T-49C/CA MOD 2

Operational and Maintenance Manual

P/N: 90008048-2

Software Revision 7.10 and Greater

20 October 2003

REVISION

A	B	C	D	E	F	G	H	I	J	K	L	M
N	O	P	Q	R	S	T	U	V	W	X	Y	Z

Tel-Instrument Electronics Corp
728 Garden Street
Carlstadt, NJ 07072
(201) 933-1600
www.telinstrument.com

Leading the AVIONICS TEST industry into the 21st Century!

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The information contained in this manual is subject to change without notice.

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PART NUMBER	VOLUMES INCLUDED	CHAPTERS INCLUDED
90008048-1	VOLUME 1	CHAPTERS I & II
90008048-2	VOLUMES 1 & 2	CHAPTERS I - VI

Chapter I – Introduction
Chapter II – Preparation for Use and Operation
Chapter III – Theory of Operation
Chapter IV – General Maintenance and Servicing Procedures
Chapter V – Schematics
Chapter VI – Illustrated Parts Catalog

VOLUME 1

OPERATIONAL PROCEDURES

T-49C/CA MOD 2 TABLE OF CHANGES

Date	REV	ECO	Page	Description
5-28-02	A			Initial Release
01-12-03	B			Complete overhaul of Manual to include but not limited too: Drawings, Parts list, Calibration procedures, and improved Graphics.
08-28-03	C		2-12 4-21 Appendix B, B-3	Added Diversity Testing Updated Calibration Procedure Updated Calibration Procedure Removed Page Borders
10-20-03	D	1797	Chapter 4	Updated Calibration Procedures

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CHAPTER I

INTRODUCTION

SECTION A

1.1 Scope of Manual

This manual is intended to familiarize the operator with the operating procedures necessary to utilize the T-49C/CA MOD 2 Test Set. If you purchased the option of Maintenance and Servicing Instructions, these procedures are included as Chapters IV, V, and VI.

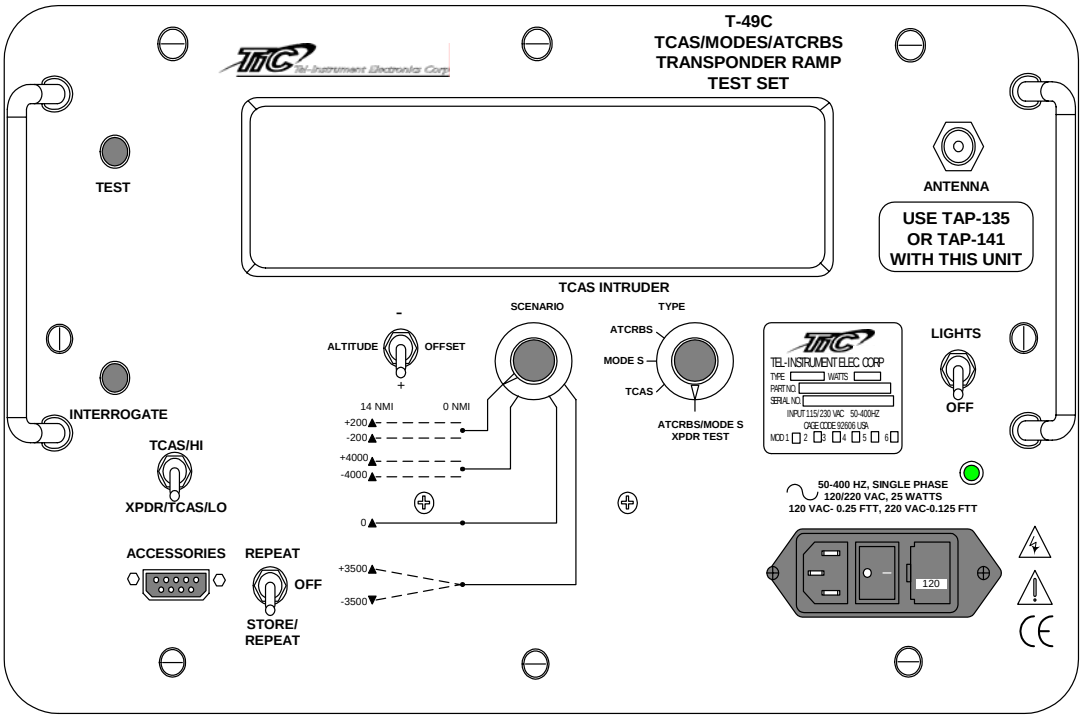


Figure 1-1

T-49C/CA MOD 2, TCAS/Transponder Ramp Test Set

1.2 Purpose and Function of the Equipment

The T-49C/CA MOD 2 Test Set (T/S) tests airborne ATCRBS MODE A & C and MODE S transponders and TCAS I/II systems. It is a self contained and battery operated unit that requires no direct hardware connection to the equipment under test. The Test Set receives and radiates signals to the Unit Under Test (UUT) from an antenna supplied with the T/S. For MODE S and ATCRBS transponder tests, an antenna coupler unit is provided to measure transponder transmitter power, receiver frequency, receiver sensitivity, and diversity operation.

1.3 Regulatory Responsibilities

The Federal Aviation Administration (FAA), requires that transponders operated under *Federal Aviation Regulation (FAR)* Part 91.215(a), 121.345(c), or 135.143(c) be tested and inspected every 24 calendar months in accordance with *FAR Part 43-Appendix F*. The Tel-Instrument Electronics Corp. T-49C/CA Test Sets perform all of the tests as required by *FAR Part 43-Appendix F*, paragraphs (a) through (j).

1.4 Warranty

The Tel-Instrument Electronics Corporation warrants that each product it manufactures is free from defective material and workmanship for a period of two (2) years subject to the following terms and conditions. Tel-Instrument Electronics Corporation will remedy any such warranted defect subject to the following:

This warranty requires the unit to be delivered by the owner to Tel-Instrument intact for examination, with all transportation charges prepaid to the factory, within two (2) years from the date of sale to original purchaser. Tel-Instrument will solely determine when such defect exists.

This warranty does not extend to any of Tel products which have been subject to misuse, neglect, accident, improper installation, or used in violation of operating instructions. This warranty does not extend to units which have been repaired, calibrated, or altered in any way by a facility that is not approved, in writing, by Tel-Instrument Electronics Corp. to perform such work. This warranty does not apply to any product where the seals or serial number thereof has been removed, defaced or changed, nor to accessories not of our own manufacture.

Repair parts will be made available for a minimum period of five (5) years after the manufacture of this equipment has been discontinued.

This warranty is in lieu of all other warranties expressed or implied and all such other warranties are hereby expressly excluded. No representative or person is authorized to assume for us any other liability or warranty in connection with the sale of Tel's products.

This warranty does not cover or include batteries (batteries have a separate 90 day warranty).

Additional information with regard to the applications and maintenance of this equipment will be available from time to time.

SECTION B

EQUIPMENT DESCRIPTION

1.5 Specifications [1]

Transmitter

Frequencies	1030 MHz and 1090 MHz ± 0.1 MHz
Output power, HIGH	+10 dBm ± 1 dBm
LO	-10 dBm ± 1 dBm
Pulse amplitude on/off ratio	greater than 35 dB
Differential Phase Shift Keying (DPSK) accuracy	± 22 degrees
DPSK amplitude modulation	less than 10%

Receiver

Frequency Range	1030 ± 3MHz and 1090 ± 3 MHz
Sensitivity	< -25 dBm

Transponder Measurements Performed (Measured utilizing the TAP-141)

Receiver Sensitivity	Range -65 to -82 dBm, accuracy ± 2 dB
Radiated Power	40 to 60 dBm ± 2 dB (10 to 1000 watts)
Frequency	1087 to 1090 MHz ± 300 KHz
Reply Efficiency	0 to 99 ± 5%

Physical Properties

Packaging	MIL-PRF-28800F, Style C
Operating Temperature	-22 to +122 degrees F (-30 to +50 degrees C)
Size	14.5 x 9.4 x 6.5 inches
Weight	19.0 lbs. W/ line cord, antenna coupler, omni and directional antennas
Battery Life	8 hours Min. at 50% duty cycle
Supplied Antennas	Directional Dipole, Omni-Directional, TAP-135 Antenna Coupler (CA contains 2) TAP-141 Direct Connect Coupler (Optional)

[1] Tel Instrument Electronics Corp. reserves the right to modify and change specifications without notice.

1.6 T-49C TCAS Test Scenarios

Selectable Scenarios	Intruder Speed	Intruder Range	Altitude Separation	Altitude Offset
+3500/-3500	300 kts.	14 to 0 nmi.	3500 ft.	Altitude offset will decrease as distance decreases or Vice-Versa.
0	300 kts.	14 to 0 nmi.	0	Constant
+4000/-4000	300 kts.	14 to 0 nmi.	4000 ft.	Constant
+200/-200	300 kts.	14 to 0 nmi.	200 ft.	Constant

1.7 Safety Considerations

The following are general safety precautions that are not related to a particular test or procedure. These are recommended procedures that all personnel must apply during many phases of operation and maintenance. It is assumed that the operator has general knowledge of electrical theory and the dangers associated with it.

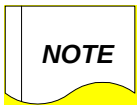
1. When performing any of the tests thoroughly read and understand all procedures before actually performing them.

2. The various front panel connectors, switches, and controls specified can be located by referring to Figure 2-1 on page 2-2.

3. Take the time to learn the proper operation and function of the Test Set as outlined in Chapters 1, 2, and 3. Through knowledge of the Test Set and its capabilities greatly improves the time it takes to complete the tests.

4. Pay particular attention to **NOTES** and **WARNINGS** that may accompany some test procedures.

WARNINGS
Alerts the operator to potential dangers associated with a particular test. Thoroughly understand the warning before proceeding in order to prevent a potentially dangerous situation or damage to the Test Set.



NOTES
Provides supplemental information that enhances the test procedure.

5. Observe all standard safety procedures when working with live voltages. The potential for electric shock exists any time the Test Set is removed from its case.

6. DO-NOT service the unit or make adjustments alone. Always be in the presence of another person when working with live voltages.

7. Be familiar with general first aid procedures and CPR (Cardiopulmonary Resuscitation). Contact your local Red Cross for more information.

8. Ensure the test equipment and the tools you utilize are in good operational condition and not damaged in any way.

1.8 Calibration and Repair

The T-49C/CA Test Set will require Calibration on an Annual Basis. This calibration requires the opening of the Test Set, measuring Inputs and Outputs, and making adjustments when required. This Calibration can be performed at Tel-Instrument Corp or at one of our authorized repair facilities.

When utilizing Tel-Instrument Corp. as your calibration depot, any applicable Service Bulletins and/or Software upgrades that were introduced since you purchased the Test Set will be installed at no charge.[2]

In addition, the owner/operator will maintain the standard warranty that came with your Test Set. See *Paragraph 1.4,* ***Warranty***, for specific information and details regarding our warranty.

To schedule your Calibration and/or repair, please contact:

Tel Instrument Electronics Corp.
728 Garden Street
Carlstadt, NJ 07072
(201) 933-1600 EXT – 322

Or visit our Web Site at www.telinstrument.com.

[2] Only Service Bulletins and Software revisions affecting the correct operation and/or function of the Test Set will be considered “No Charge”. Modifications to the Test Set which enhances and or changes the performance or features will be subject to charge. Contact your Tel representative for specific information regarding Service Bulletins and repair services.

1.9 Abbreviations, Acronyms and Glossary of Terms[3]

A/A	Air to Air
A/A B	Air to Air Beacon
ac or AC	Alternating Current
A/D	Analog to Digital
Address	The unique code to which a MODE S transponder replies. This is not to be confused with the 4096 code used for identifying ATCRBS transponders. The address of a MODE S transponder is not alterable by the pilot or crew.
Altitude	The pressure altitude of the aircraft as transmitted by an ATCRBS or MODE S transponder. This information is obtained from an external sensor and transmitted to the transponder.
AM	Amplitude Modulation
ATCRBS	Air Traffic Control Radar Beacon System
ATC	Air Traffic Control
AUT	Aircraft Under Test
BIT	Built in Test
Comm	Refers to the communications and data-link capability of a MODE S transponder. There are four (4) capabilities: No Comm, Comm A/B, Comm A/B/C and Comm A/B/C/D. The Comm. capability is displayed when the transponder is determined to be a MODE S.
CW	Continuous Wave
D/A	Digital to Analog
dB	Decibel
dBm	Decibels above 1 milliwatt
dc or DC	Direct Current
DME	Distance Measuring Equipment
DPSK	Differential Phase Shift Keying. The method of modulation used for the selective MODE S uplink interrogations.
DF	Downlink Format. The format included in a MODE S transponder reply to an interrogation or squitter message that indicates the type of message.
ELM	Extended Length Messages
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FIFO	First In First Out
FREQ	Frequency
ft.	Feet
G/A	Ground to Air
Hz	Hertz
IF	Intermediate Frequency
IFF	Identify Friend or Foe
KHz	Kilohertz
kts.	Knots
LCD	Liquid Crystal Display
LED	Light Emitting Diode
MODE S	A secondary radar system where transponders can be individually interrogated or selected (the “S” in MODE S) so that in a crowded air traffic area, the amount of interference or garble can be reduced to a minimum.
ATCRBS/MODE S All Call	Interrogation that causes all ATCRBS/MODE S transponders to reply.
MHz	Megahertz
nmi.	Nautical mile

[3] Further definitions may be found in the following reference books and documents: Helfrick, A.D. Principles of Avionics. Leesburg: Quality Books, 2000. RTCA/DO-181B. Minimum Operational Performance Standards for Air Traffic Control RADAR Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment. Washington D.C.: 1999. United States. Federal Aviation Administration. Federal Register Fed 3, 1987 FAA rules Part 91.

ns	Nanosecond
PAM	Pulse Amplitude Modulation
PDME	Precision Distance Measuring Equipment
PMCS	Preventative Maintenance Checks and Services
PPM	Pulses per Minute
PRF	Pulse Repetition Frequency
PW	Pulse Width
PWR	Power
RA	Resolution Advisories
Receiver Efficiency	The Test Set's Measurement of valid replies received. Displayed as a Percentage.
Reply Codes	A transmitted response, from the airborne transponder, to an interrogation. Commercial transponders responses are designated as either ATCRBS/A where the reply includes the pilot selected 4096 ID code, or ATCRBS/C, where the reply includes the aircraft pressure altitude. These same responses for military transponders are designated as MODE 3A and MODE 3C. The associated intruder type panel designations on the T-48 is "ATCRBS".
RF	Radio Frequency
RMS	Root Mean Square
R/T	Receiver Transmitter
SIF	Selective Identification Feature
SLS	Side Lobe Suppression. A pulse transmitted from an omni-directional antenna, used as a reference level to prevent replies to interrogations received from the secondary radar antenna side lobes.
Squitter	The self-generated transmissions made by a MODE S transponder, not in reply to an interrogation, for the use of the collision avoidance system.
Surveillance Altitude	An interrogation that causes only the addressed MODE S transponder to reply.
Surveillance ID	An interrogation that causes only the addressed MODE S transponder to reply to its "4096" code.
TA	Traffic Advisories
TACAN	Tactical Air Navigation
TCAS	Traffic Alert and Collision Avoidance System
TX	Transmitter
UF	Uplink Format. The format in a MODE S interrogation that indicates the type of reply expected.
VORTAC	VOR and TACAN (co-located)
VOR	VHF Omni-Directional Range
VSWR	Voltage Standing Wave Ratio
WOW	Weight On Wheels
UUT	Unit Under Test
XPDR	Transponder
XPDR UT	Transponder Under Test
4096 Code	This refers to the octal number dialed into either an ATCRBS MODE A or MODE S transponder by the pilot. This is to be distinguished from the address of the MODE S transponder, which cannot be changed.

