T-49/T-49C/T-49CF

TCAS/TRANSPONDER

RAMP TEST SET

OPERATING AND MAINTENANCE INSTRUCTION MANUAL

18 JULY 00
REV T

WARRANTY

The Tel-Instrument Electronics Corporation warrants each new product manufactured by it to be free from defective material and workmanship and agrees to remedy any such defect of its manufacture which under normal installation, use and service discloses such defect This warranty requires the unit is delivered by the owner to Tel intact for examination, with all transportation charges prepaid to the factory, within two years from the date of sale to original purchaser and provided such examination discloses, in Tel's judgment, that it is thus defective This warranty does not include batteries (NiCad batteries have a 90-day warranty).

This warranty does not extend to any of Tel products which have been subjected to misuse, neglect, accident, incorrect wiring not our own, improper installation, or to use in violation of instructions furnished by us, nor extend to units which have been repaired or altered outside of our factory, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used herewith 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 no representative or person is authorized to assume for us any other liability in connection with the sale of Tel's products

ADDITIONAL INFORMATION with regard to the applications and maintenance of this equipment will be available from time to time. Users of our instruments are urged to discuss their problems with us and to suggest such modifications as might make them more adaptable to their special requirements

T-49/T-49C/T-49CF RECORD OF CHANGES

Date	REV	ECO	Page	Description
8-13-96	H		2-13	Add diversity and vertical status bit
8-13-96	H		2-9,2-15,2-17	Par 2a,2b, Par 2a,2b; Par 2 typo corrected
8-13-96	H		2-17	Add Note· TCAS Testing
8-13-96	H		4-1, Appendix A	Change calibration test to annual
9-23-96	I		C-1 Appendix C	RS -232 syntax command clarified
9-23-96	I		1-2	Add description of Mode A/C reporting, (last paragraph)
9-23-96	I		1-5	Add +/- 10K ft constant altitude scenario
12-17-96	J		E-4	TAP 131 Antenna Coupler added for Power, Frequency, and Sensitivity measurements
2-3-97	K			Models T-49/T-49C/T-49CF manuals merged to cover all three units
2-3-97	K		1-2	Syntax error corrected
4-17-97	L		E-5	TAP-131 Antenna Coupler used with blade antenna
4-3-98	M	1450	Section 5	Program memory change
5-13-98	N	1463	Fig. 5-2 & 5-2A, & 6-15	SA602AN Replaces NE602N
6-5-98	O	1464	Fig 5-8A, 6-10A 6-11A, 6-12A	U37 FIFO Chip Replacement
3-3-99	P		4-9	Correct Test Procedure (Remove Note and Step h)
3-18-99	Q		4-3; 4-8	Remove 1KHz from 5. d ; Remove 300mV from 6 c
6-1-00	R		2-6, Appendix F	Add- Battery Replacement Procedure
6-9-00	S		1-1, 2-2, 2-21, 2-23, 2-25	T-49CF Altitude Select
7-18-00	T		1-7, 2-2, 2-5, 2-19, 2-20, 2-21, 2-25	Change T-49CF part number to 90 000 074 Adjust auto shut-off time. General corrections and improved formatting on entire document

T-49/T-49CF OPERATING AND MAINTENANCE INSTRUCTION MANUAL

TABLE OF CONTENTS

SECTION 3 THEORY OF OPERATION

SECTION 4 TEST, CALIBRATION, AND MAINTENANCE

SECTION 5 SCHEMATICS

SECTION 6 PARTS BREAKDOWN

APPENDIXES

SECTION 1

GENERAL INFORMATION

1-1 Description

This manual provides operating instructions for the T-49, T-49C, and the T-49CF test sets The T-49C and T-49CF incorporates TCAS certification scenarios recommended by the OEM's and Airframes Throughout this manual, T-49 will refer to the T-49, T-49C, and the T-49CF unless otherwise noted.

The T-49 tests airborne ATCRBS (Mode A/C) and Mode S transponders and TCAS I/II systems. It is a self-contained battery-operated test set that requires no direct hardwire connection to the equipment under test. The test set receives and radiates signals to the units under test (UUT) from an antenna. For Mode-S and ATCRBS, an antenna coupler unit is provided to measure transponder transmitter power, frequency, receiver sensitivity, and diversity operation

For ATCRBS (Mode A/C) and Mode-S transponder testing, the T-49 test set simulates a secondary radar, radiates an interrogation (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 UUT replies, both (Mode A/C) ATCRBS and Mode-S, to insure that they are the correct reply for the interrogation

For TCAS testing, the T-49 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 unrequested third party reply transmissions are also provided

When the T-49 intruder type switch is set to ATCRBS (Mode A/C) the unit responds to ATCRBS Mode C interrogations A varying delay time, controlled from the microprocessor, delays the replies returned to the TCAS from as far as 14 nautical miles and as close as a few hundred feet The apparent distance from the simulated intruder to the TCAS system under test decreases as if the intruder was converging on the aircraft under test. The test set determines the altitude of the aircraft under test by interrogating the Mode-S transponder, using an ATCRBS-C Mode-S All Call interrogation. The T-49CF permits the manual entry of AUT altitude from the front panel. By adding or subtracting the desired differential altitude, as selected by the front-panel scenario switch, the initial altitude of the scenario is controlled by the microprocessor This altitude, like the distance, is varied so that the simulated intruder converges on the aircraft's position.

