly to a power meter.

- f Hold down the INTERROGATE switch on and verify a power level of -10dBm +/-2dB
- g Set the XPDR/TCAS / (HIGH/LOW) switch to high Hold down the INTERROGATE switch and verify a level of +12 dBm +/-2dB
- h Set the XPDR/TCAS/ (HIGH/LOW) switch back to low

4 Receiver Local Oscillator

- a Stop interrogation and reset the spectrum analyzer to the following settings

Frequency:	1045 MHz
Power Level:	-30 dBm

- b Verify the existence of the Receiver Local Oscillator on the Spectrum Analyzer
The continuous wave should be measured at 1045 MHz +/-1MHz.

5 Mode S Pulse Modulated Signal

- a Set the TCAS INTRUDER TYPE to MODE S interrogation
- b Set the T-49 for a +1000 feet interrogation
- c Set the Spectrum Analyzer to the following settings

Frequency:	1090 MHz
Power Level:	-10 dBm

- d Press the INTERROGATE switch and verify the existence of a pulse modulated signal at a frequency of 1090 MHz +/-1 MHz

6 Omni Directional Antenna XPDR Test

- a Disconnect the UUT from the Spectrum Analyzer.
- b Connect the omni directional antenna to the output connector
- c Make sure the XPDR which is being tested is functional and powered on See Figure 4-1 for transponder system setup.
- d Set the TCAS INTRUDER TYPE to XPDR TEST
- e Press the INTERROGATE switch to communicate to the XPDR and identify the transponder type.

- f Press the INTERROGATE switch once again to begin a series of test to the XPDR.
- g Successful completion of XPDR test should result in the following displayed information:

4096	(Always displayed)
Altitude	(If available and not a Mode A XPDR)
Tail Number	(Mode S only)

7 TAP-115, TAP-125, or TAP-121 Antenna Coupler XPDR Test

- a Disconnect the omni directional antenna.
- b Connect the TAP-115 coupler to a 3' X 3' Blade mounted antenna plate and the UUT. If testing TAP-121, connect it directly to transponder. See Figure 4-1
- c Make sure the XPDR which is being tested is functional and powered on
- d Press the INTERROGATE switch to communicate to the XPDR and identify the transponder type.
- e Press the INTERROGATE switch once again to begin a series of test to the XPDR
- f Successful completion of the XPDR test should result in the following displayed information:

4096	(Always displayed)
Altitude	(If Available and not a Mode A XPDR)
Tail Number	(Mode S only)
Frequency	(+/- 100 KHz)
Power	(+/- 2 dB)
Sensitivity	(+/- 2 dB)