[3] Further definitions may be found in the following reference books and documents: Helfrick, A.D. Principles of Avionics. Leesburg: Quality Books, 2000. RTCA/DO-181B. Minimum Operational Performance Standards for Air Traffic Control RADAR Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment. Washington D.C.: 1999. United States. Federal Aviation Administration. Federal Register Fed 3, 1987 FAA rules Part 91.

CHAPTER II

PREPARATION FOR USE AND OPERATION

SECTION A

2.1 General

This Chapter contains all necessary information on the initial unpacking, inspection, and set-up of the T-49C/CA MOD 2 Test Set. From this point forward, the T-49C/CA MOD 2 Test Set will be known as the T-49C, T-49, Test Set, or T/S.

2.2 Unpacking

When receiving the T-49C for the first time, ensure that there is no damage to the shipping container. Carefully unpack the unit and save the shipping container in a safe location for shipping or extended storage.

Examine the unit for obvious signs of damage. Check all displays, switches, and connectors before utilizing the Test Set.

If any damage is found, DO NOT use the Test Set until a determination of the Test Sets functions can be assessed. Refer to the procedures outlined in Chapter 4, Section B, Test Set Verification and Acceptance Checks. You may also contact Tel-Instrument Electronics Corp. for assistance.

The T-49C batteries were installed and fully charged when shipped from the factory.

2.3 Installation

The T-49C is ready to use from the factory. There are no installation procedures applicable.

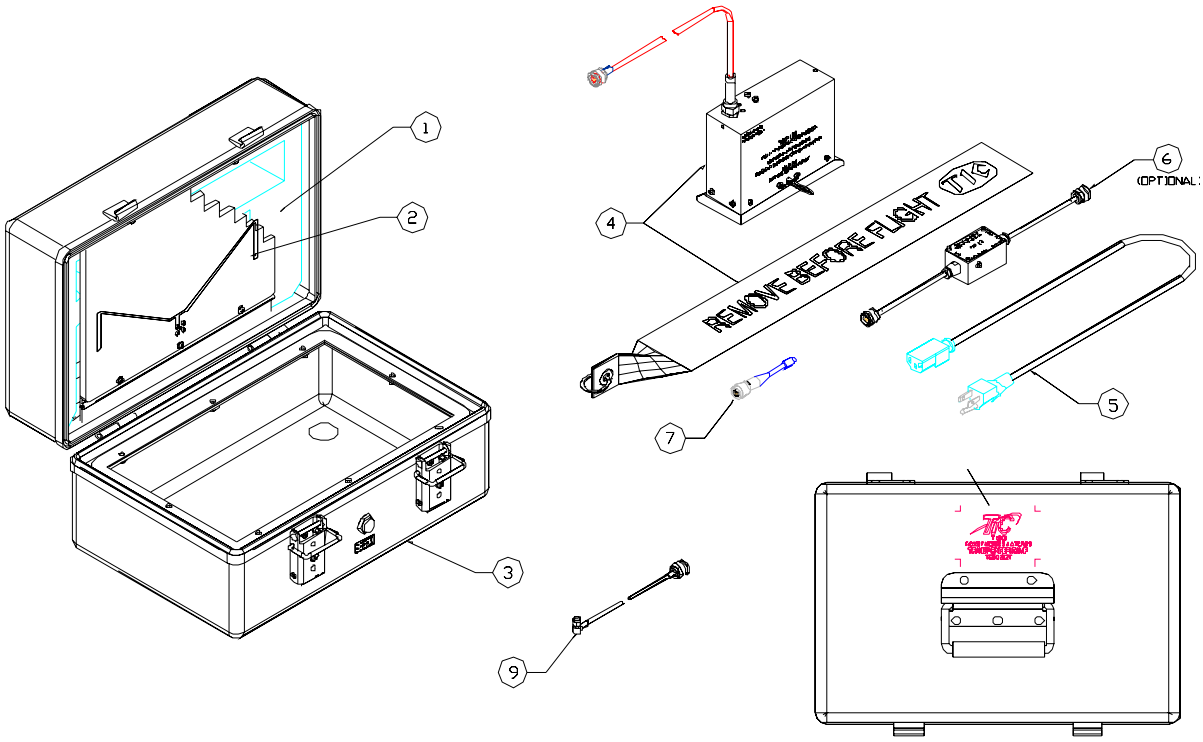
2.4 Accessories

Check that all accessories that were purchased with the Test Set are accounted for. The T-49C comes standard with the following (see Table 2-1 and Figure 2-1):

T-49C/CA MOD 2 Test Set, P/N- 90 000 048 MOD 2

Table 2-1

#	NOMENCLATURE	P/N	QTY
1	Foam Insert, Case	31000007	1
2	Directional Antenna Assembly	89000028	1
3	Case, Universal	64030034	1
4	Coupler, Antenna TAP-135 (10 ft)	89000145	1
5	Cable Assembly, AC Line Cord	75010025	1
6	Direct Connect Coupler, TAP-141	89000147	**OPTIONAL**
7	TSP-1A, Omni Antenna	40030011	1
9	Cable Assembly, Directional Antenna	75010036	1
X	Operational and Maintenance Manual	90008048	1
X	Coupler, Antenna TAP-135 (50 ft)	T-49CA	**OPTIONAL**



T-49C Accessories

Figure 2-1

SECTION B

OPERATING CONTROLS, INDICATORS, AND CONNECTORS

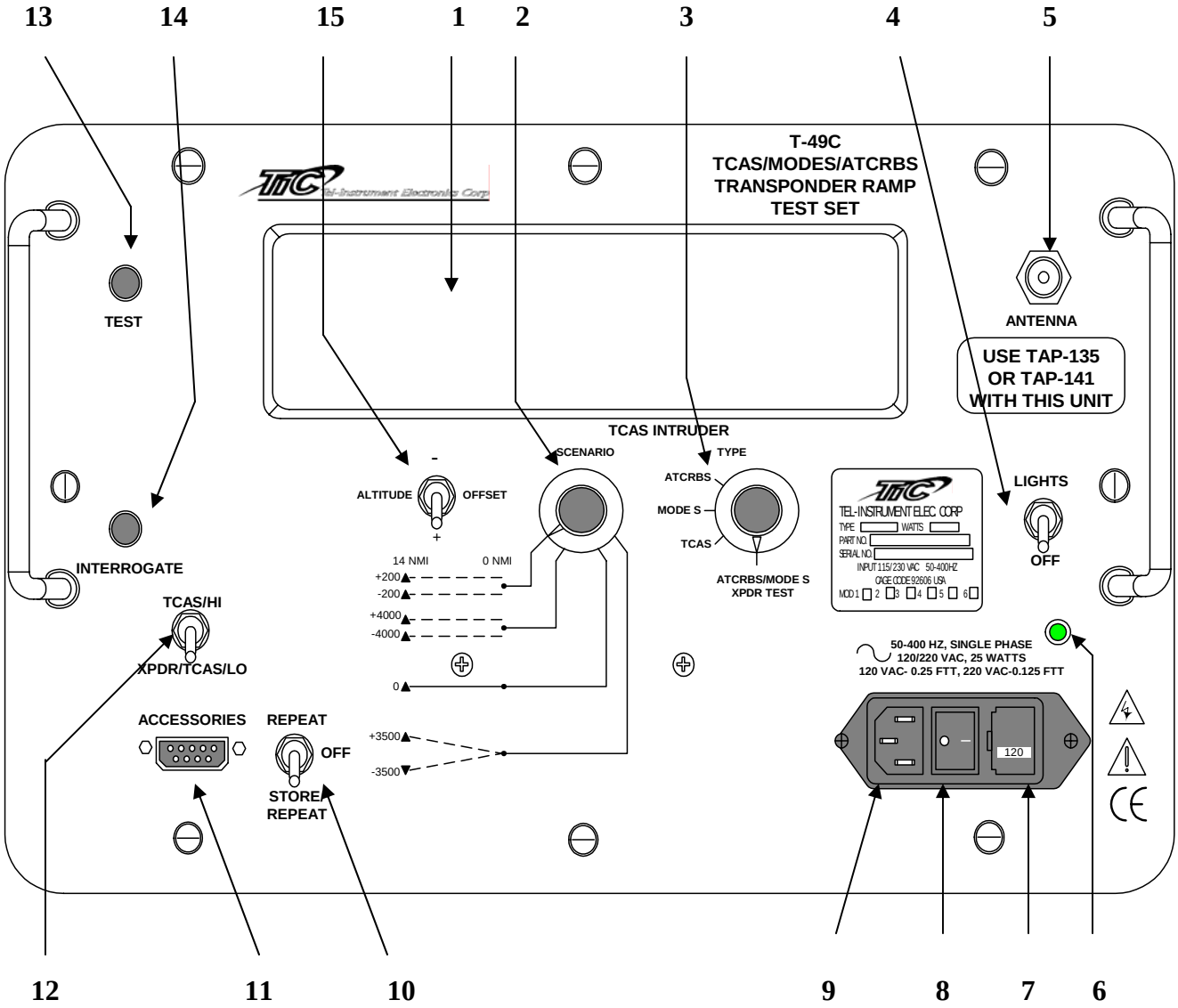
2.5 General

This section covers location and function of the operating controls, indicators, and connectors. All controls, indicators, and connectors are located on the front panel of the Test Set.

2.6 Controls, Indicators, and Connectors

Table 2-2 and Figure 2-2 describes and shows locations for the T-49C Test Set controls, indicators, and connectors.

	Control, Indicator or Connector	FUNCTION (Table 2-2)
1	**DATA DISPLAY WINDOW**	Alpha/Numeric Display (two lines/20 characters) provides operational instructions, error messages, and scenario progress and test results.
2	**SCENARIO** Select Switch	When any TCAS Intruder mode selected, 4 scenarios are available: +200/-200, +4000/-4000, 0 and +3500/-3500.
3	**TCAS INTRUDER** Select Switch	1. Utilized to select Transponder or TCAS test scenarios. 2. In **ATCRBS/MODE S XPDR TEST**, selects transponder tests. 3. In **TCAS**, **MODE S** or **ATCRBS**, selects TCAS selectable test scenarios.
4	**LIGHTS/OFF** Switch	De-energizes Test Set when toggled down. Provides Backlighting for display when toggled up.
5	**ANTENNA** Connector	Connector for Omni-Directional Antenna, Directional Dipole and TAP-135 Antenna Coupler.
6	**AC POWER** Indicator	Green “LED” indicates battery charging and AC power connected. When the battery alone is being used, the LED will not illuminate.
7	VOLTAGE CHANGE/FUSE CARTRIDGE	Contains 2- 250V ¼ amp removable fuses for 115 VAC operations. Permits the operator to also configure for 220VAC operation.
8	**AC POWER** Switch	AC ON/OFF Switch (“-” = ON, “0” = OFF).
9	AC Power Receptacle	Allows the connection of the supplied AC power cord.
10	**STORE/REPEAT** Switch	Permits the operator to repeat a specific test or store data in the T/S RAM for download to a PC. Allows access to “Calibration Mode”.
11	**ACCESS** Connector	RS-232 link for download of stored data to a PC.
12	**TCAS/HI** **XPDR/TCAS LO**	Selects T/S RF Power Output of +10 dBm in the **HI** position and –10 dBm in the **LO** position. **FOR SENSITIVITY MEASUREMENTS, LEAVE THE SWITCH IN THE LO POSITION.** Used for TCAS Operation.
13	**TEST SWITCH**	1. Allows manual sequence of tests to run and be displayed. 2. Used in-conjunction with **INTERROGATE** Switch to enter AUT (Aircraft Under Test) altitude. 3. With Test Set “OFF”, pressing the **TEST** Switch will turn the Test Set “ON”. 4. In the TCAS modes, halts the Intruder range and altitude, pressing it a second time resumes the original track.
14	**INTERROGATE** Switch	1. Initiates Automatic Test Sequence for Transponder and TCAS testing. 2. Serves to enter and store data on the T/S RAM. 3. Used in conjunction with **TEST** switch to enter Aircraft Under Test (AUT) altitude. 4. With Test set “OFF”, pressing the **INTERROGATE** Switch will turn it “ON”.
15	**ALTITUDE OFFSET**	Select above (+) or below (-) the aircraft intruder scenario.



T-49C Test Set Controls, Indicators, and Connectors

Figure 2-2

SECTION C

OPERATING INSTRUCTIONS

2.7 General

The Test Set utilizes an easy to read display that provides the operator with easy to follow "On Screen" instructions. To run a scenario, in either TCAS or ATCRBS modes, the **TCAS INTRUDER** and **SCENARIO** select switches are set to the desired positions followed by the momentary press of the **INTERROGATE/TEST** switch. A subsequent press of the **INTERROGATE/TEST** switch will commence the scenario or test sequence.

2.8 Battery Operation

The T-49C Test Set is equipped with a rechargeable Ni-Cad battery capable of operating the Test Set using a 50% duty cycle for 8 hours at 77 degrees F (25 Degrees C). This represents a full day of typical testing on a single charge. Operating the Test Set in lower temperatures, will decrease the overall battery life.

Due to the Ni-Cad batteries ability to maintain a constant current level, the operator will be able to utilize the Test Set until the batteries are nearly depleted. The unit may then be plugged into a standard 120 (220 if so configured) VAC power source to continue testing. By observing a Duty Cycle (DC) of 50%, the Test Set batteries will begin regaining their charge while testing is in progress.

It is strongly recommended that the batteries be charged for a short time each week regardless if the Test Set has been utilized or not. A completely discharged battery will require approximately 16 hours to fully charge. Occasional charges of 16 hours on partially depleted batteries will have no adverse effects.

To charge batteries, utilize the following procedures:

1. Remove the power cord from the inside cover and attach it to the **AC POWER** receptacle.

2. Connect the power cord to a suitable 120 or 220 (if configured) VAC outlet. For 220 VAC operations, see paragraph 2.8.1.

3. Turn the **AC POWER** switch to the "ON" position (-).

4. Verify the green LED **AC POWER** indicator is lit signifying that the battery has commenced charging.

WARNING
If the battery voltage has been depleted to the point the Test Set will not turn "ON". DO NOT attempt to Turn the Test Set "ON" until the Unit has been charging for a minimum of 30 minutes.

2.8.1 Low Battery Warning

T-49C Test Sets with Software Revision **7.00 or greater** will provide the operator with several low battery warnings to notify them to charge the battery. These warnings will give the operator ample time to complete current tests underway or time to utilize AC power to supplement if further tests are necessary. When utilizing the Test Set for an extended period, the operator may receive the following display:

1st Warning

BATTERY LOW RECHARGE BATTERY

By depressing either the **INTERROGATE** or **TEST** button, the operator may continue to conduct tests. If extended tests continue, a second warning is displayed to notify the operator of an imminent battery low condition. As with the first warning, the operator may bypass this warning to complete tests in progress.

2nd Warning

2ND WARNING RECHARGE BATTERY

The third and final warning cannot be overridden, and the Test Set will prevent further testing until the operator charges the battery IAW Paragraph 2.8.

3rd Warning

SHUT DOWN NOW AND RECHARGE BATTERY

In addition to the Low Battery Warnings, the T-49C Test Set also has a circuit designed to turn the Test Set *OFF* after 15 min. This circuit is active in both battery and AC Operation.