In the ATCRBS (Mode A/C) intruder test, the T-49 receiver is designed to behave exactly as an ATCRBS/Mode A/C transponder so that the replies to the TCAS "whisper-shout" interrogations result in, typically, one to three replies per TCAS interrogation sequence.

When the T-49 intruder type is set to Mode S, the T-49 will only respond to Mode S interrogations. In addition to replies, the T-49 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 T-49 intruder's address may be obtained from downlink format 11 or 4, 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 T-49 simulated intruder.

If the T-49 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 T-49 intruder. The T-49 test set computes and reduces the time delay (and altitude offset) in order to simulate a converging track.

When the intruder type scenario switch is set to TCAS, the T-49 provides squitters and replies to third party Mode-S interrogations, as it did in the Mode-S intruder mode. In this case, the TCAS system may using, from the proper interrogations, that the simulated intruder is TCAS equipped and is capable of communicating with extended length messages.

When in the TCAS intruder mode, the address used for the T-49 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 T-49 address will be forced to be the lower address for all cases.

When simulating an intruder, the T-49, with the desired antenna attached, is placed in sight of both the Mode-S and either the lower or upper TCAS antennae. Generally, the directional antenna should be used for TCAS testing and the omni antenna should be used for transponder tests. The directional antenna and the antenna coupler can also be used for transponder testing.

The optimum distance for the omni antenna should be between 50 to 100 feet, while the directional antenna is suited for distances up to 300 feet. Many users will not find the directional antenna necessary for transponder testing, but some situations, especially those involving multipath reflections, will benefit from the directional antenna. The directional antenna will also allow the test to be performed from a greater distance and would expand the choices of locations where both the TCAS and Mode-S antennae are in sight.

To run a scenario, the intruder type and scenario select switches are set to the desired positions followed by the momentary press of the interrogate push-switch. A second press of the interrogate push-switch will begin the scenario which will run until the test sequence is completed.

The original (thru serial #327) T-49 test set is equipped with a fixed distance intruder simulation which will allow the testing of the TCAS directional antenna. The simulated intruder, at the fixed position from the TCAS has an optional altitude of either 1000 feet above or 1000 feet below, as set by the scenario select switch and the associated toggle switch. The new T-49C and T-49CF scenarios can be stopped and re-started at operator selected range and altitude offsets The fixed scenario is ideal for verifying the bearing accuracy of the TCAS directional antenna By selecting the fixed scenario and positioning the T-49 at various bearings around the aircraft, the bearing accuracy of the TCAS antenna can be verified by the indicators in the cockpit This test is most effectively performed in an area free of buildings, equipment, and other aircraft, to prevent excessive multipath interference

1-2 Definition Of Terms

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 a ATCRBS or Mode S transponder This information is obtained from an external sensor and transmitted to the transponder.
ATCRBS	Air Traffic Control Radar Beacon System The original non-selective secondary radar beacon system using the usual two-pulse interrogation and an auxiliary SLS pulse.
Comm	Refers to the communication and data-link capability of a Mode-S transponder There are four 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 Mode-S.
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.
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.
Mode S All-Call	An interrogation that causes all Mode-S transponders to repiy

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 identification 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-49 and T-49C is ATCRBS and on the T-49CF is Mode A/C
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 sidelobes
Squitter	The self-generated transmissions made by a Mode S transponder, not in reply to an interrogation, for the use of collision avoidance systems
Surveillance Alt.	An interrogation that causes only the addressed Mode S transponder to reply with its altitude
Surveillance, ID.	An interrogation that causes only the addressed Mode S transponder to reply with its "4096" code.
UF	Uplink format. The format in a Mode S interrogation that indicates the type of reply expected
"4096" Code	This refers to the octal number dialed into either a ATCRBS Mode A or Mode S transponder by the pilot or other crew member. This is to be distinguished from the address of a Mode S transponder which cannot be changed by front panel switches

Further definitions may be found in the following reference documents

(1) RTCA Document DO-181, Minimum Operational Performance Standards for Air Traffic Control Beacon System/Mode Select Airborne Equipment March 1983.

(2) Modern Aviation Electronics, A. D Helfrick, Englewood Cliffs, NJ Prentice Hall, Inc

(3) Federal Register, Feb. 3, 1987 FAA rules part 91. FAA Advisory Circular number 20-131,10/3/88, Airworthiness and Operations Approval of Traffic Alert and Collision Avoidance Systems (TCAS II) and Mode-S Transponders.