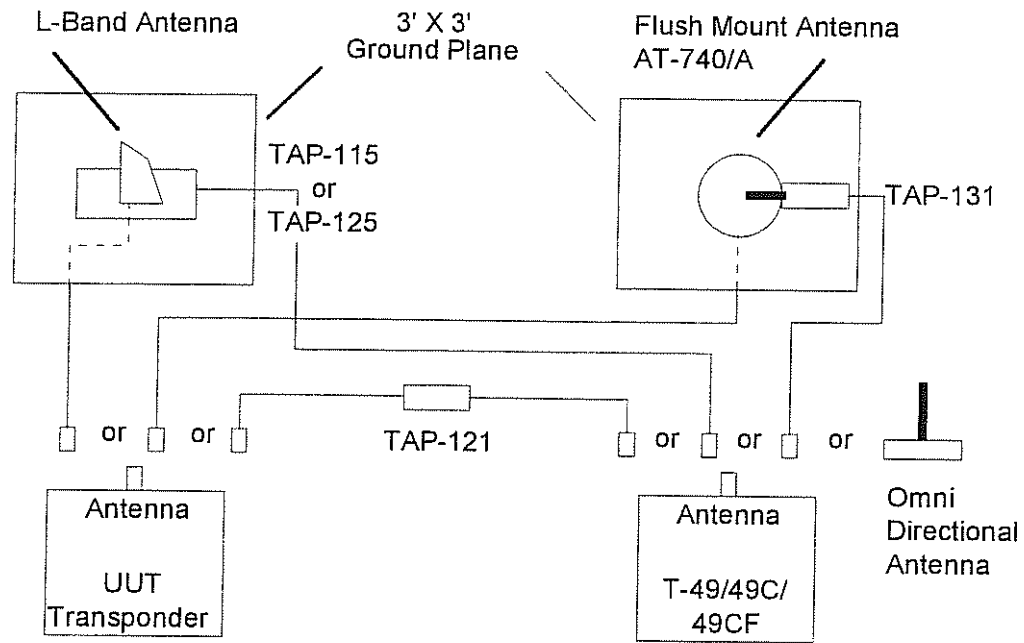


Figure 4-1
Transponder/Test Set Setup

4-3 Sub-Assembly Adjustment Tests

4 3 1 Equipment Needed

- 1 Digital voltmeter (Fluke Model 8000A)
- 2 Spectrum analyzer (Hewlett Packard 8558B/182 T)
- 3 RF signal generator capable of providing a pulsed RF carrier at a frequency of 1030 MHz and 1090 MHz (Wavetek Model 2520)
- 4 Pulse generator for providing the modulation for the RF signal generation (Tektronix Type 114)
- 5 Oscilloscope with 50 MHz bandwidth, minimum A 10X oscilloscope probe (Tektronix Model 2235)
- 6 Frequency counter with a high-impedance input that may be used with an oscilloscope probe (Hewlett Packard 5327A)
- 7 L Band pulse generator (Tel-Instrument T-460 with Wavetek 2520)

4 3 2 RF PCB Procedure

1 Voltage Settings

- a Remove the T-49 from the transit case and remove the cover from the RF subassembly

- b Select the XPDR TEST mode and switch on the T-49. Check the output of the following voltages on the RF PCB.

U1	pin 3	+5V +/-0.5V
U34	pin 3	+6V +/-0.5V
Neg Lead C76		-4V +/-0.5V

- c Set the +10V supply available at pin 5 of U21 on the RF board for 10V +/-0.1V by adjusting R52

2. Frequency Settings

- a Energize the T-49 by placing the mode switch in the "ATCRBS (Mode A/C) Intruder" position and then by pressing the INTERROGATE switch. The T-49 should display the following message

ATCRBS (Mode A/C) Intruder Press Interrogate

Note: Do not press the INTERROGATE switch a second time.

- b Measure the frequency at TP1 using a frequency counter with an oscilloscope probe
- c Adjust C99 for a frequency of 4.023423 MHz +/-45Hz
- d Measure the frequency at pin 1 of U17 using the frequency counter with an oscilloscope probe
- e Adjust C70 for a frequency of 8.164063 MHz +/-45Hz
- f Turn off the T-49 using the OFF switch. Place the function switch in the "ATCRBS Intruder" position and energize the T-49 using the INTERROGATE switch. The T-49 should display the following message

ATCRBS (Mode A/C) Intruder Press Interrogate

Note: Press the INTERROGATE switch a second time.

- g Place the frequency counter with the oscilloscope probe at TP1.
- h Adjust C106 for 4.257813 MHz +/-45Hz
- i Place the frequency counter at pin 1 of U17
- j Adjust C65 for 8.398438 MHz +/-45Hz.
- k Turn off the T-49 using the OFF switch

3 1030 MHz Receiver Sensitivity

- a Feed a pulse modulated signal at 1030 MHz at a level of 0 dBm from a signal generator into the Antenna input/output connector. Use a 1 us pulse width with a PRF of about 1 KHz.
- b Energize the T-49 with the function switch in the "ATCRBS (Mode A/C) intruder" position. The following message should be displayed on the front panel

ATCRBS (Mode A/C) Intruder Press Interrogate

Note: Press the INTERROGATE switch.

- c Monitor the demodulated pulses at pin 10 of U13, while triggering the oscilloscope from the pulse generator.
- d Reduce the signal level until the demodulated pulses begin to break up. This should occur with a level of -10 to -20 dBm. If the receiver lacks sensitivity, either the input band-pass filter or the 45 MHz IF filter requires alignment. It is not recommended that these items be adjusted in the field.

4 1090 MHz Receiver Sensitivity

- a Feed a pulse modulated RF signal at 1090 MHz from a signal generator into the Antenna input/output connector using the same pulse width and repetition rate as in step 3a above.
- b Energize the T-49 in the ATCRBS (Mode A/C) Intruder mode. The front panel should display the following:

ATCRBS (Mode A/C) Intruder Press Interrogate

Note: Do not press the INTERROGATE switch a second time.

- c Monitor the demodulated pulses at pin 10 of U13, while triggering the oscilloscope from the pulse generator.
- d Reduce the signal level until the demodulated pulses begin to break up. This should occur at a level of -10 to -20 dBm for TAP 115 and lower than -20 dBm for TAP 125. This difference in receiver sensitivity between the 1090 and 1030 MHz inputs should not exceed about 5 dB. A disparity greater than this indicates mis-tuning of the receiver input filter rather than the IF filter. It is not recommended that this item be adjusted in the field.