2.8.2 220 Volt Operation

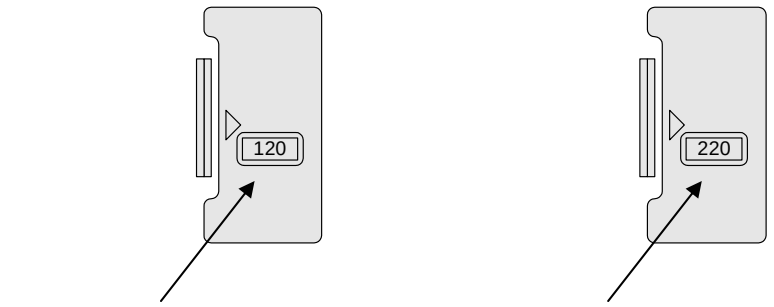
The Test Set is configured from the factory for 120 VAC. To operate the Test Set using 220 VAC, follow the procedures as listed below.

WARNING
Failure to properly configure the Test Set for 220 VAC operations before use may result in severe damage to the Test Set.

1. Remove the **FUSE CARTRIDGE** from the Test Set by releasing the Tab and pulling straight the cartridge straight out.

2. Remove and store/dispose of the two fuses.

3. Pull the bottom fuse holder from the rear of the cartridge, rotate, and reinstall the cartridge, ensuring that **220** is viewable through the front window.



Fuse Cartridge

Figure 2-3

4. Replace the fuses with **250V 1/8A, FTT** fuses (or equivalent) and reinstall the fuse cartridge in the fuse housing.

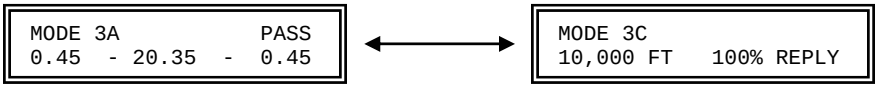
2.9 STORE/REPEAT Switch

The **STORE/REPEAT** switch allows the operator several options, which enhances the testing procedure. When conducting Transponder Tests, in the Manual mode, toggle the switch to the "*Down"* position. This will *REPEAT* the current test a second time. Subsequent toggles of the switch will continue to repeat the current test.

By placing the **STORE/REPEAT** switch to the "*UP"* position, the Test Set will continually retest the selected mode until the switch is returned to the "OFF" position.

NOTE	Ensure to return the **STORE/REPEAT** switch back to the **OFF** position when testing is complete.

Test Sets having software version **6.00** and greater, also have the capability of conducting Altimeter checks. Access the MODE C test page (see paragraph 2.12.2). Place the **STORE/REPEAT** switch in the "*Up*" position; the Test Set will begin to conduct the MODE C Test continually. The screen will alternate between the MODE C test page and the PW measurement page (See paragraph 2.13 for further information).



After 30 seconds has passed, the Test Set will discontinue the PW measurements and only display the MODE C altitude. This altitude is updated at a rate of approximately once per second. The operator will be able to observe the Mode C altitude while utilizing a Pitot Static Test Set and *Pump Up* the altitude verifying correct transponder altitude information.

Altitude will update at a rate of once per second. →

```
MODE 3C
10,000 FT   100% REPLY
```

When the Altimeter checks are complete, ensure that the **STORE/REPEAT** switch is returned back to the **OFF** position to prevent unintentional battery discharge.

2.10 T-49C Supplied Antennas

The T-49C is equipped with three (3) antennas for a variety of tests. An Omni-Directional Antenna, Directional Antenna, and Antenna Coupler (TAP-135) are supplied as standard equipment.

NOTE

To improve overall accuracy when making power, receiver sensitivity and frequency measurements, utilize the TAP-135 Antenna Coupler or direct connect to the transponder with the ***OPTIONAL* TAP-141** Coupler. The Omni Directional Antenna and Directional Antennas are used for a QUICK check of the system only. Power, Frequency, and Receiver Sensitivity are not displayed.

An *OPTIONAL* Direct Connect Coupler (TAP-141) with an attenuated path to protect the Test Set may be purchased separately for direct connection of a transponder receiver transmitter to the T-49C. This is useful to determine and troubleshoot problems by separating the aircrafts antennas and cables from the rest of the system.

2.10.1 Omni-Directional Antenna

The Omni-Directional Antenna, stored inside the T-49C cover, primary task is to provide a quick-test capability for ATCRBS Mode A/C and Mode S equipment. The following suggestions will improve your overall test results when utilizing the Omni-Directional Antenna. Transponder RF power, receiver sensitivity, and frequency measurements are not displayed.

1. Connect the antenna directly to the **ANTENNA CONNECTOR** located on the front panel of the T-49C Test Set.

2. Maintain a 15-100 ft. separation from the Test Set and the aircraft under test (AUT), and a clear unobstructed path from the antenna and the Test Set (Figure 2-4).

3. Ensure the transponder that you are testing is significantly closer to the Test Set than another operating transponder equipped aircraft. An undesired reply may occur or erroneous indications may result.

4. DME and transponder antennas are similar in shape and appearance. Have positive identification of the correct antenna as to adhere to the 15-100 ft. range.

5. If the aircraft you are testing is dual transponder equipped, ensure the correct antenna and transponder is selected.

2.10.2 Directional Antenna

The Directional Antenna is a printed circuit sandwiched between two opaque Lexan sheets. It is hinged to the T-49C Test Set case cover and primarily utilized for TCAS and Transponder tests. As with the Omni-Directional Antenna: RF power, receiver sensitivity, and frequency measurements are not measured when using the Directional Antenna. Use the TAP-135 or TAP-141 Direct Connect Coupler to conduct power, frequency, and sensitivity measurements.

NOTE

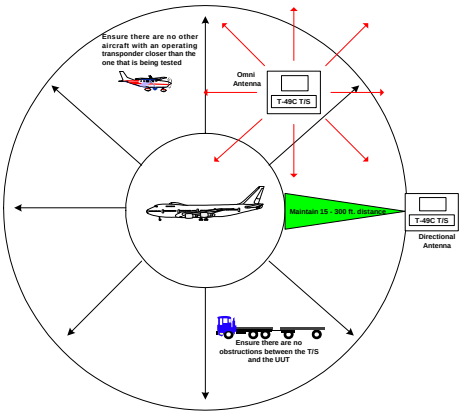
When utilizing the Directional Antenna, remove all accessories from the cover. The cover is designed to act as an antenna reflector. Results with items left in the cover may be inaccurate or vary.

1. Open and remove the T-49C Test Set case cover. Release the two (2) push button holders and fold down the Directional Antenna. Remove the AC power cord, Omni Antenna, and the TAP-135 Antenna Coupler and store them in a safe location.

2. Fold the antenna into position in the case cover and re-engage the push button holders. Attach the antenna cable connector to the **ANTENNA** connector on the Test Set.

3. Position the Test Set and antenna assembly with a 15-300 ft. unobstructed separation from the Aircraft under test (Figure 2-4).

4. Aim the Directional Antenna at the Aircraft Under Test (AUT) antennas and conduct the appropriate test sequence.



Directional Antenna

Figure 2-4

2.10.3 Antenna Coupler (TAP-135) (T-49CA is equipped with 2 TAP-135 Couplers)[1]

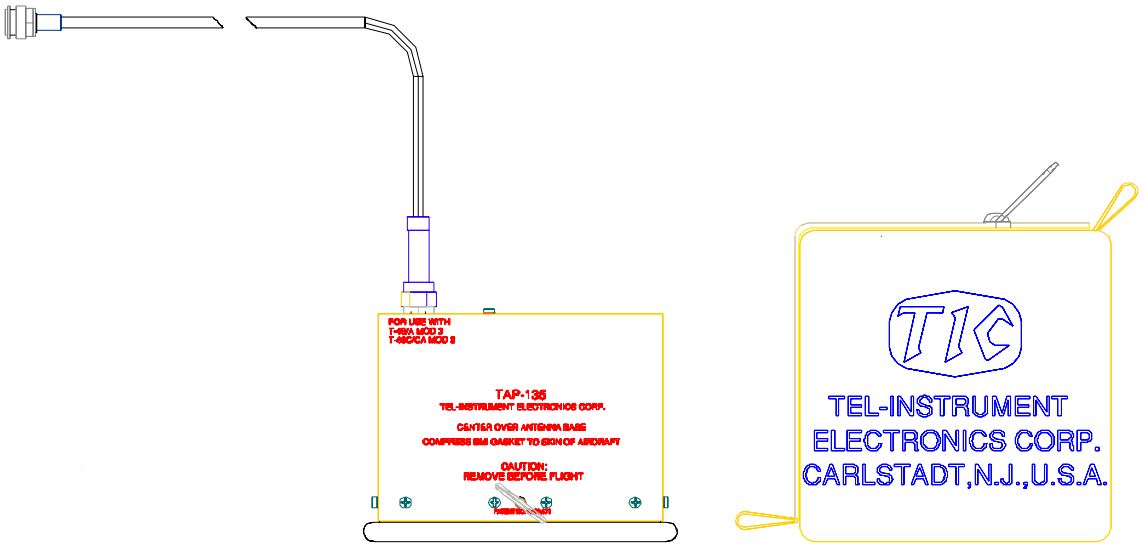
The Antenna Couplers provide transponder power, frequency, and sensitivity measurements. The Antenna Couplers may only be utilized on blade type antennas. When using the Antenna Coupler, ensure you have selected the correct antenna to test.

1. Remove the TAP-135 from the Test Set front cover, unwind the cable and connect the cable to the **ANTENNA** connector on the front panel of the T-49C Test Set.

2. Pull the snap ring located on the side of the coupler and slip the coupler onto the antenna to be tested. The TAP-135 utilizes internal springs to maintain pressure on the antenna blade. Ensure a snug fit, flat on the aircraft fuselage.

3. Ensure that the coupler is centered over the antenna to be tested (Fig 2-6).

4. Due to the availability of numerous styles of L-Band antennas, slight adjust of the Coupler may be necessary to receive accurate measurements. If incorrect readings occur, re-position and ensure a snug fit on the antenna. Move the TAP-135 forward or back and double check a firm and snug seal on the aircraft surface. The adjustment is correct when the maximum power is displayed on the *POWER RCVR, FREQ,* page.

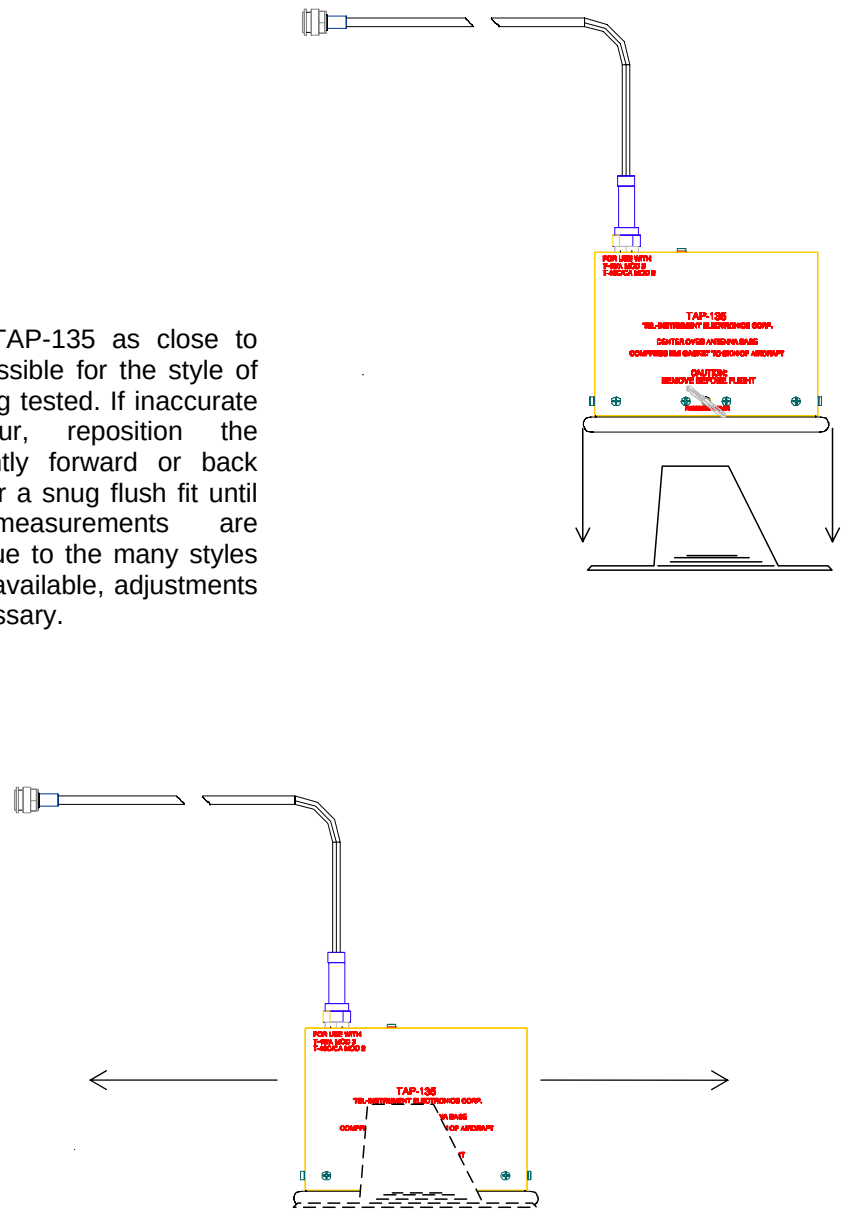


TAP-135 Coupler

Figure 2-5

[1] Measurements utilizing the TAP-135 are accurate within ± 3dB.

Center the TAP-135 as close to center as possible for the style of antenna being tested. If inaccurate results occur, reposition the coupler slightly forward or back and check for a snug flush fit until accurate measurements are displayed. Due to the many styles of antennas available, adjustments may be necessary.



TAP-135 Antenna Placement

Figure 2-6

2.10.4 Diversity Testing Utilizing the TAP-135

Some Mode S transponders have the capability to be connected to 2 aircraft antennas. Mode S transponders that have this capability are called “Diversity Transponders”. The 2 antennas are typically mounted in a configuration with one on top of the aircraft and one on the bottom of the aircraft. The diversity capability allows the transponder to receive interrogations on each of the 2 antennas and to respond on the antenna with the strongest incoming signal level.
Transponder specifications require that a diversity transponder shall have an isolation or diversity between the 2 antennas of at least 20 dB.

The diversity test can be performed using 1 or 2 couplers. The diversity test is performed during the automatic (press **INTERROGATE**) or manual (press **TEST**) sequence of tests.

A diversity transponder will transmit an acquisition squitter (DF11) out of the 2 antenna ports. The squitter transmission will alternate between the 2 ports, first out of one port and then out of the second port one second later.

To perform the diversity test using one coupler, mount the coupler on the aircraft antenna using instructions found in paragraph 2.10.3. Connect the T-49C to the coupler cable. Select the diversity test in either the Manual Mode of Tests or Automatic Mode of tests.

1. The Test Set will measure the power level of the squitter being transmitted out of the antenna connected to the coupler.

2. One second later, the T-49C will perform a second measurement.

3. The power measured in step #2 shall be down at least 20 dB from the first measurement.

4. If the power in Step #2 is less than 20 dB down from the power measured in Step #1, the Test Set will display a *”FAIL”.*

5. Steps 1 – 4 may be continually run by select the **REPEAT** switch.

If the tests described in Steps #1 to #5 are performed on a non-diversity transponder, the T-49C will show FAIL. A non-diversity transponder has only one RF connector. A non-diversity transponder will transmit a squitter every second. As a result, the power level measured by the T-49C in Step #1 and Step #2 will be the same and will result in a FAIL condition. This is a normal condition.