1-3 Regulatory Responsibilities

Effective April 6, 1987, The Federal Aviation Administration (FAA) has required certain testing to be performed on transponders, both the conventional ATCRBS and Mode-S. In preparation for the installation of new air traffic control radar facilities, the FAA required new measurements to be performed on existing transponders and instituted the required tests for Mode-S transponders. FAR Part 43, Maintenance, Preventive Maintenance, Rebuilding, and Alteration section has been modified to require ATCRBS transponders to be interrogated at a rate of 235 interrogations per second and checked for an output frequency of 1090 MHz +/- 3MHz, SLS suppression, receiver sensitivity; and RF power output for both upper and lower limits.

For the case of non-diversity Mode-S transponders, the following tests must be made at an interrogation rate of 50 interrogations per second with the following requirements: output frequency 1090 MHz +/- 1MHz (+/- 3MHz for class 1B, 2B and 3B); SLS suppression, receiver sensitivity, power output for both high and low limit, surveillance format (UF =4/UF = 5) for consistency with ATCRBS Mode A and C transponders, all-call modes, and squitter transmissions

1-4 Specifications

Transmitter

Frequencies	1030 MHz & 1090 MHz +/-10KHz
Output power high/low	+10dBm/-10dBm
Pulse amplitude on/off ratio	greater than 60 dB
DPSK accuracy	180 +/-22 deg.
DPSK amplitude modulation	less than 10%

Receiver

Frequencies	1030 MHz & 1090 MHz
Sensitivity	-15 dBm

Transponder Tests

Receiver Sensitivity*	-65 to -88dBm +/-2dB
Radiated Power*	10 to 500 watts +/-2dB
Frequency*	+/- 5 MHz +/-100kHz
Reply Efficiency	0 to 99 +/-1%

* These measurements require the antenna coupler installed on the UUT antenna.

T-49 TCAS Test Scenarios

	A-upper	A-lower	B	C	D
Start range	4 nmi	4 nmi	14 nmi	14 nmi	14 nmi
End range	4 nmi	4 nmi	0 nmi	0 nmi	0 nmi
Range Rate	0 kts	0 kts	450 kts	900 kts	720 kts
Start Altitude	+1000 ft	-1000 ft	+3500 ft	-2000 ft	0 ft
End Altitude	+1000 ft.	-1000 ft	0 ft.	0 ft	0 ft

T-49 C TCAS Test Scenarios

	Constant altitude	Constant altitude	*Constant altitude	Co-altitude	Closing altitude
Start/end range	14 nmi	14 nmi	14 nmi	14 nmi	14 nmi
Min. Separation	0 nmi	0 nmi	0 nmi	0 nmi	0 nmi
Range Rate	300 kts	300 kts	300 kts	300 kts	300 kts
Start Altitude	+200/-200 ft	+4000/-4000 ft	+10K/-10K ft	0 ft	+3500/-3500 ft
End Altitude	+200/-200 ft	+4000/-4000 ft.	+10K/-10K ft	0 ft.	0 ft

* T-49CF adds this scenario

Physical

Packaging	MIL-T-28800
Temperature, operating	-30 to +50 degrees C
Size	14 5 x 9 4 x 6 5 inches
Weight	19 0 pounds with line cord, antenna coupler, omni and directional antennas installed
Battery life	8 hours minimum at 50% duty cycle
Antennas	detachable dipole

1-5 Equipment and Accessories Supplied

The following equipment and accessories are supplied with the T-49

Description	P/N
Test Set T-49	90 000 027
Test Set T-49C	90 000 048
Test Set T-49CF	90 000 074
AC Line Cord	75 010 025
Omni Antenna (TSP-1A)	40 030 009
Directional Antenna	89 000 028
Antenna Coupler (T-49) TAP-115	90 000 038
Diversity Coupler (T-49C) TAP-125 Lower	89 000 043
Antenna Coupler (T-49CF) TAP-131	89 000 065
Floppy Disk T-49	43 008 002
Floppy Disk T-49C	43 008 012
Instruction Manual	
Direct Connect Coupler (T-49CF only) TAP-121	89 000 051

The following optional accessories are also available

Description	P/N
Anti-Radiation Coupler, TAP-125	
Lower Antenna	89 000 043
Upper Antenna	89 000 044
Direct Connect Coupler TAP-121	89 000 051