5 RF Output Power Level Setting

- a Activate the T-49 in the "XPDR TEST" mode and place the STORE/REPEAT switch in the repeat mode. This causes the T-49 to transmit on a frequency of 1030 MHz. Connect the Antenna input/output of the T-49 to a peak power meter. Set the XPDR/TCAS (high/low) switch to low
- b Adjust C12 for a maximum peak power output of the P1 pulse. This value should be -10 dBm +/-1 dB. Changes in power may be affected by adjusting C12
- c Connect the T-49 Antenna input/output to a spectrum analyzer. Connect Vertical Output of the spectrum analyzer to the oscilloscope and measure P2 as -9dB +/-1dB relative to P1. If out of this spec then do the remaining steps in this section.
- d Adjust R96 full counter-clockwise. Adjust R101 for a minimum amplitude of the P2 pulse
- e Adjust R96 for a power level of -9dB from the peak power of the P1 pulse

6 RF Power Measurement Calibration Setting

- a Remove 5 screws that hold the RF case to the chassis. On the Digital Board, ground TP4 to the chassis
- b Turn on T-49 by pressing STORE/REPEAT switch to place the T-49 in the calibration mode
- c Provide a pulse generator signal at a 1 KHz PRF with 1 us pulses at the following amplitudes into the Antenna input/output connector of the T-49. Verify the calibration of the power measurement as shown in the table below

Pulse Amplitude	Power Reading
1.26V	500 watts +/-75 watts
800mV	200 watts +/-30 watts
500 mV	100 watts +/-15 watts

4.3.3 Digital PCB Procedure:

1 Frequency & Voltage Settings

- a Remove T-49 body from the case.

- b Remove five screws that hold RF case to the chassis.
- c Leave the coax RF cable from the RF board to the front panel and the ribbon cable from the RF board to the Digital board both connected
- d Place the rotary switch in "XPDR TEST" position and then power on the T-49 by pressing the STORE/REPEAT switch.
- e The front panel should display the following

CALIBRATION xxx W x.x MHz

- f Using a voltmeter check for the following voltages

+10 V (+/-0.2V) at TP8

-10 V(+/-0.5V) at TP7

+5V (+/-0.2V) at Pin 3 of U55 (7805CTH)

Note: Ground is on TP10.

- g Using an oscilloscope verify a the following 5Vpp +/-1V signals

TP3 0.20us +/-0.05us period

TP2 0.25 us+/-0.05us period

- h Turn off the T-49 unit.

2 ATCRBS/C Interrogation Test

- a Connect an L-Band Pulse Generator to the RF connector on the front panel. The L-Band Pulse Generator must be able to generate pulse forms similar to an ATCRBS/A, ATCRBS/C, and a Mode S interrogation at 1030 MHz with an RF output of -10 dBm. See Figure 4-2
- b Input from the pulse generator generates a signal that represents an ATCRBS/C interrogation at 1030 MHz, at -10 dBm
- c Set the T-49 rotary switches and scenario to the following settings.

ATCRBS (Mode A/C) Intruder Type
14 nmi, +3500'

- d Power up the T-49 by pressing the INTERROGATE switch. The front panel should display the following.