After successful completion of the diversity test on one antenna, the coupler should be connected to the other antenna. The diversity test should be repeated on the second antenna.

For ease of testing, the T-49CA is supplied with 2 couplers. The coupler with the long cable should be connected to the antenna on top of the aircraft and the other coupler should be connected to the bottom antenna. The coupler cables can be connected to the T-49C one-at-a-time to perform the diversity test.

2.10.5 *Optional* Direct Connect Coupler (TAP-141)[2]

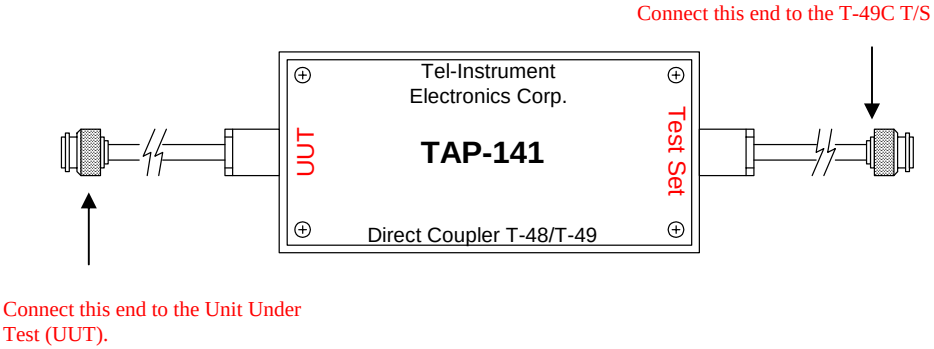
The TAP-141 Direct Connect Coupler provides a means of connecting a transponder directly to the T-49C Test Set, thus providing an accurate means of checking transponder power, frequency, sensitivity, and diversity measurements. The TAP-141 supplies an attenuated path protecting the Test Set from the high RF power associated with transponders.

1. Ensure power to the transponder is secured to prevent accidental transmission without a load connected.

WARNING
The TAP-141 Coupler is labeled as to which end is connected to the Test Set and which end to the UUT. Ensure the proper connections are made before testing the UUT. If the proper connections are not observed, the Test Set and/or UUT may require repair and calibration (Figure 2-7).

2. Connect the TAP-141 **TEST SET** connector to the **ANTENNA** connector located on the front panel of the T-49C Test Set.

3. Connect the TAP-141 **UUT** connector directly to the transponder antenna connector.



TAP-141 Connection Criteria

Figure 2-7

4. Conduct the appropriate tests.

5. When testing is complete, ensure to de-energize the transponder under test and re-connect the antenna connection to your transponder to prevent accidental damage to your unit.

[2] Measurements utilizing the TAP-141 are accurate within ± 2 dB.

2.11 Initial Start-up Procedure

When utilizing the T-49C Test Set, always begin with a fully charged battery or AC power connected. The following displays are shown without a transponder connected.

1. With the **TCAS INTRUDER** type switch selected to **ATCRBS/MODE S - XPDR TEST**, press the **INTERROGATE** button to activate the Test Set. The following display will come into sight, briefly denoting the current software version of the T-49C Test Set:

```
TEL INSTRUMENT
T-49C     REV.X.XX
```

2. The T-49C will then begin searching for a transponder to test. If the transponder is not connected or powered up, the following will be displayed. The *"Rotating Bar"* in the upper right of the display signifies the Test Set searching to acquire a RF signal.

```
XPDR TESTING ... /
NO REPLY
```

Rotating Bar

3. Hold the **LIGHTS/OFF** switch in the "UP" position to verify that the backlighting for the display is operating. Once the operator releases the switch, the backlighting extinguishes to conserve battery power.

4. Press "DOWN" and release the **LIGHTS/OFF** switch to turn power *OFF* to the Test Set.

5. Ensure that the **TCAS HI/LO** switch is in the **XPDR/TCAS/LO** position when conducting Transponder Tests.

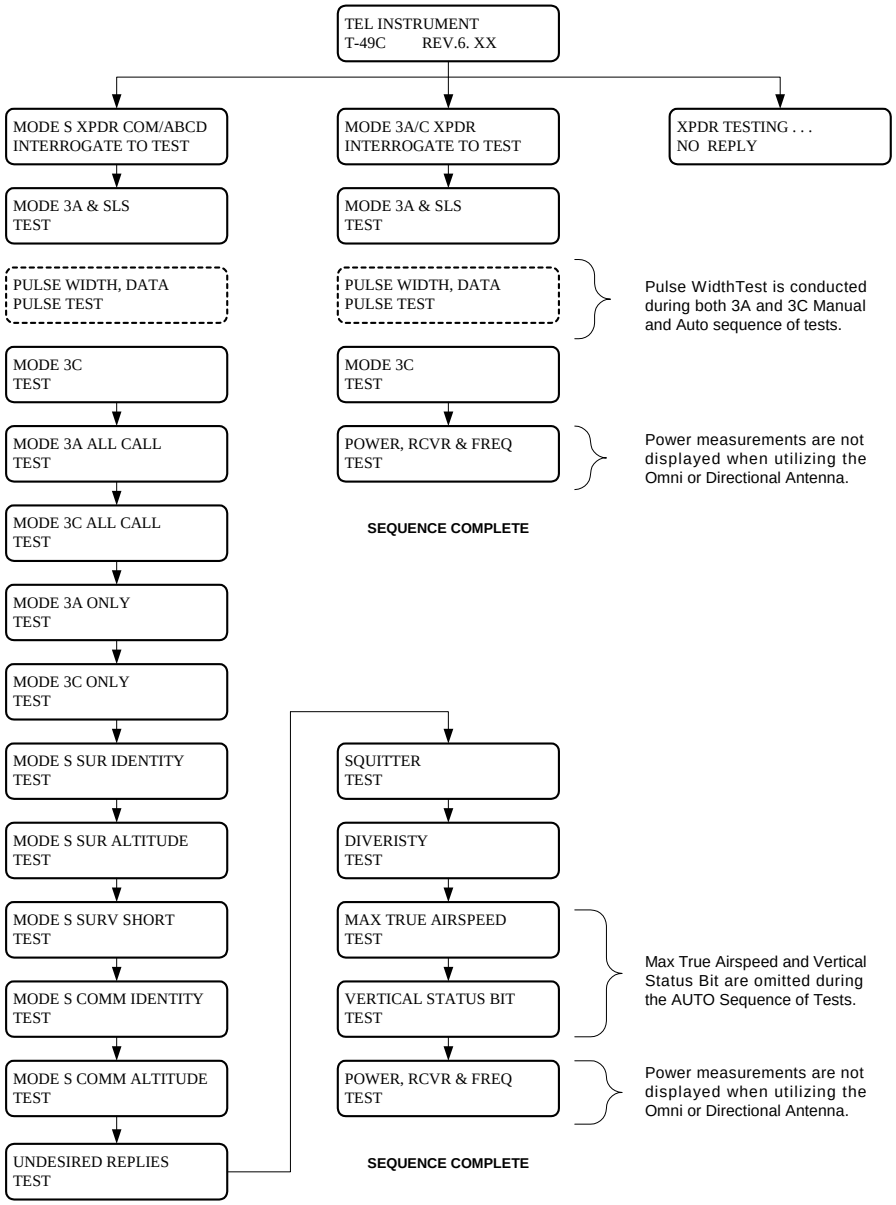
NOTE

Transponder Sensitivity measurements may be inaccurate if left in the **HI** position.

2.12 Transponder Test Sequence

The T-49C is capable of testing ATCRBS Mode A, Mode C, and Mode S transponders. The tests that are conducted will satisfy all requirements of FAR 43 Appendix F, paragraphs (a) to (j). The operator may select an Automatic sequence of tests ending in the Power, Receiver Sensitivity, and Frequency display or manually select the tests one at a time. Figure 2-8 lists the sequence of tests available in the Auto and Manual sequence of tests.

The T-49C will determine upon receiving the transponder RF signal the appropriate sequence. If the transponder is Mode S equipped, the T-49C will automatically select the Mode S menu. If the transponder is Mode A/C capable, the T-49C will initiate the Mode 3A/C transponder tests.



Transponder Sequence of Tests

Figure 2-8

NOTE

Any displays illustrated were the actual results from a calibrated Transponder. The results may be typical of tests performed, but operators must utilize the literature provided by their transponder manufacturer or FAA guidelines when testing their transponder. The results displayed throughout this manual are for **ILLUSTRATION PURPOSES ONLY**.

2.12.1 Mode 3A/C Automatic Sequence of Transponder Tests

Upon energizing the Transponder Under Test, the T-49C will recognize the transponder as having only Mode 3A and/or Mode C capabilities. The appropriate menu will be initiated and shown on the T-49C display.

```
MODE 3A/C XPDR
INTERROGATE TO TEST
```

The operator may now choose to select the automatic sequence of tests or the manual sequence. By depressing the **INTERROGATE** switch (as indicated on the display), the automatic sequence will commence.

The tests will proceed in order (Figure 2-8) and conclude at the POWER, RCVR & FREQ Test Page. The automatic mode does not display results of an individual test as long as the tests performed “PASS”.

If a failure occurs in any one test, the T-49C will stop the automatic sequence and display the failure.

```
FAIL    09% REPLY
CONTINUE: PRESS INT
```

By stopping the test sequence, the operator is alerted to continued and potential failures if testing is resumed. Once the sequence is stopped due to a failure, the operator may override and continue testing by depressing the **INTERROGATE** button. The T-49C will then proceed to the next test in sequence. The operator may also choose to repeat the test by toggling the **STORE/REPEAT** switch down, to initiate the failed test a second time.

When all tests are complete, with no failures, the T-49C test sequence will end with an alternating display of measured power, receiver sensitivity, and frequency (Shown with results utilizing TAP-141). The second alternating page displays power measured in watts. The Mode 3/A and 3C Sensitivity Test is also conducted and will indicate a failure if there is a 1 dB difference between the measurements.

```
POWER, RCVR & FREQ
54dB–75dB 1090.0 MHz
```

⟷

```
POWER, RCVR & FREQ
250W –75dB 1090.0MHz
```

When utilizing the Omni Directional Antenna or the Directional Antenna: power, frequency and sensitivity will not be shown. Aircraft 4096 code and altitude are displayed.

```
1234        10,000’
NO MEASURED POWER
```

2.12.2 Mode 3A/C Manual Sequence of Transponder Tests

To manually display each test performed by the T-49C Test Set; the operator must select the **TEST** switch. The T-49C will then run each test in order (Figure 2-8) but pause and display the results of each test. The operator must then depress the **TEST** button again to proceed to the next test in sequence.

MODE 3A/C XPDR INTERROGATE TO TEST	**TEST** button depressed.
MODE 3A & SLS TESTING . . .	MODE 3A and SLS (Side Lobe Suppression) Test Initiated.
MODE 3A & SLS PASS 1234 100% REPLY	MODE 3A Test Complete. Display indicates transponders 4096 Octal Code (1234) and Receiver Efficiency (100%) as a percentage. SLS Test PASS. Framing Pulse Widths and Spacing are also tested. Refer to paragraph 2.13 for further information.

To check the transponder under test *"IDENT"* function. Press the appropriate button in the aircraft or on the test fixture. Toggle the **STORE/REPEAT** switch on the T-49C. The MODE 3A test will commence and the display will indicate *"IDENT",* verifying the SPI was received.

MODE 3A IDENT 1234 100% REPLY	*"IDENT"* signal received.

The **TEST** button must then be pressed to proceed to the next test.

MODE 3C TESTING . . .	MODE 3C Test Initiated.
MODE 3C 10,000FT 100% REPLY	MODE 3C Test completed. Display indicates transponder reported altitude in feet (to the nearest 100th) and receiver efficiency as a percentage. Framing Pulse Widths and Spacing are also tested.

TEST button depressed to proceed to the final Mode 3A/C Transponder Test.

POWER, RCVR & FREQ TEST	Transponder power, receiver efficiency and frequency test initiated.

Test Set measures transponder RF output (54dBm) Receiver Sensitivity (-75dBm) and Frequency (1090.0 MHz). Second alternating page displays power as watts (250W). The Mode 3/A and 3C Sensitivity Test is also conducted and will indicate a failure if there is a 1 dB difference between the measurements.

During any test in the manual mode of operation, the operator may chose to repeat a particular test by toggling the **STORE/REPEAT** switch. The current test displayed will commence again. The operator may continue doing this as long as the Test Set remains “ON”. Turning the Test Set “OFF” and then “ON” will require the operator to go through all previous tests again to reach the desired test they want to repeat. By leaving the switch in **REPEAT**, the Test Set will continue testing until toggled back to **STORE.**

NOTE

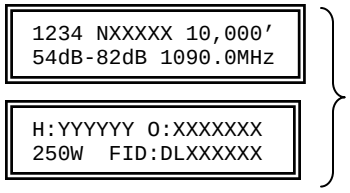
Always return the **REPEAT** switch to **STORE** when testing is completed.

2.12.3 Mode S Automatic Sequence of Transponder Tests

Figure 2-8 lists the sequence of tests performed with a Mode S equipped transponder under test. Paragraph 2.12.4; Mode S Manual Sequence of Transponder Tests, describes in detail each test performed. When the **INTERROGATE** button is pressed, the sequence will continue as long as normal indications are received for each test. If an abnormal result occurs, the sequence will stop at that test and a "FAIL" message will be displayed. To override after a "FAIL" message, press the **INTERROGATE** switch to continue testing with the failure.

First display shown once the T-49C has determined a Mode S equipped Transponder is being received.

When selecting the Automatic sequence of tests, the results of the tests will not be displayed until the final test is completed. At that point, the POWER, RCVR & FREQ display will appear and testing will cease until the **INTERROGATE** or **TEST** button is depressed again to initialize another series of tests.



The final displays of Mode S Transponder tests alternates between two (2) pages. The first page indicates the 4096 octal code, the decoded aircraft address, aircraft altitude and power, sensitivity, and frequency measurements.
The second page displays the aircraft address in both Hexadecimal and Octal, power measured in watts and the decoded Flight Identity.

In the Automatic sequence of tests, "**MAX TRUE AIRSPEED**" and "**VERTICAL STATUS BIT**" tests are omitted. In addition- The operator will be unable to verify the testing of the UUT *"IDENT"* function
.
If the operator requires the results of either of them, the Manual sequence must be utilized. Paragraph 2.12.4; Mode S Manual Sequence of Tests, explains each test and typical results.

2.12.4 Mode S Manual Sequence of Transponder Tests

By selecting the manual sequence of Mode S tests, the operator will be able to view the results of each test, repeat them as necessary, test the function of the transponders "IDENT" function, and display Pulse Width, Pulse Spacing and Data Pulse measurements.

To commence the manual sequence, the operator must depress the **TEST** button after the Test Set has verified a RF signal and the first test display is shown on the front panel of the T-49C.

MODE S XPDR COM/AB INTERROGATE TO TEST	The T-49C has determined a Mode S equipped transponder is being received. To continue testing, the operator must depress the "**TEST**" button.
MODE 3A & SLS TESTING . . .	MODE 3A and SLS (Side Lobe Suppression) test initiated. Framing Pulse width, data pulse, and spacing are also tested but are not displayed unless a failure was detected.
MODE 3A & SLS PASS 1234 100% REPLY	Mode 3A Test Complete. Display indicates the transponders 4096 Octal code (1234) and receiver efficiency (100%) as a percentage. SLS Test Passed.