SECTION 2

PREPARATION FOR USE AND OPERATION

2-1 Operating Controls

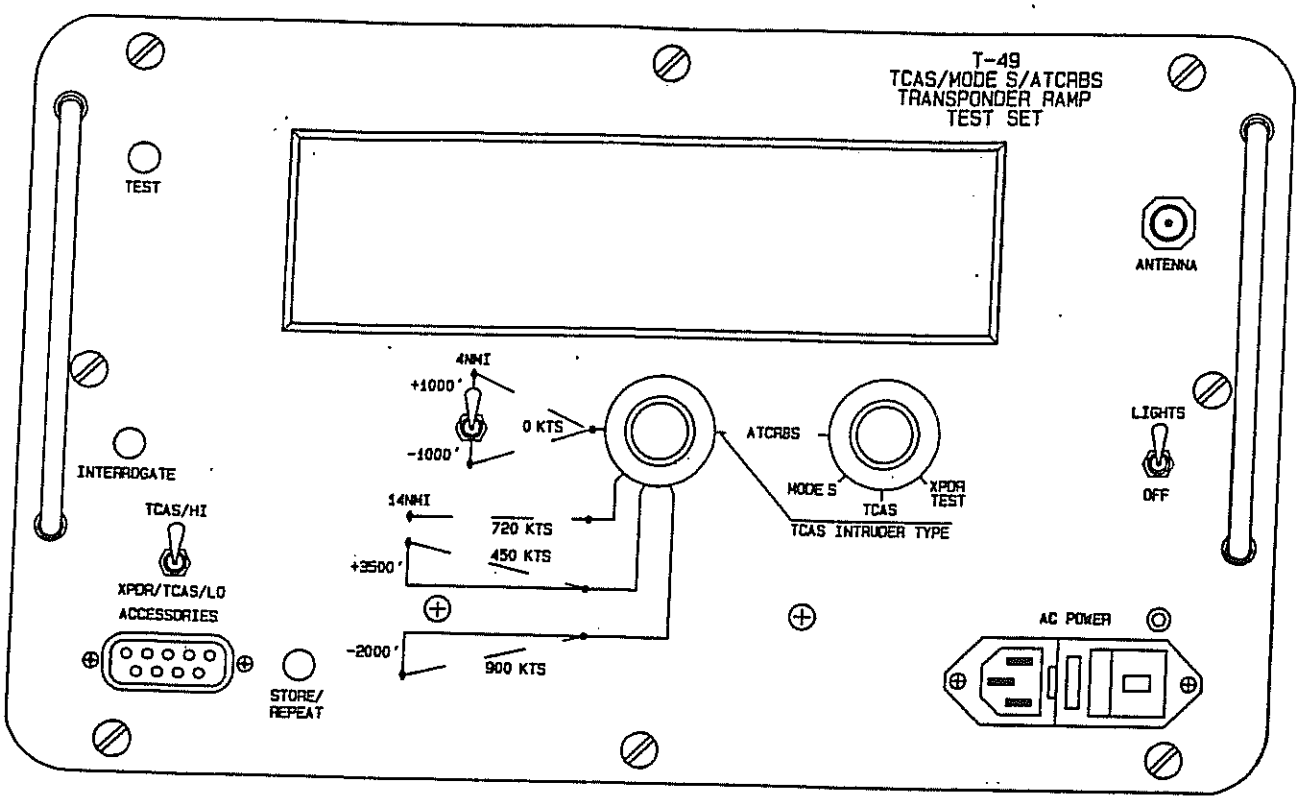
All operating controls and displays for the T-49 are located on the front panel as shown in Figure 2-1 Table 2-1 lists each front panel item and describes its purpose.

Table 2-1

Operation Control Functions

DATA DISPLAY WINDOW	Alpha numeric display (two line, 20 character) provides operational instructions, error messages, scenario progress, and test data
ANTENNA CONNECTOR	Connector for omni-directional dipole antenna, directional antenna and antenna coupler
POWER OFF AND DATA DISPLAY CONTROL	When pressed to OFF, de-energizes the test set When pressed and held at LIGHTS, provides back-lighting to the data display when the unit is on.
AC POWER INDICATOR	Red LED on when battery is charging.
VOLTAGE CHANGE/ FUSE CARTRIDGE	Manual pull-out permits use of either 110 VAC or 220 VAC for battery charging The unit is factory wired for operation on 110 VAC. For 220 VAC operation, a wiring change is necessary
AC POWER SWITCH	AC power On-Off Switch for battery charging
AC POWER CONNECTOR	Receptacle for AC line cord (supplied)
INTERROGATE SWITCH	Initiates the complete test sequence for transponder tests when the Function Switch is at XPDR Test. Initiates selected Scenario when Function Switch is at TCAS, Mode-S, or ATCRBS (Mode A/C) position If test set is de-energized, this switch will turn it on. For the T-49CF, this switch also decreases the altitude when manually entering AUT altitude
TEST SWITCH	Allows individual tests to be run and displayed Each press of the TEST switch advances to the next test of the series To repeat a test, press the Store/Repeat switch Pressing the TEST switch with the unit de-energized, causes the unit to activate and places the unit in the starting condition Pressing Test Switch for a