ATCRBS (Mode A/C) Intruder Press Interrogate

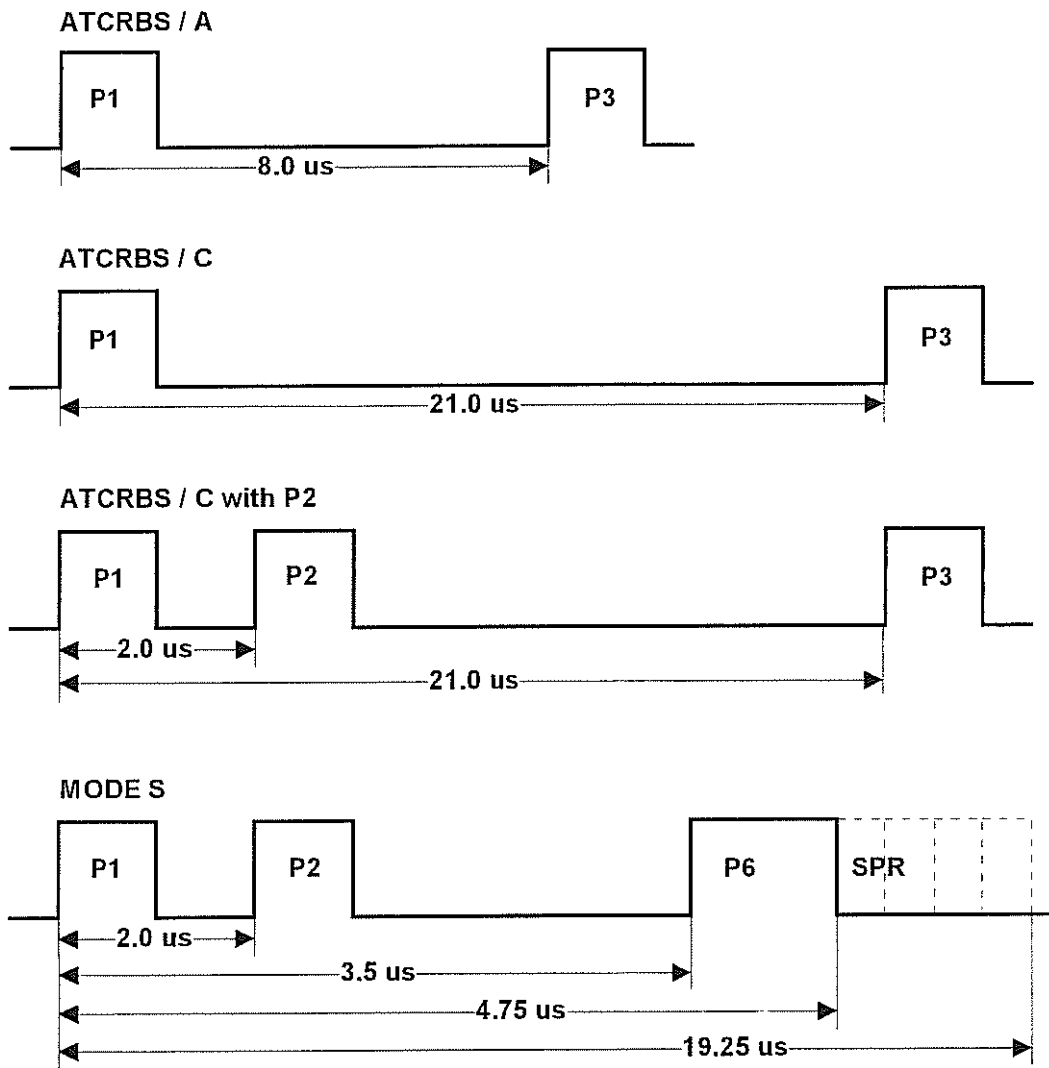
- e Start the scenario by pressing the INTERROGATE switch.
- f Trigger the oscilloscope off of P2 pin 25 or U18 pin 3. With another scope probe monitor P2 pin 8.
- g Verify at P2 pin 8 an ATCRBS/C reply approximately 190 us from the trigger of the ATCRBS/C interrogation. This reply is 21 us long and has a changing pattern (simulates the changing altitude of an intruder aircraft). The reply moves in time from 190 us to 28 us. When the reply reaches 28 us the scenario reverses and moves out in time.
- h Vary the ATCRBS/C interrogation to the following individual settings

-ATCRBS/A Interrogation

-Mode S Simulated Interrogation

-ATCRBS/C Interrogation with full P2 pulse (SLS)

Note: All these variations should cause the T-49 to stop replying to the invalid interrogations and therefore no reply signal at P2 pin 8 probe.



Note:

1. The width of P1, P2, and P3 is 0.8 μs
2. P6 can be any combination of logic ones or zeros

Figure 4-2
Interrogation Waveforms

3 Mode S Interrogation Test

- a Input from the pulse generator a signal that represents a simulated Mode S interrogation at 1030 MHz, at -10 dBm

- b Set the T-49 rotary switches and the scenario to the following settings

Mode S Intruder Type
14 nmi, +3500', and 450 kts

- c Power up the T-49 by pressing the INTERROGATE switch. The front panel should display the following message:

Mode S Intruder Press Interrogate

- d Start the scenario by pressing the INTERROGATE switch
- e Trigger the oscilloscope off of P2 pin 25 or U18 pin 3. With another scope probe monitor P2 pin 8.
- f Verify at P2 pin 8 a Mode S reply approximately 300 us from the trigger of the Mode S interrogation. This reply is 64 us long and has a changing pattern (simulates the changing altitude of an intruder aircraft). The reply moves in time from 300 us to 130 us. When the reply reaches 130 us the scenario reverses and moves out in time.
- g Vary the Mode S interrogate to the following individual settings

-ATCRBS/A Interrogation
-ATCRBS/C Interrogation

Note: All these variations will cause the T-49 to stop replying to the invalid interrogation and therefore no reply signal at P2 pin 8 probe.