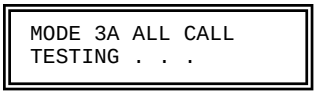
To test the transponder *"IDENT"* function, press the appropriate button in the aircraft or on the Test Fixture. Toggle **STORE/REPEAT** on the T-49C. The MODE 3A test will be repeated. *"IDENT"* should appear on the display indicating the receipt of the SPI pulse.

MODE 3A IDENT 1234 100% REPLY	*"IDENT"* indication displayed confirming a SPI pulse was transmitted following the last framing pulse.

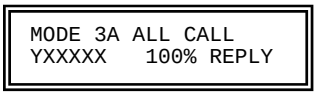
To advance to the next test, the **TEST** button must be depressed.

MODE 3C TESTING . . .	MODE 3C test initiated.
MODE 3C 10,000FT 100% REPLY	The transponders reported altitude in feet (in 100 ft increments) and receiver efficiency as a percentage.

TEST button depressed to advance to next test.

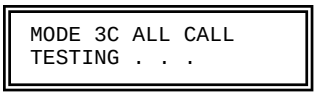


MODE 3A ALL CALL test initiated. Test Set transmits a M3A All Call.

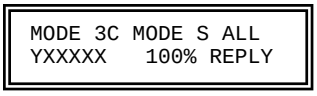


Reported aircraft address in Hexadecimal (YXXXXX) and receiver efficiency is displayed.

TEST button depressed to advance to next test.

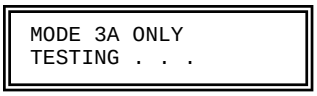


MODE 3C ALL CALL test initiated. Test Set transmits a MODE 3C-Only All Call.

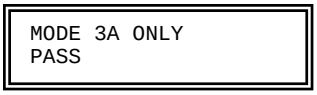


Reported aircraft address in Hexadecimal (YXXXXX) and receiver efficiency is displayed.

TEST button depressed to advance to next test.

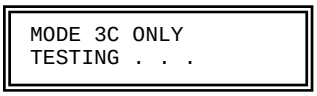


Mode 3A ONLY test initiated. Test Set transmits an ATCRBS-Only All-Call.

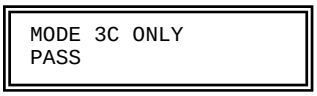


A MODE S transponder will not accept an ATCRBS Only All Call. A "*PASS"* displayed, indicates that the Mode S transponder did not reply.

TEST button depressed to advance to next test.



MODE 3C ONLY test initiated. Test Set transmits an ATCRBS Only All Call.



A MODE S transponder will not accept an ATCRBS Only All Call. A *"PASS"* displayed, indicates that the Mode S transponder did not reply.

TEST button depressed to advance to next test.

```
MODE S SURV IDENTITY
TESTING . . .
```

MODE S Surveillance Identity test initiated. The Test Set transmits an UF=5 Interrogation.

```
MODE S SURV FS: AIR
1234      100% REPLY
```

A DF=5 reply will display the decoded 4096 field (1234) and Flight Status (FS). FS is utilized in the DF=4, 5, 20 and 21 formats.

NOTE

Possible FS displays are **AIR** (Airborne), **GND** (On Ground), **AL/AR** (Alert/Airborne), **AL/GD** (Alert/Ground), **AL/SP** (Alert/SPI), and SPI.

TEST button depressed to advance to next test.

```
MODE S SURV ALTITUDE
TESTING . . .
```

MODE S Surveillance Altitude test initiated. The Test Set transmits an UF=4 Interrogation.

```
MODE S SURV FS: AIR
10,000FT  100% REPLY
```

The DF=4 reply will display reported altitude (to the nearest 25 ft. level), flight status and the receiver efficiency.

TEST button depressed to advance to next test.

```
MODE S SURV SHORT
TESTING . . .
```

MODE S Short Air to Air Surveillance test initiated. The Test Set will transmit a short special interrogation, UF=0 format.

```
MODE S SRV 100%REPLY
YXXXXX  GND 10,000FT
```

The Mode S Transponder will reply with a short special reply in DF=0 format. Aircraft address in Hexadecimal, aircraft altitude, and flight status is displayed.

TEST button depressed to advance to next test.

```
MODE S COMM IDENTITY
TESTING . . .
```

MODE S COMM A Identity test initiated. The Test Set transmits a COMM A/B, ABCD transmission utilizing a UF=5/RR:18 format. This tests a transponders communication and data-link capabilities.

```
IDENTITY: DLXXXXXXX
1234      100% REPLY
```

The transponder will reply in the DF=21 format. The display will show the Flight ID code and decoded 4096 field. Receiver efficiency as a percentage is also displayed.

TEST button depressed to advance to next test.

```
MODE S COMM ALTITUDE
TESTING . . .
```

MODE S COMM A Altitude test initiated. The Test Set transmits a COMM A/B, ABCD transmission utilizing a UF=5/RR:18 format. This tests a transponders communication and data-link capabilities.

```
MODE S COMM YXXXXX
10,000FT  100% REPLY
```

The transponder will reply in the DF=20 format. Aircraft Address in Hexadecimal, aircraft altitude, and the receiver efficiency will be displayed.

TEST button depressed to advance to next test.

```
UNDESIRED REPLIES
TESTING . . .
```

Undesired Replies test initiated. The Test Set will make randomly addressed interrogations. Only the correctly addressed interrogation will be accepted.

```
UNDESIRED REPLIES
NO REPLIES
```

If the transponder replies to any of the random addresses, an error message will be displayed. “NO REPLIES” indicates the transponder did not reply and has passed the test.

TEST button depressed to advance to next test.

```
SQUITTER
TESTING . . .
```

The Test Set will transmit no interrogations but receives and processes DF=11 and extended DF=17 replies. After detection of the replies is received, two alternating pages will appear displaying the time interval of received replies.

DF=11 Acquisition

```
ACQ:PASS DIV 1021 MS
ADD: AXXXXX  II:0
```


DF=17 Extended Squitter

```
EXT: PASS DIV 520 MS
ADD: AXXXXX
```

The detection time of each DF=11 and/or DF=17 message will be displayed. If the time interval is between 0.8-1.2 sec. - “PASS” is displayed. If the time interval falls in the 1.6-2.4 sec. range – “DIV” (Diversity) is also displayed. The aircraft address is also shown.

ACQ: NOT DETECTED

If a DF=11 or DF=17 message is not received- "NOT DETECTED" will be displayed.

EXT: FAIL ADD: AXXXXX

If only one message of either DF=11 or DF=17 is received in the 5.1 second measuring period, "FAIL" will be displayed and no time will be shown.

TEST button depressed to advance to next test.

DIVERSITY TESTING . . .

Diversity test initiated.

DIVERSITY PASS

Display indicates a "PASS" when the Test Set determines whether leakage relative to the inactive antenna is less than -20 dB. See Paragraph 2.10.4 for further information regarding Diversity Testing.

TEST button depressed to advance to next test. The **MAX TRUE AIRSPEED** test is not performed during the auto sequence of Mode S tests.

MAX TRUE AIRSPEED TESTING . . .

Test Set initiates a UF=0 interrogation. Verifies that the transponder airspeed code is one of seven possible RI field codes.

MAX TRUE AIRSPEED GT 300 & LE 600 KTS

The DF=0 reply reports the aircraft maximum cruising true airspeed in the RI Field of the DF=0 format.

NOTE

Eight possible RI field codes are available.
1) *NO Max airspeed data*
2) *LE 75 knots*
3) *GT 75 & LE 150 kts*
4) *GT 150 & LE 300 kts*
5) *GT 300 & LE 600 kts*
6) *GT 600 & LE 1200 kts*
7) *GT 1200 kts*
8) Not Assigned.
GT denote "Greater Than", **LE** denotes "Less than or Equal

TEST button depressed to advance to next test. The **VERTICAL STATUS BIT** test is not performed during the auto sequence of Mode S tests.

VERTICAL STATUS BIT VS=1 (ON GROUND)

Test Set receives the Vertical Status as part of the UF=0 format. A display of ONE (VS=1) is aircraft on ground. A display 0f ZERO (VS=0) is aircraft airborne.

TEST button depressed to advance to next test.

POWER, RCVR & FREQ TESTING . . .

The Test Set begins transponder RF power, receiver sensitivity, and frequency tests.

POWER,RCVR & FREQ 01 TESTING

The Test Set will take the receiver sensitivity measurement four (4) times and average the results. The number in the upper right corner counting; **01-02-03** signifies the sensitivity test progressing.

The final test in the manual sequence will end with an alternating display of transponder RF power output (54dBm), receiver sensitivity (-75dBm) and transponder frequency (1090.0 MHz). The second page displays power in watts. The Mode 3/A and 3C Sensitivity Test is also conducted and will indicate a failure if there is a 1 dB difference between the measurements.

POWER,RCVR & FREQ 54dB-75dB 1090.0 MHz

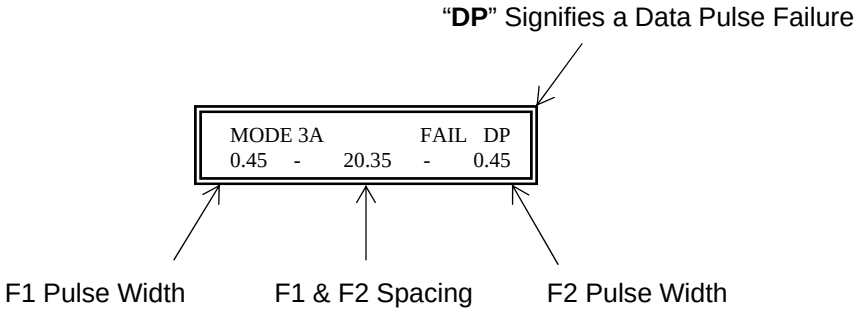
POWER,RCVR & FREQ 250W-75dB 1090.0 MHz

2.13 Pulse Width, Spacing and Data Pulse Measurements

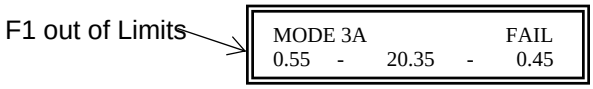
NOTE

Pulse Width, Pulse Spacing, and Data Pulse measurements are not reliable if the T-49CTest Set Receiver efficiency is less than 90%.

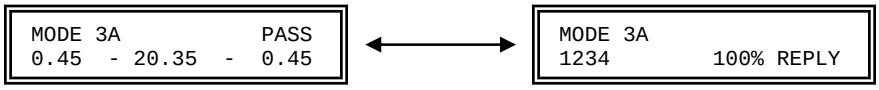
The T-49C/CA accurately measures each Framing Pulse, Pulse Width, and Pulse Spacing. Each Data Pulse entered will also have the width and spacing measured. Both Mode S and ATCRBS transponders are tested during the Mode 3A and Mode C portion of the **MANUAL** and **AUTO** test sequence. If no failures are detected, no display is shown. In the event of a failure, the Test Set will cease testing and display the failure. The Test Set will display the measured Framing Pulse Width (F1), Spacing between F1 and F2, and Pulse width of F2 (see figure 2-9).



A "**FAIL"** signifies a F1/F2 Width failure, or a Framing Pulse Spacing Failure.



The operator may also chose to repeatedly measure and test the Pulse Width, Spacing and Data Pulses by placing the **STORE/REPEAT** toggle in the "UP" position after completing either the Mode 3A or Mode C test. The Test Set will then alternately test the appropriate Test (Mode 3A or C) and the Pulse Width measurements. The display will also alternate showing the results each time it is tested.



When conducting the PW test in the MODE C test page, after 30 seconds has passed, the Test Set will discontinue the PW measurements. To continue to measure the PW, the operator must cycle the **STORE/REPEAT** switch to begin another 30 seconds of PW measurements.

2.13.1 PW, Spacing and Data Pulse Test Example

As an example, the operator of an ATCRBS transponder selects 1234 as the 4096 code. Turn the Test Set "ON" by pressing the **INTERROGATE** button. The Test Set will automatically determine an ATCRBS only transponder is transmitting. Press the **TEST** button to initialize the manual sequence of tests.

```
MODE 3A & SLS
TESTING . . .
```

MODE 3A Test Initialized. Test Set also performs Framing Pulse Width and Data Pulse Tests. With 1234 entered, the T-49C will measure Framing Pulses, their width, and their spacing. The Test Set will also measure each Data Pulse in each time slot and their separation (D4, C2, C1, B2 and A1).

```
MODE 3A
1234    100% REPLY
```

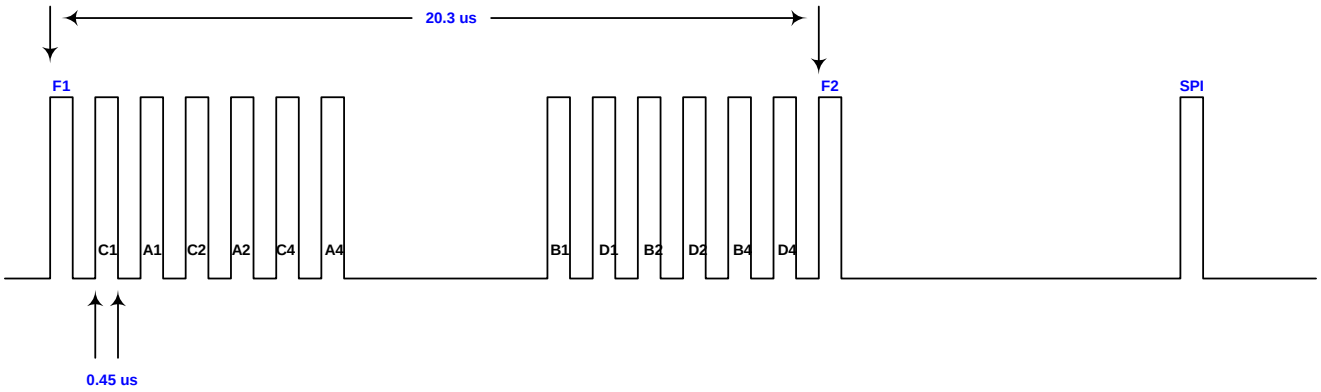
Display indicating no failures.

Table 2-3 contains each parameter and their failure criteria.

PARAMETER	NORMAL INDICATION	LIMITATIONS
Framing Pulse Width	.45 µs	± .1µs
Framing Pulse Separation	20.3 µs	± .1µs
Data Pulse Width	.45µs	± .1µs
Data Pulse Separation	1.45µs	± .1µs

Pulse Width and Spacing Criteria

Table 2-3



Framing and Data Pulses

Figure 2-9

2.14 TCAS Test Scenarios

The T-49C Test Set is capable of testing ATCRBS and Mode S, TCAS I/II systems (Traffic Alert and Collision Avoidance System). The operator is able to select four separate Intruder scenarios. When properly configured, the Test Set will simulate an Intruder aircraft converging on the position of the UUT. The operator may then observe the UUT TCAS display to ensure correct heading and altitude displays are shown. The appropriate TA's (Traffic Advisory) and RA's (Resolution Advisory) will also be heard and displayed.