TEST SWITCH cont	T-49C and T-49CF TCAS scenario will stop the simulated intruder at the current range. Pressing Test Switch again starts the intruder at the current range. For the T-49CF, this switch also increases the altitude when manually entering AUT altitude
FUNCTION SWITCH	
XPDR	Interrogates ATCRBS and/or Mode-S transponder Performs pre-programmed test sequence which will continue unless a failure occurs (error message displayed) or until the test is completed successfully (relevant data displayed).
TCAS	Simulates approach of a TCAS equipped intruder. Works with scenario selector to provide different intruder scenarios Theparameters for each scenario are screened on the front panel Provides Mode-S replies in response to Mode-S interrogations. Response to uplink format with a Mode-S reply which indicates simulated intruder is TCAS equipped. Also supplies Mode-S squitter transmissions and simulated replies, not in response to interrogations
MODE-S	Simulates approach of Mode-S equipped intruder Works with scenario selector as described under Function Switch (TCAS position). Provides Mode-S interrogations Also supplies Mode-S squitter transmissions and simulated replies, not in response to interrogations.
ATCRBS (T-49 & T-49C)	Simulates approach of an ATCRBS equipped intruder Works with scenario selector as noted under Function Switch (TCAS position)
Mode A/C (T-49CF)	Provides ATCRBS/C replies in response to valid ATCRBS/C interrogations.
SCENARIO SELECTOR	Simulates approach of intruder aircraft scenario. The altitude and closing speed for each scenario is screened on front panel The T-49 Fixed Scenario Selector selects a fixed intruder at 4nmi at +1000 ft or -1000 ft. relative altitude. The T-49C and T-49CF Altitude Offset Selector selects the positive or negative altitude offset for the scenario selected. Also note that the T-49C and T-49CF can stop (fixed intruder) and start any scenario in progress by pressing the Test Switch.
STORE/REPEAT SWITCH	Press after interrogate mode is completed to store test data in RAM These data can later be down loaded to a PC Press after test mode is completed to repeat the current test.
ACCESSORIES CONNECTOR	For connecting RS-232 communication link to computer other devices


T-49
TCAS/MODE S/ATCRBS
TRANSPONDER RAMP
TEST SET
TEST
ANTENNA
4NMI
+1000'
0 KTS
-1000'
ATCRBS
LIGHTS
INTERROGATE
14NMI
720 KTS
MODE S
XPDR TEST
OFF
TCAS/HI
+3500'
450 KTS
TCAS
TCAS INTRUDER TYPE
XPDR/TCAS/LO
ACCESSORIES
AC POWER
-2000'
900 KTS
STORE/
REPEAT

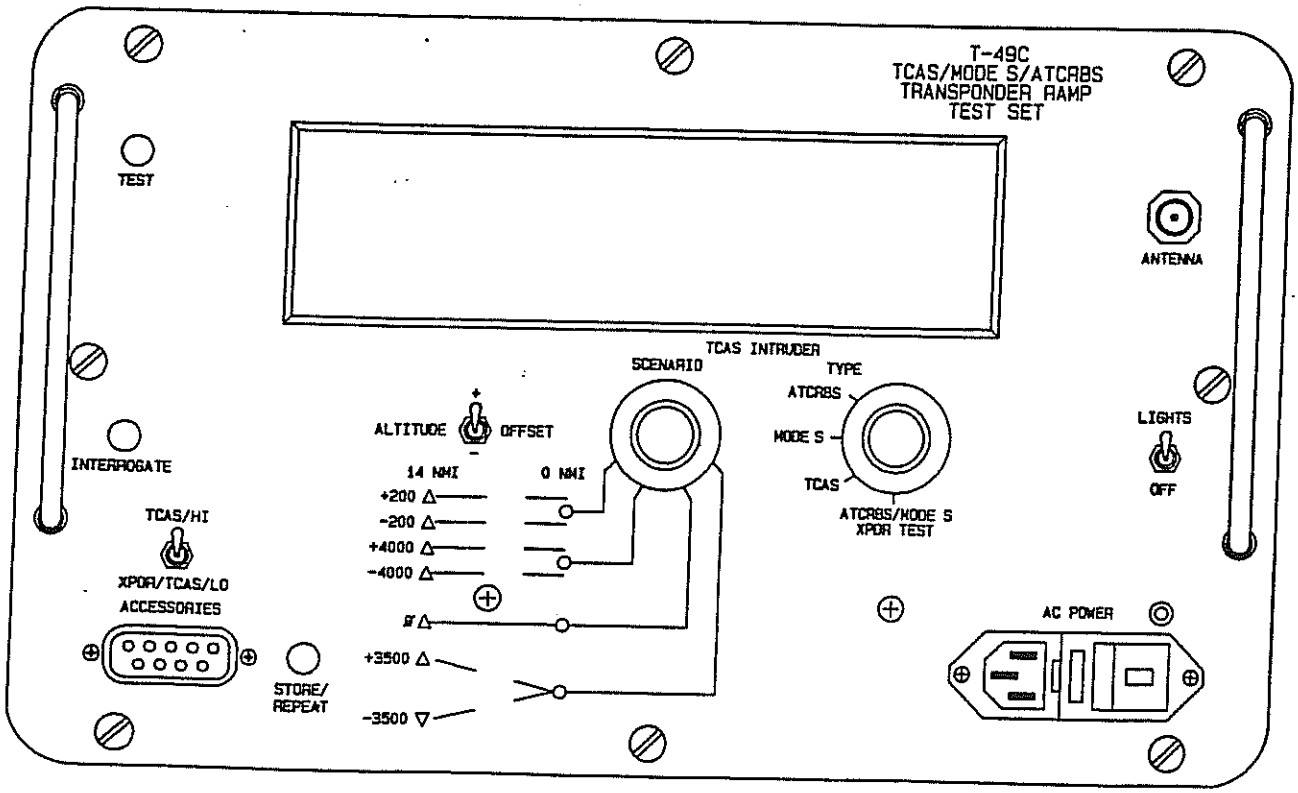

T-49C
TCAS/MODE S/ATCRBS
TRANSPONDER RAMP
TEST SET
TEST
ANTENNA
TCAS INTRUDER
SCENARIO
TYPE
ATCRBS
ALTITUDE
OFFSET
LIGHTS
INTERROGATE
14 NMI
0 NMI
MODE S
+200 Δ
-200 Δ
TCAS
OFF
TCAS/HI
+4000 Δ
-4000 Δ
ATCRBS/MODE S
XPDR TEST
XPDR/TCAS/LO
ACCESSORIES
AC POWER
+3500 Δ
STORE/
REPEAT
-3500 ▽

Figure 2-1

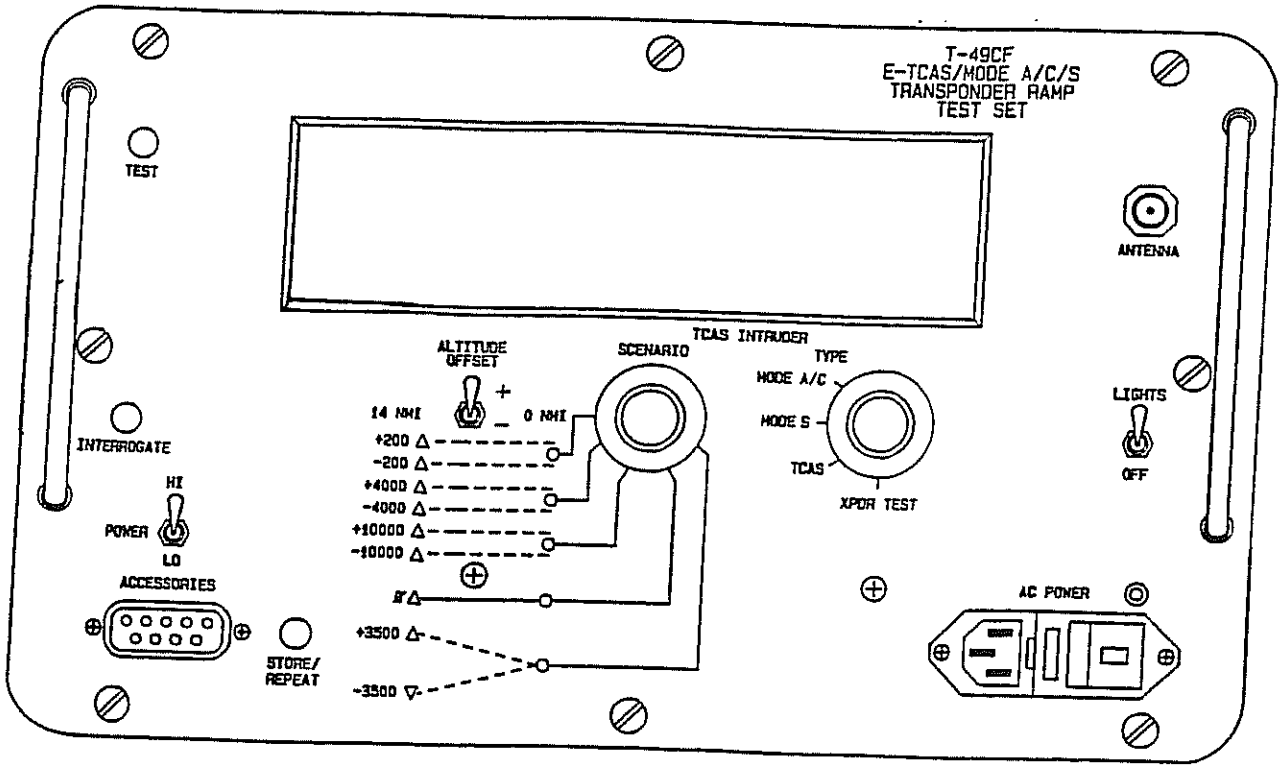


Figure 2-1 (continued)