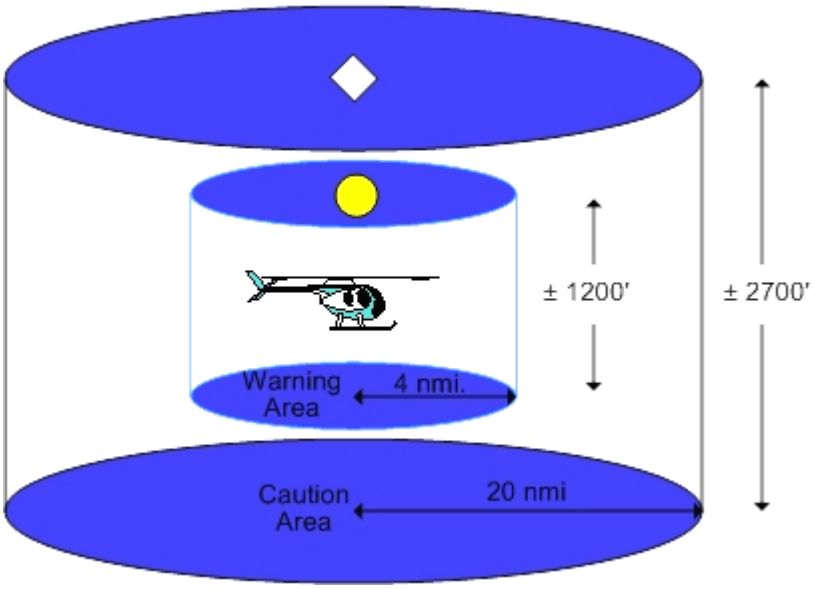
2.14.1 Typical TCAS Concepts

NOTE

All illustrations shown are for demonstration purposes. Though the test results may be typical, they are not meant to replace FAA guidelines and manufacturer recommendations.

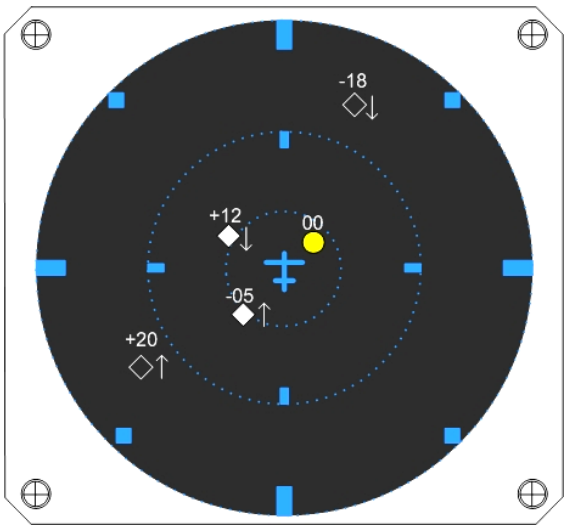
TCAS is a system, which provides situational awareness of the surrounding airspace of an aircraft to the pilot and crew. A TCAS establishes a volume of airspace around the aircraft. The size of the airspace is based on range, speed and altitude. By working in-conjunction with the aircraft Transponder system, the TCAS can determine the relative threat of an aircraft, issue visual and audible advisories to assist the crew in locating and/or take action to prevent a collision.

The perimeter of the *CAUTION AREA* is approximately 20 to 48 seconds to the time the intruder would enter the *COLLISION AREA*. Refer to Figure 2-10.



Caution, Warning, and Collision Areas for a TCAS I System

Figure 2-10



A Solid Amber Circle indicates a **TA** (Traffic Alert), signifying a possible collision threat to your aircraft. Accompanied by a audible warning of “Traffic, Traffic”

A solid white diamond signifies a proximate traffic. Aircraft that are within 4nmi and ± 1200 feet altitude.

An open white diamond signifies other traffic within the selected range.

-05 Numbers represent the intruder aircrafts relative altitude ± 100 ft levels from your aircraft.

The arrows indicate if the intruder aircraft is ascending or descending from your relative position.

Typical TCAS I Display

Figure 2-11

The perimeter of the *WARNING AREA* is approximately 15-35 seconds from entering the *COLLISION AREA* *(not depicted)*.

When an aircraft enters the *CAUTION AREA*, a “TA” (Traffic Advisory) is issued. This would consist of an audible and visual warning in the cockpit.

When an intruder enters the *COLLISION AREA*, the TCAS will issue a “RA” (Resolution Advisory). “RA’s” consist of audible and visual warnings and possible instructions to avoid a collision.

A TCAS display will vary dependent on the manufacturer. Typically, a TCAS I system, as shown in figure 2-11, will display Traffic Advisories. A TCAS II System will be incorporated with a Vertical Speed Indicator (VSI), which will issue a RA, the pilots VSI will display a course of action to avoid a collision with an aircraft located in the COLLISION AREA.

2.14.2 TCAS Intruder Types and Scenarios

The operator is able to select four (4) separate Intruder scenarios by means of the **SCENARIO** select knob on the front of the T-49C Test Set. Table 2-4 lists each scenario available.

Selectable Scenarios	Intruder Speed	Intruder Range	Altitude Separation	Altitude Offset
+3500/-3500	300 kts.	14 to 0 nmi.	3500 ft.	Altitude offset will decrease as distance decreases or Vice-Versa
0	300 kts.	14 to 0 nmi.	0	Constant
+4000/-4000	300 kts.	14 to 0 nmi.	4000 ft.	Constant
+200/-200	300 kts.	14 to 0 nmi.	200 ft.	Constant

TCAS Intruder Scenarios

Table 2-4

The operator may also select what type of Intruder to simulate. MODE 3A/C and MODE S are available by turning the **TCAS INTRUDER** select knob on the T-49C.

NOTE

The **TCAS** position on the **TCAS INTRUDER** select knob is identical in use as the **MODE S** position. This was incorporated into the T-49 T/S for possible future expansion.

2.14.3 TCAS Testing Cautions

Due to the nature of operating a TCAS system, especially Mode S equipped, the potential exists to create false targets in the airspace surrounding the test area, causing local aircraft and FAA ATC Centers to display false intruders.

The TAP-135 antenna couplers offer sufficient attenuation to suppress the transponder output during TCAS testing. Place the coupler tightly over the unused antenna during TCAS testing to minimize false target problems. The coupler does not require connector termination when utilized in this fashion.

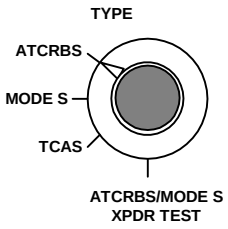
2.14.4 TCAS Test Sequence

The Test Set utilizes the Directional Antenna for TCAS simulation. This offers the operator the ability to move the Test Set to different locations around the aircraft to check if correct heading information is being shown on the TCAS Display. Refer to Paragraph 2.10.2 on Directional Antenna procedures.

To configure the Test Set to simulate an intruder aircraft, the AUT (Aircraft Under Test) altitude must be known. *Typically*, the Intruder Altitude is set to the same altitude as the AUT to ensure that the simulated Intruder converges with the AUT for verification of al RA's and TA's.

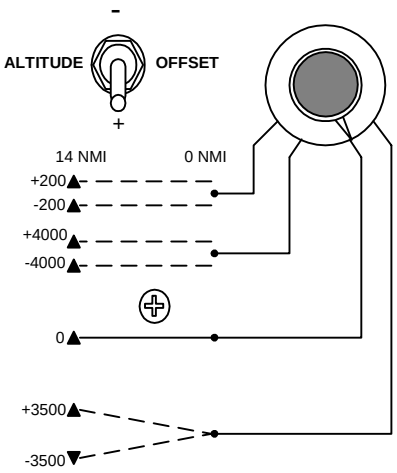
The T-49 will automatically acquire the AUT altitude by conducting a MODE C test upon turning on the Test Set. If the transponder is not operating properly, or is powered down, the operator may still enter the altitude manually.

1. Start the Intruder Scenario by selecting the type of intruder to be simulated. Utilize the **TCAS INTRUDER TYPE** switch to select either a **MODE S** or an **ATCRBS** intruder.



An **ATCRBS** Intruder is shown selected.

2. Use the **SCENARIO** switch to select the appropriate Intruder simulation. The operator may also select an offset of above the AUT (+) or below the AUT (-) for any scenario, with the exception of the **0** Offset Scenario (as shown here).



The 0 ft. Offset Scenario is shown selected.

3. Turn the Test Set "*ON*" by depressing the **TEST** or **INTERROGATE** button.

4. The Test Set will briefly display the *Start* Screen.

```
TEL INSTRUMENT
T-49C    REV . 6.10
```

5. The Test Set will automatically conduct a MODE C Test to obtain the current aircraft altitude. If the Altitude is unavailable, the Test Set will briefly display:

```
MODE C ALTITUDE
NOT AVAILABLE
```

Followed by the TCAS SETUP Screen.

```
ALT  3,800'  CONT: STR
SLEW UP: TEST DN: INTR
```

6. Enter the AUT Altitude, if not obtained as in *Step 5,* by pressing the **TEST** and **INTERROGATE** buttons to the desired altitude. The Altitude is adjustable in 100' increments from -1000 ft. to +99,900 ft.

NOTE

If the AUT altitude is changed while testing is in progress, the operator may have to reinitialize the Test over to reacquire the MODE C altitude or manually insert the altitude.

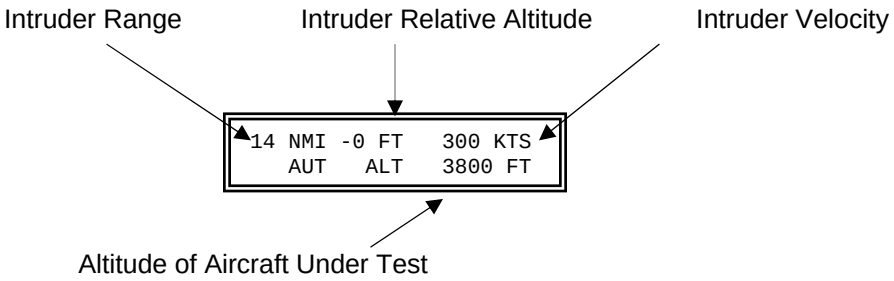
7. Toggle the **STORE/REPEAT** switch "*Down"* to store the entered values. The Test Set will display the selected intruder Start Page.

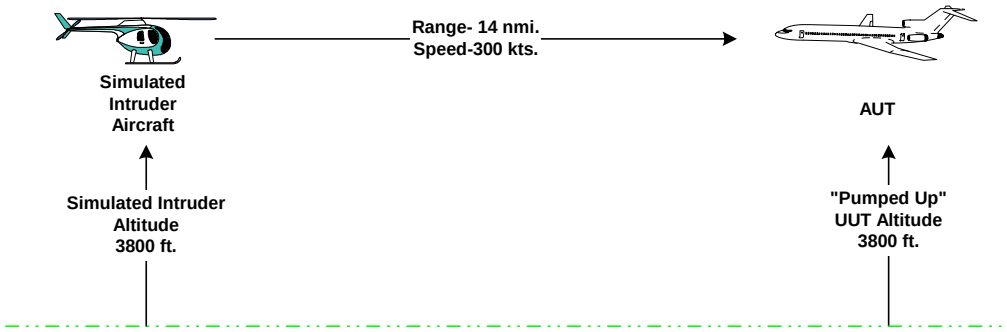

```
TCAS INTRUDER
PRESS INTERROGATE
```

```
MODE S INTRUDER
PRESS INTERROGATE
```

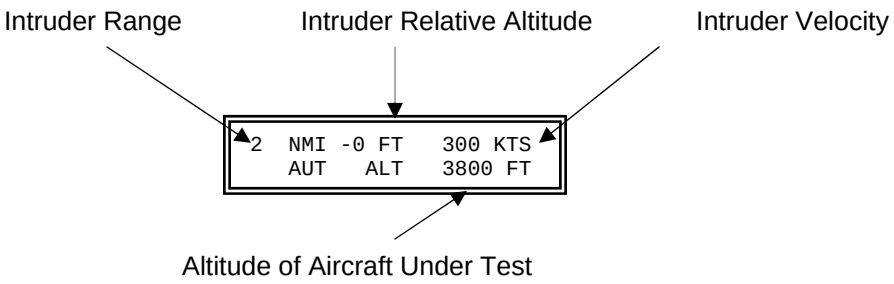
```
MODE 3A/C INTRUDER
PRESS INTERROGATE
```

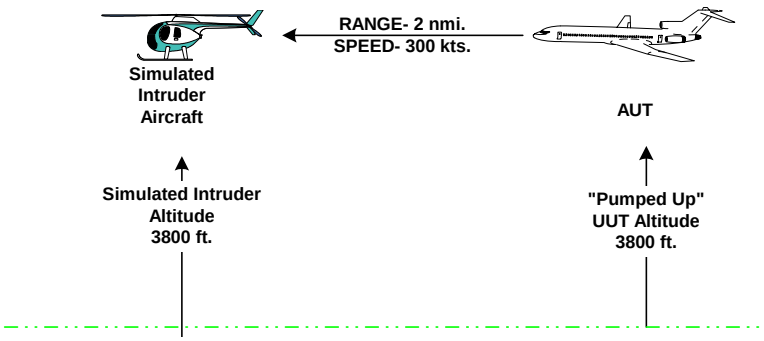
8. Press the **INTERROGATE** button to initiate the TCAS Simulation.



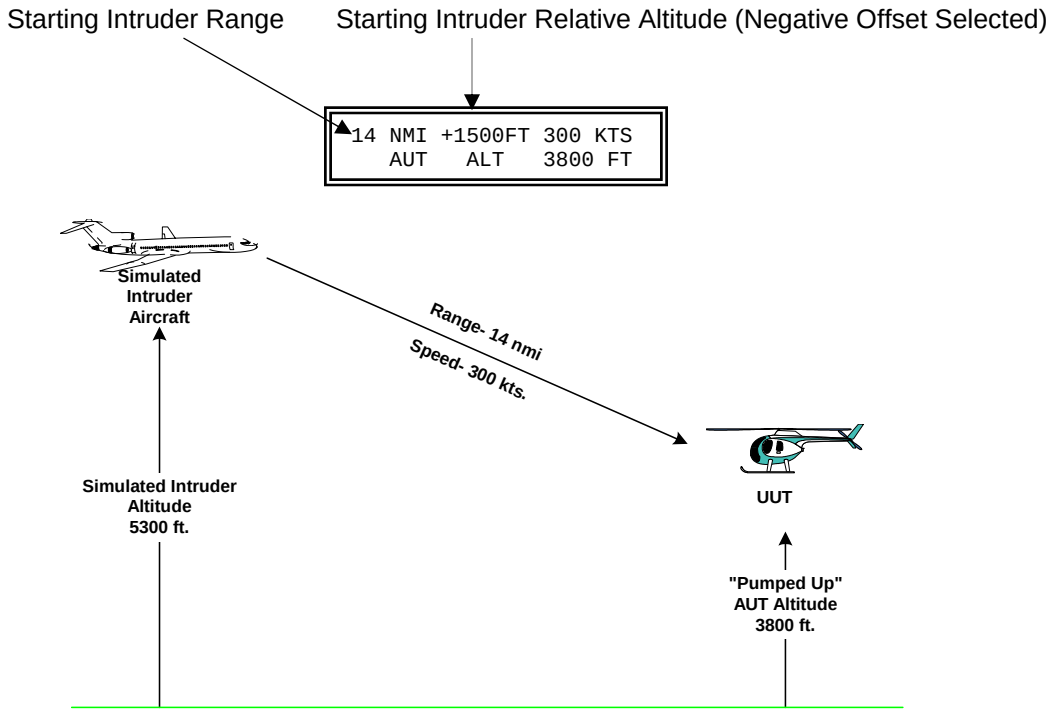


The Scenario will run from 14 nmi. to 0 nmi. and return back to 14 nmi. It will continue this cycle until another scenario is selected, the Test Set is turned "*OFF*" or times out.

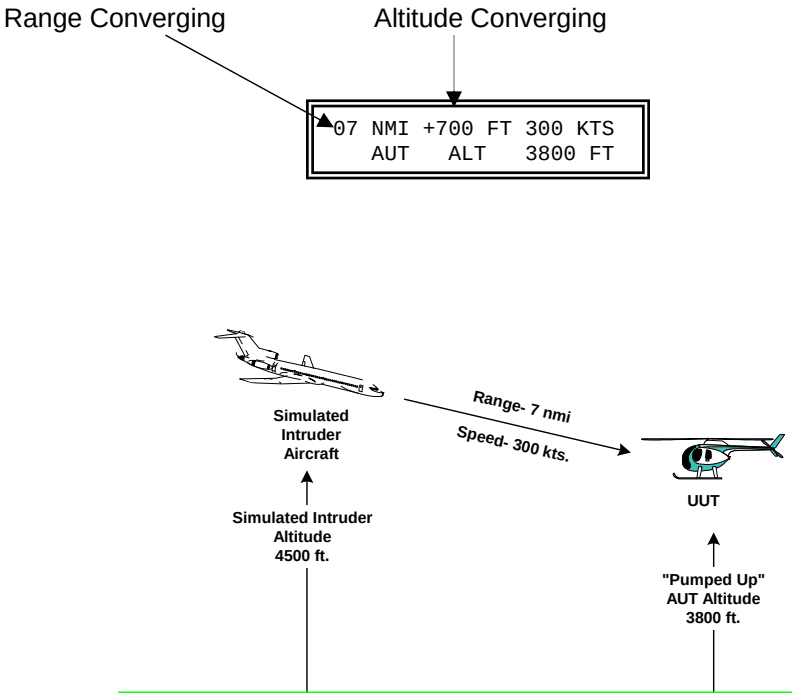




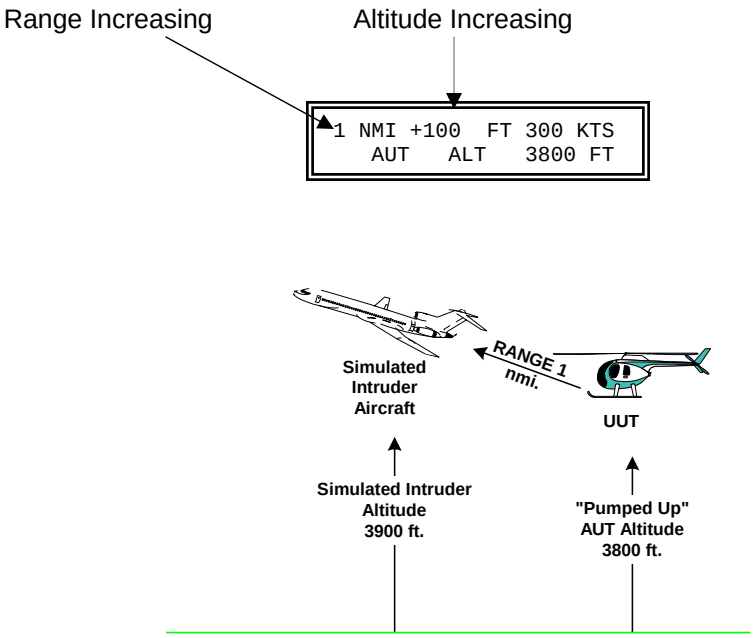
When utilizing the **+3500/-3500** Intruder Selection. The T-49C altitude will also increase or decrease (dependent on offset selected) altitude to intercept the Aircraft Under Test altitude. When the altitude and range converge, the test will reverse back out to the 14 nmi. initial range.



As the Range Decreases, the relative Altitude also decreases until they converge at 0 nmi. and 0 FT.



Once the Intruder Simulation reaches **0**, the simulation will reverse direction and return back to 14 nmi.



9. When you are unable to observe the simulated target on the TCAS display, reposition the TCAS directional Antenna to a different location. Observe that there are no obstructions between the Test Set and the AUT TCAS Antenna. If no display is still present, place the **TCAS/HI-XPDR/TCAS/LO** switch to the **HI** position**.**

By placing the switch in **HI**, the Test Set power was increased by +10 dBm. Ensure to return the switch back to the **LO** position when testing is complete.

10. At any time during the sequence, the operator may *HALT* the simulation at any point. The Test Set can then be moved to another location around the AUT to verify correct bearing and heading. Press the **TEST** button a second time to resume the simulation.

2.15 RS-232 Download Procedures

Test Sets with Software Revision **7.00 or greater** contains memory to down load results received during the **AUTOMATIC** sequence of tests to a PC thru the use of the RS-232 port located on the front panel of the Test Set. Once downloaded, the information can be displayed in an Excel file to be viewed and saved for future reference. The following Tests and results are captured to the Test Set's memory:

1. **MODE 3A & SLS**
   Re: Mode A Reply, Mode A Code, MA SLS

2. **MODE 3C**
   Re: Mode C Reply, Mode C Altitude

3. **MODE 3A ALL CALL**
   Re: Mode A & C Reply, MA and C Address

4. MO**DE 3C ALL CALL**
   Re: MC & A Reply, Mode A & C Address

5. **MODE 3A ONLY**
   Re: Results

6. **MODE C ONLY**
   Re: Results

7. **MODE S SURVEILLANCE IDENTITY**
   Re: DF5 Reply, DF5 ID, DF5, Flight Status

8. **MODE S SUVEILLANCE ALTITUDE**
   Re: DF4 Reply, DF4 Altitude, DF4 Flight Status

9. **MODE S SURVEILLANCE SHORT**
   Re: DF0 Reply, DF0 Altitude, DF0 VS

10. **MODE S COMM IDENTITY**
    Re: DF20 Reply, DF20 ID, DF20 Flight ID

11. **MODE S COMM ALTITUDE**
    Re: DF20 Reply, DF20 Altitude

12. **UNDESIRED REPLIES**
    Re: Results

13. **SQUITTER**
    Re: ACQ Per, ACQ Address, Ext PER, Extended Address

14. **DIVERSITY**
    Re: Results

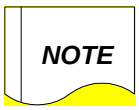
15. **POWER, SENSITIVITY, AND FREQUENCY**
    Re: Power (in dB), Power (in Watts), MA Sensitivity, MC Sensitivity, and Frequency

The Test Set Captures up to 25 series of tests, after capturing the 25th test, the Test Set will then begin overwriting the oldest captured data. The software required to download the stored information is part of the Test Set memory. No external software is required to be loaded onto the PC to accomplish the transfer.

Results are transferred via a RS-232 Cable (not supplied) to a COMM port on the computer at a 4800-baud rate. With the computer HyperTerminal, the data is downloaded as a comma delimited file, which can be opened in an Excel spreadsheet program. The operator may also choose to put it in another file of their choice.

2.15.1 Setting Up Your Computer for RS-232 Download

It is necessary to configure your Computer to properly display the data downloaded. Once this is accomplished, the operator can then sort the data in the excel file in any way they prefer. The T-49C Test Set utilizes a Hyper Terminal Program that is part of the Microsoft Windows Operating System. If this is not installed on your computer, you can obtain the program from the Microsoft Website or from your Windows Software the was supplied with your Computer. The following describes a suggested way to configure your computer to properly display the data.



The following procedures are abbreviated and may not match your operating system exactly; contact your computer administrator or computer manufacturer for assistance.

1. Select *START* on the computer desktop.
2. Select *PROGRAMS.*
3. Select *ACCESSORIES.*
4. Select *COMMUNICATIONS.*
5. Select *HYPER TERMINAL.*
6. Enter a name for the Terminal Connection (e.g. – T-49C).
7. Select *CONNECT TO* and pick the correct COM port you will be utilizing on your computer. For most users, this will be *COM1*.
8. Set the Port Settings to the following.
   a. BIT PER SECOND – 4800
   b. DATA BITS – 8
   c. PARITY – None
   d. STOP BITS – 1
   e. FLOW CONTROL – Hardware
9. Select *APPLY*.
10. Select *OK*.

Close the Program. You have not created a permanent short cut configured for the T-49C RS-232 download feature. You will not be required to repeat this procedure. When preparing to download data, select the T-49C Hyper Terminal that should be located within the Hyper Terminal program selection dropdown.

2.15.2 Downloading the Data

Ensure the Test Set is **OFF** before connecting the Test Set to your computer.

1. Connect a standard RS-232 extension cable (not supplied) to the RS-232 connector located on the front panel of the Test Set and connect the other ends to the COM Port that was selected paragraph 2.15.1 step 7 (typically COM1).

2. On the computer, select the T-49C Short Cut that was created in the paragraph 2.15.1.

3. Select *TRANSFER* from the Hyper-Terminal drop down menu.

4. Select CAPTURE TEXT and save the file to your desktop (recommended) and name the file to your preference but utilize a .csv extension (for example - Serial Number 2345Date.csv). Select *START*.

5. Press the **INTERROGATE** or the **TEST** switch on the T-49C to begin downloading the data and observe the following:

```
TEL-INSTRUMENT
Transferring Data…
```

The data will download to the Hyper-Terminal program and can then be observed on the computer display. Once all of the data has been transferred, the Test Set will indicate:

```
Output Completed
Press Test To Erase
```

Select *TRANSFER* on the Hyper-Terminal drop-down menu, then *CAPTURE TEXT* and *STOP.* The data is now saved to the file. The operator may now choose to erase the stored data on the Test Set by pressing the **TEST** button on the Test Set. Simply turn the Test Set *OFF* if you desire to keep the file in the memory.

6. Turn OFF the Test Set and disconnect the RS-232 cable.

2.15.3 Loading the Data to a Microsoft Excel File

1. Open up Microsoft Excel; do not double click on the file stored on the computers Desktop. Select *FILE* then *OPEN*. Locate the file on the Desktop (or wherever it was saved to) and open the file.

2. Depending on the edition of Microsoft Excel you currently have, the file may directly open and can then be organized as necessary. If the *IMPORT WIZARD* opens, follow step 3, if the file opened properly, skip to step 4.

3. If the *IMPORT FILE WIZARD* opens, select a *DELIMITED* file then click *NEXT. Select COMMA-DELIMITED* and deselect all others. Select *NEXT* and *FINISH.*

4. Once the file is loaded onto the Excel Spreadsheet, the operator can choose how to organize and display the information. By selecting “Auto Fit” options and selecting the appropriate Text, the operator can modify the spacing between each block. Refer to the Excel help file for further information.

CHAPTER III

PRINCIPLES OF OPERATION

3.1 General

The Test Set contains a transmitter and receiver that communicate with the Traffic Alert and Collision Avoidance System (TCAS) or transponder (XPDR) under test. Both transmitter and receiver are capable of operating on either 1030 MHz or 1090 MHz, with both pulse amplitude and Differential Phase Shift Keying (DPSK) modulation.

3.2 Test Modes

3.2.1 ATCRBS (Mode A/C) and Mode S Transponder Testing

When the **TYPE** switch is set to **ATCRBS/MODE S, XPDR TEST** the test set simulates secondary radar, radiates interrogations Mode A/C to the transponder under test, and receives the reply. A series of ATCRBS (Mode A/C) interrogations are transmitted, followed by Mode S interrogations. The test set analyzes the replies of the transponder under test, both Mode A/C and Mode S, to insure that they are the correct reply for the interrogation.

3.2.2 TCAS Testing

For TCAS testing, the Test Set simulates an intruder by replying to UUT TCAS interrogations with the characteristics of a specific transponder type, as selected by the front panel rotary switch. Squitter and other un-requested third party reply transmissions are also provided.

When the **TCAS INTRUDER TYPE** switch is set to TCAS or MODE S, the Test Set will only respond to Mode S interrogations. In addition to replies, the Test Set also provides normal squitter with downlink format 11 (All-Call Reply), as well as simulated replies to interrogators other than the TCAS system with downlink format 4 (Surveillance, Altitude). Replies to Mode S interrogations from the TCAS UUT will be in downlink format 0 (Short Special Surveillance).

The TCAS system determines the existence of a potential Mode S intruder by receiving squitter and other simulated interrogation replies from the Test Set. The Test Set intruder's address may be obtained from the squitters, while the altitude is available from downlink format 4. Thus, without interrogating the potential intruder, the TCAS system may discern the altitude and the address of the Test Set simulated intruder.

If the Test Set intruder altitude, or altitude rate, are determined by the TCAS system to require further information, the TCAS system will interrogate the simulated intruder using the address obtained from the received squitter or simulated third party replies. By measuring the elapsed time from the initiation of the interrogation to the receipt of the reply, the TCAS system will determine its distance from the Test Set intruder. The Test Set computes and reduces the time delay (and altitude offset) in order to simulate a converging track.

When in the TCAS intruder mode, the address used for the Test Set is selected to be one digit lower than the UUT address. Should two TCAS equipped aircraft decide to issue a resolution advisory simultaneously, the TCAS aircraft with the higher address will be given priority. To insure that the aircraft under test issues the correct advisory, the Test Set address will be forced to be the lower address for all cases.

When the **TCAS INTRUDER TYPE** switch is set to **ATCRBS** for TCAS Testing, the Test Set will provide replies to ATCRBS Mode 3A or C interrogations. Simulated reply distances at 14 nautical miles down to 0 nautical miles are provided by varying the reply time delay. The TCAS UUT sees the Test Set reply as an aircraft converging on the TCAS equipped aircraft under test. The altitude of the aircraft under test (AUT) may be obtained by using the Test Set in **ATCRBS/MODE S XPDR TEST** and interrogating the AUT in Mode C or entered manually by pressing the **TEST** and **INTERROGATE** buttons at the TCAS start page. An offset altitude is added or subtracted from the AUT altitude to represent the altitude of the Test Set simulated intruder aircraft. This offset altitude may be fixed or variable depending on the scenario selection using the Test Set front panel switches.

3.3 Theory of Operation

The T-49C Test Set contains a transmitter and receiver which communicates with the TCAS or Transponder under test. The Test Set transmitter and receiver are capable of operating on either 1030.0 MHz or 1090.0 MHz, with both pulse amplitude and DPSK modulation (1030.0 MHz only).

3.3.1 RF Transmitter

The transmitter section generates the desired carrier frequency using a frequency synthesizer. The Oscillator, Q6, is a varactor-tuned oscillator that is followed by two stages of buffer amplifiers, U22 and U23, to ensure minimal frequency modulation due to the phased amplitude modulation applied to the carrier. A divide-by256 prescaler, U33, is fed from the first buffer amplifier and drives the phase detector U36. The phase detector output drives a single loop filter/amplifier, which in turn closes the loop by feeding the varactor diode, Q8 and Q11, of the VCO.

The transmitter oscillator is operated on one of two frequencies. By selecting one of two crystal oscillators at 1090.0/256 = 4.257812 MHz, Y3, or 1030.0/256 = 4.0234225 MHz, Y4. The desired oscillator, Y3 or Y4 is selected by applying power to oscillator.

Modulation is applied to the transmitter carrier by using a combination of two methods. A balanced mixer, U28, provides either amplitude modulation or Phase Shift Keying Modulation. Following the balanced mixer, buffer amplifiers U25 and U26 are modulated by the DAC. These amplifiers provide 20 dB of gain variation. U11 is gated to provide

further amplitude modulation since the balanced mixer would not provide sufficient on/off ratio.