2-2 Setup Procedure

The T-49 has been carefully checked and the batteries are fully charged when shipped from the factory. However, before attempting to use the unit, proceed as follows:

1. Carefully unpack the unit and inspect it for obvious signs of damage.

2. Release the two latches, open the cover, and check inside the cover for the following accessories:

    a. Line Cord
    b. Omni-Directional Dipole Antenna
    c. Directional Antenna
    d. The appropriate Antenna Coupler depending on the Test Set model

3. Check the front panel controls, data display window, and connectors for obvious signs of damage.

4. Select XPDR Test and press INTERROGATE Switch. Check the Data Display window for the following message:

    Tel-Instrument
    T-49 Rev. x.x*

    ***Note: The revision of the installed firmware will appear in this message in place of "x.x."**

    Immediately followed by:

    No Reply from XPDR.

5. Check if unit de-energized after about 15 minutes with no further use of unit.

2-3 Battery Operation And Charging

The rechargeable NI-Cad Battery in the test set is capable of operating the unit for about 8 hours at 25 degrees C, representing more than one week of typical testing. Operation at lower temperatures will result in somewhat less total operating time.

The unit may be operated with almost totally depleted batteries by plugging the AC line cord into a suitable AC power receptacle. However, the duty cycle of the test set should be held to less than 50% to allow a net increase in battery charge while the unit is in use.

NI-Cad batteries exhibit a self discharge phenomena which is temperature dependent and which can cause fully charged cells to become almost completely depleted in several weeks. For this reason, it is strongly recommended that the battery be charged for a short time once each week, regardless of the total time the test set has been in use. For maximum battery life, if the test set has been used heavily since that last charge, use a charge time of about up to 16 hours. A completely exhausted battery can be fully charged in 16 hours. Occasional 16 hour charges on

partially depleted cells will cause no damage. If it is determined that the battery has to be replaced, refer to instructions in Appendix F. To charge the battery proceed as follows.

1. Remove the power cord from inside the cover and attach it to the AC Power receptacle
2 Be sure the voltage change/fuse cartridge is set for the correct AC power to be used
3 Connect the power cord to an appropriate AC outlet.
4 Turn AC POWER Switch to the on position Verify charging by observing that the Red AC POWER lamp is lit.
5 After use, charge the battery to restore full operational capability The total time of recharging should be at least twice as long as the test set was operated since its last full charge, but a charge time of up to 16 hours will not damage the NI-Cad cells

2-4 Operation With Omni-Directional Antenna

The omni-directional antenna is fastened inside the case cover. This antenna provides a quick-test capability for ATCRBS (Mode A/C) and Mode- S equipment only Remove the dipole antenna from its mounting clips inside the cover and attach to the antenna connector

Perform the ATCRBS (Mode A/C) and Mode- S tests maintaining a 50 to 100 foot distance between the test set and the UUT antenna. Although the T-49 will perform equally well at any location around the aircraft, the following operating hints should be followed for best results

1 When operating the test set at a long distance from the transponder, be sure that the UUT is significantly closer to the test set than other nearby transponders. If the test set is closer to an active transponder in a non-target aircraft, the undesired transponder will reply and cause the test set to receive signals from the undesired transponder, or from both transponders, causing erroneous indications

2 Since DME and transponder antennas have similar appearance, make positive identification of transponder antenna to assume the 50 to 100 foot distance between the UUT and the test set

3 Some large aircraft have two transponder installations. Since only one system may operate at any time, always make positive identification of the active antenna before performing tests

2-5 Operation With Directional Antenna

The directional antenna is a printed circuit sandwiched between two opaque Lexan sheets and is hinged inside the case cover. It can be used for TCAS and for ATCRBS (Mode A/C) and Mode- S testing

1 Open and remove the T-49 case cover. Release the two black snap holders, fold down the directional antenna, and remove the line cord, the omni-directional dipole antenna, and the TAP Antenna Coupler from the cover

> Note In operation, the case cover functions as the antenna reflector This is why all accessories must be removed from the cover before use

2 Guide the directional antenna cable out of the case cover, fold the antenna into position in the case cover, re-engage the two snap holders, and attach the antenna cable connector to the Antenna Connector.

3 Locate a position that provides clear line-of-sight between the directional antenna and the transponder antenna on the aircraft with a 50 to 300 foot separation between the two antennas.

> Note Any obstructions (e.g. ladders, wheels, access panels, other equipment, etc) that interfere with the line-of-sight, will have an adverse effect on test performance

4 Point the directional antenna at the aircraft antenna, then perform the test.

2-6 Operation With Antenna Couplers

An antenna coupler is to be used when measuring the following transponder functions UUT transmitter power, frequency, and receiver sensitivity. Readings of these three functions are shown on the data display window, assuming all tests ran positively, as the last three blocks of the automatic interrogate scenario. If a coupler is not used, the last three scenario blocks appear blank Note that the coupler must be positioned on the proper antenna blade. To access the coupler

1 For the TAP-115, open the cover, detach the two snap holders, and fold down the directional antenna. Separate the Velcro-mounted TAP-115 coupler body from the cover Unwind the coupler cable.

   a Visually check the FWD-AFT orientation and then slide the antenna coupler over the transponder blade antenna Make sure the screened information on the TAP-115 is toward the aircraft surface.

   b Connect the antenna coupler connector to the antenna jack

2 For the TAP-125, remove from carrying case and unwind the coupler cables.

a Refer to Appendix E for operation procedures.