An analog switch, U27, under digital control, provides the modulation to the balanced mixer. This analog switch provides positive and negative current into the balanced mixer to provide both phase in-phase and reverse-phase for DPSK modulation. In addition, this chip provides power switching for the buffer amplifier U11 through Q12 and Q13. R96 is utilized to adjust the Side Lobe Suppression (SLS) P2 power level.

3.3.2 RF Receiver

The receiver is a single-conversion superheterodyne using an IF of 45.00 MHz. The local oscillator frequencies used are 1045 MHz, for receiving 1090 MHz, and 1075 MHz, for receiving 1030 MHz. Since the pulse and DPSK modulations employed in transponder and TCAS technologies are not spectrum sensitive, the resultant inverted spectra are not a factor. The use of both high side and low side injection was done to reduce the frequency spread of the local oscillator and therefore, enhance the lock-up time. In addition, the 45 MHz IF, rather than the conventional 60 MHz, prevents the receiver local oscillator from being present at the transmit frequency and, therefore, avoiding the difficult task of reducing to an acceptable level the amount of local oscillator radiation.

The receiver input feeds a broadly tuned transmission line resonator filter which passes both 1030 and 1090 MHz. The mixer follows, which is fed the local oscillator from the output of the two buffer amplifiers, U19 and U3). The mixer output is followed by amplifier U4 which feeds a two-pole IF filter tuned to 45 MHz.

The IF amplifier is a logarithmic amplifier. It is important that the receiver have characteristics similar to an airborne transponder so that it will react in a similar fashion to the "whisper-shout" interrogations from the TCAS computer. Therefore, the receiver uses a pulse amplitude-following detector to provide pulse amplitude discrimination similar to that found in a typical ATCRBS (Mode A/C) transponder.

3.3.3 Power, Frequency and Sensitivity Measurements

With a TAP-135 or TAP-141 connected, the Test Set measures the frequency and the power output of the MODE S or ATCRBS transponder under test. The frequency measurement is made using a frequency discriminator in the receiver IF at 45 MHz. Whenever pulses are received, the output of the frequency discriminator is gated to an integrator. Immediately preceding the measurement period, a 45 MHz calibration oscillator is energized and the center frequency of the discriminator is adjusted using a varactor diode. The analog output from the discriminator is fed to an A/D converter for conversion and reading by the microprocessor.

To measure transponder power and receiver sensitivity, a TAP-135 or TAP-141 must be connected to the Test Set.

Rectified transmitter pulses are fed to the peak power measuring circuit consisting of U29, U30, Q14 and Q15. This is a peak following circuit where a capacitor, C121, is charged by the comparator, U29, to the peak of the input pulse. The capacitor voltage is

fed to a buffer amplifier and amplified by an op-amp, U30. The output of this amplifier is converted with the A/D converter U32 and is read by the microprocessor.

To measure receiver sensitivity, the signal level from the test set is steadily reduced while the replies from the transponder under test are monitored. The level of output signal is controlled by applying a negative bias to the output amplifiers through a D/A converter, (U3, located on the digital board) under control of the microprocessor. When the reply efficiency has reduced to 90% in the ATCRBS mode and 99% in the Mode S mode, the microprocessor reads the last level applied to the D/A converter and calculates the equivalent receiver sensitivity.

3.3.4 Diversity Measurements

Diversity is measured by comparing the magnitude of two successive squitter transmissions from a Mode S transponder using the peak power measurements described above. The TAP-135 anti-radiation/diversity couplers are placed over both Mode S transponder antennas. The coax cable from one coupler is first connected, and the diversity check run, and then this test is repeated with the other coupler connected. The cable from the unused coupler does not have to be terminated. These tests determine whether the leakage from the active antenna is less than 20dB. The use of the TAP-135 couplers also reduces external radiation by over 20dB.

3.3.5 Microprocessor

The digital board contains the microprocessor and all of the bus-connected peripheral chips. The microprocessor, U4, is a CMOS 80C31AH. The program memory, U13, has 256K bits. The RAM, U11, is battery backed for storing test data while IC's U1-U9 are latches for interfacing with various peripheral circuits including those located on the RF board. U14 is a latched demultiplexer decoder that is used for demultiplexing some of the latches and providing other control signals.

When testing transponders, the transmitter modulation is generated by a first-in first-out (FIFO) chip, U46. The required pulse train for the modulation envelope is loaded into the FIFO at a slow rate and clocked out at a much faster rate for the interrogations. This is necessary, because the microprocessor is not capable of providing the necessary pulse manipulations at the necessary clock speeds. The microprocessor is incapable of storing and analyzing the data as received from the transponder under test. Therefore, the received data are clocked into the same FIFO at real time, to be stored temporarily, and then clocked out by the microprocessor at a slower rate for analysis. Since transmitting and receiving occur at two different times, the same FIFO may serve both purposes. FIFO, U46, is used for receiving and transmitting transponder tests.

In the case of TCAS testing, the possible replies are loaded and stored into a second FIFO, U37. The received interrogations are decoded, using logic elements, and the desired reply is selected and transmitted without microprocessor assistance. The nature of the interrogation is then investigated and should any changes be made to the reply, the FIFO is loaded with the new data, which will constitute the next reply. Because of the need to retain the reply message within a FIFO, while the test set is receiving, two FIFO's are required. U46 is used for receiving while U37 contains the possible transmit messages.

The received interrogation for TCAS testing is decoded using discrete logic due to the time constraints involving the microprocessor. The Mode C and Mode S decode circuitry are clocked using a 20 MHz clock for 50 ns maximum jitter. Decoding either a valid Mode C or Mode S interrogation results in a reply for the interrogation mode. U18 through U27 are the ICs involved in this decoding process.

After either a Mode S or Mode C interrogation has been decoded, a range delay is inserted before a reply is transmitted. This time delay is variable and programmed by the microprocessor.

3.3.6 Battery Charger and Power Supply

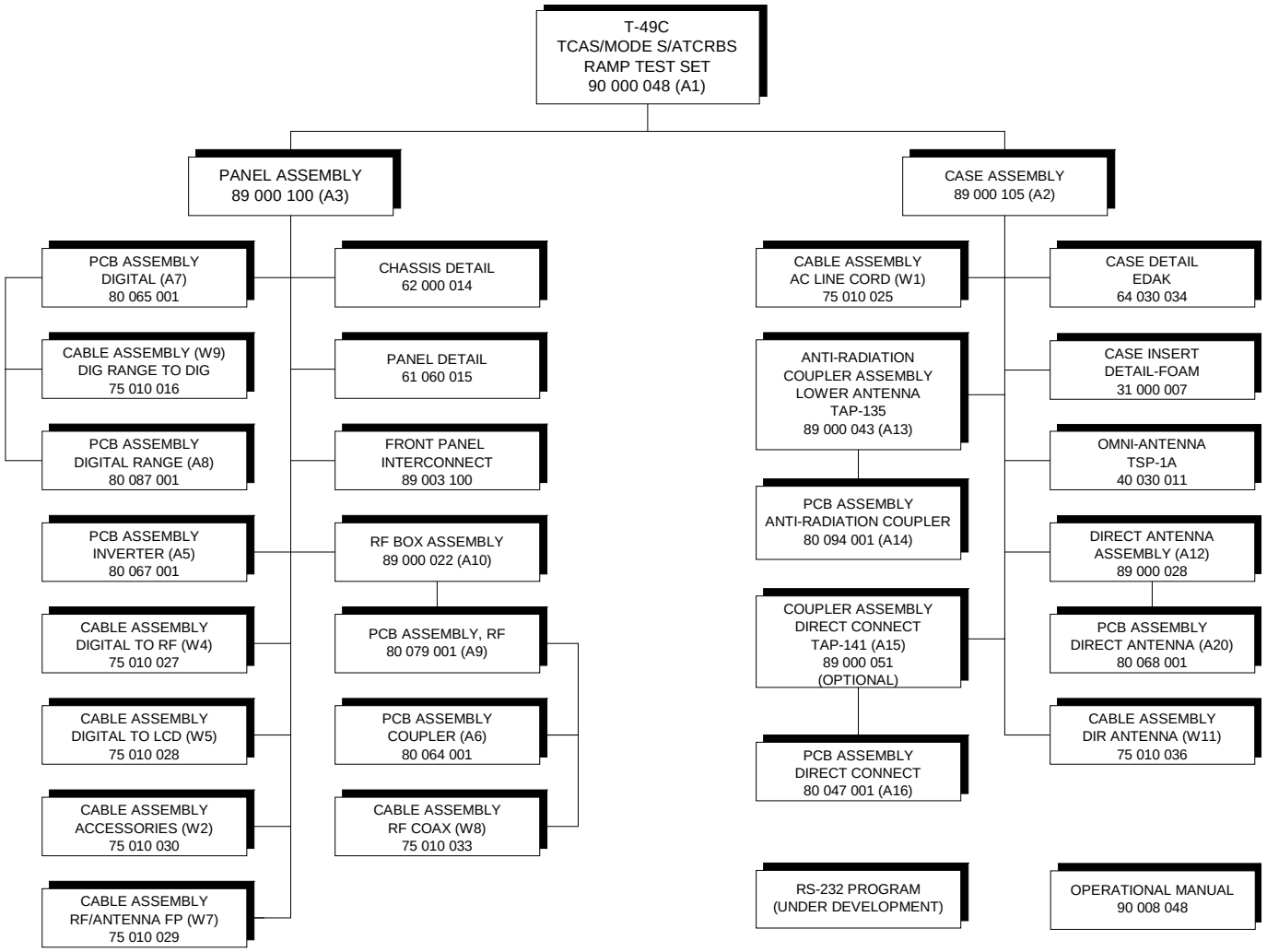
Power for the Test Set is supplied by a set of rechargeable Ni-Cad cells, B1. A battery charging circuit, capable of fully charging a depleted battery in 16 hours, is provided. Charging current level is only about half of that required to operate the Test Set. Operating the Test Set at 50% duty cycle, with the charger on, will result in a no net change in the state of charge of the battery.

The battery charger is a simple full wave bridge rectifier consisting of diodes CR4-CR7 with a series resistor for current limiting. The battery charger also supplies current to the front panel green LED indicator that will indicate that the battery charger is operating. The power supply control circuits are located on the digital board.

The Test Set is provided with two DC fuses, F1 and F2 both of which are located behind the front panel in the return line of the battery. This is done so that if a tool touches the fuse holders during assembly or disassembly or when removing the fuses, it will not result in a short across the battery. The Ni-Cad battery is capable of providing very large peak energy and a direct short across the battery could result in damage to the interconnecting wires.

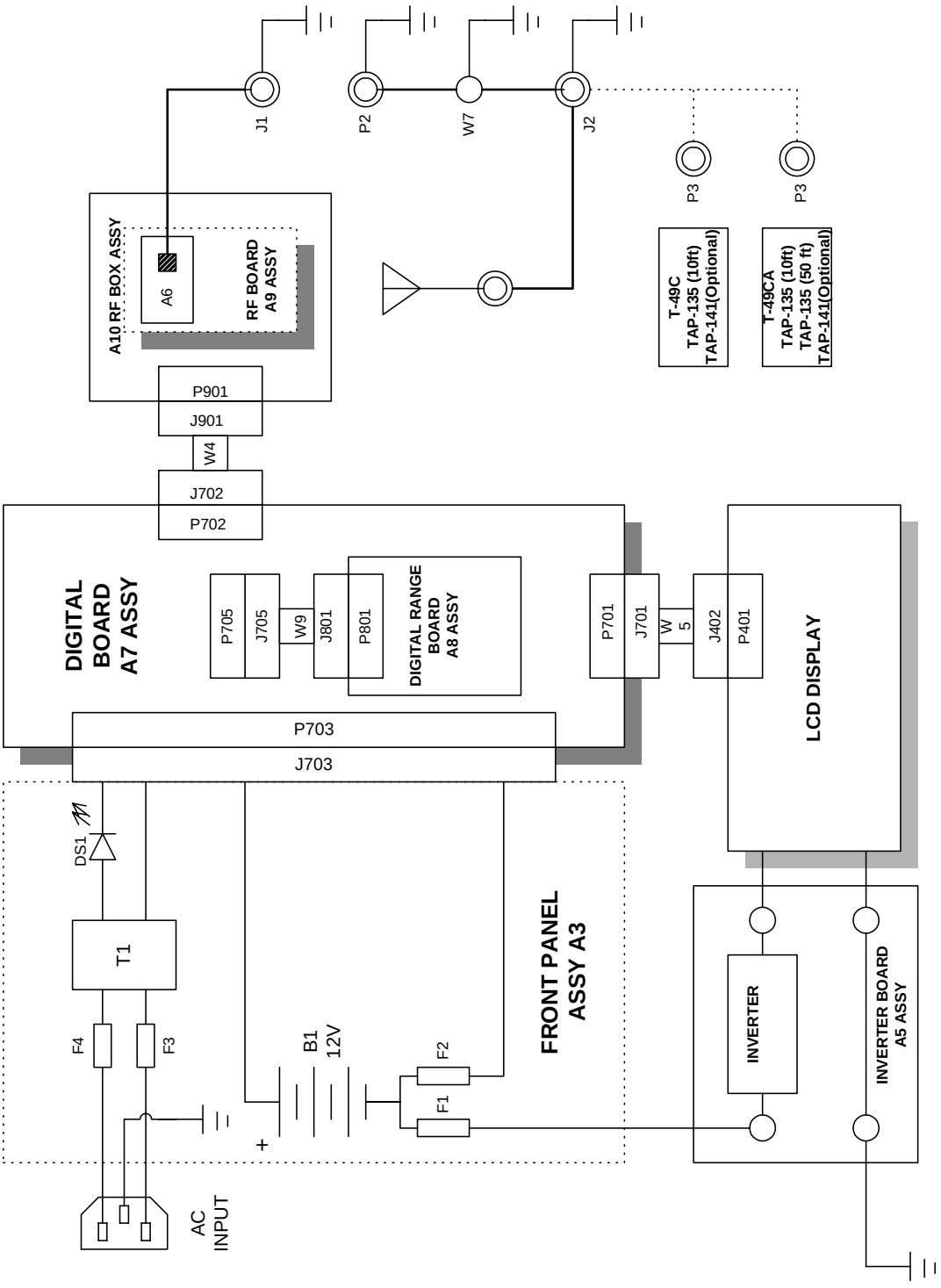
The battery charger has a separate fuse so that if the battery fuse is open, the unit will not operate on the battery charger voltage that is uncontrolled and is capable of causing damage to the unit. The unit is provided with a dual primary transformer T1 for operation at supply voltages of 110 VAC. Two line voltage fuses F3 and F4 are provided for protection. An inverter located on inverter board A5 provides 70 VRMS, 400 Hz power for the LCD backlighting.

All positive operating voltages for the test set are derived from linear integrated circuit regulators U56 and U55. A switching regulator, U51, is provided to supply -10 volts for those circuits requiring a negative supply voltage. A 900 second timer circuit automatically shuts-off the unit. The output is fed to 4096 counter U17 that in turn shuts the unit off if the time has expired. The LIGHTS/OFF front panel switch may be used to force the unit to off before the 200-second period has elapsed. The integrated circuit, U21, provides interfacing for the RS-232 connector. This circuit provides -9VDC for this interface.



T-49C Configuration Chart

Figure 3-1



T-49C/CA Simplified Block Diagram

Figure 3-2