3 For the TAP-131 refer to Appendix E for operation procedures

2-7 Operation With Direct Connect Couplers

The TAP-121 provides the capability to hard wire the Mode-S transponder to the test set through supplying a calibrated attenuation path and also protects the test set from the high power output of the transponder.

The coupler is labeled as to which end is connected to the test set and which end is connected to the transponder If this is not observed or the transponder is connected directly to the test set without the coupler, the coupler and test set will require repair and calibration

With the transponder connected to the coupler which is connected to the test set, all tests including UUT power, frequency, sensitivity and diversity may be performed

2-8 Transponder Testing Overview

The display of data at the end of the interrogation mode indicates that all tests have passed the criteria in Appendix A of this manual. Three data sets are displayed The 4096 code, the Mode S address or registration number of the aircraft, and the reported pressure altitude

Note: For aircraft having Mode-S addresses within the block of addressed assigned to civilian US aircraft, the registration number of the aircraft will be displayed For non-US and military aircraft the Mode-S address will appear as hexadecimal, preceded by the letter N. If hexadecimal Mode-S address is displayed in the INTERROGATION Test Switch mode for a US civil aircraft, this is an indication of an incorrectly wired transponder. In the TEST Switch mode, all Mode-S transponder addresses will be displayed in hexadecimal.

2-9 Performing Individual Tests

When range testing a transponder, pressing the Interrogate Switch starts the interrogate mode which is a complete sequence of tests ending in the display of measured data These data must be interpreted relative to the class of transponder installed in the aircraft to assure complete compliance to the applicable regulations. If a failure exists, the test is automatically stopped at the point of failure because subsequent tests may not be reliable As an example, if a transponder does not reply to a Mode-S all-call, surveillance tests are not possible because the Mode-S address obtained during the all-call test is used as the interrogating address during the Mode-S surveillance testing

The INTERROGATE mode does not display the results of the individual test and, as long as the tests performed are passed, the sequence of test will continue to completion The intermediate results are available by initiating the tests using the Test Switch After each test, the results are displayed To advance to the next test, press the Test Switch. To repeat the current test, press the Store/Repeat Switch

There are two functions available in the TEST mode which are not available in the INTERROGATE mode. The first is the testing of the IDENT Switch of the transponder Select the ATCRBS/A test and repeat it using the Store/Repeat switch Then push the IDENT switch on the transponder and the T-49 will display IDENT in the upper right corner of the display The second function available is the maximum true airspeed data of the transponder This test is found at the end of the test mode. Also, for theT-49C and T-49CF, a test of the vertical status (weight on wheels) of a Mode-S transponder is done.

Table 2-2 shows the display during the performance of a Mode-S transponder test with a typical display of the results. If the UUT were to fail the test, as per the requirements of Appendix A, the displayed results would be "FAIL " Table 2-3 shows typical displays for a ATCRBS (Mode A/C) transponder

The final data display in the TEST mode is similar to the final display of the INTERROGATION mode The one exception, however, is the Mode-S address which lists the Mode-S address in hexadecimal Because there is no simple correlation between registration number and the Mode-S address, the hexadecimal Mode-S address is required to determine a mis-wired Mode-S unit

Table 2-2

Typical Displays For Individual Sequence Of Mode-S Transponder Tests

ATCRBS/A and Mode A	ATCRBS/A 1234 100% Reply
MODE 3A (T-49CF only)	MODE 3A 1234 100 % Reply
ATCRBS/C and Mode C	ATCRBS/C 10,500 Ft 100% Reply
MODE 3C (T-49CF only)	MODE 3C 1234 100 % Reply
ATCRBS/A Mode S All	ATCRBS/A Mode S All 148DC 3 100% Reply
MODE 3A/Mode S All (T-49CF only)	MODE 3A/Mode S All 148DC3 100% Reply

ATCRBS/C Mode S All	ATCRBS/C Mode S All 148DC 3 100% Reply
MODE 3C/Mode S All (T-49CF only)	MODE 3C/Mode S All 148DC 3 100% Reply
ATCRBS/A Only	ATCRBS/A Only No Reply from XPDR
MODE 3A Only (T-49CF only)	MODE 3A Only No Reply from XPDR
ATCRBS/C Only	ATCRBS/C Only No Reply from XPDR
MODE 3C Only (T-49CF only)	MODE 3C Only No Reply from XPDR
MODE S SURV IDENTITY	***** No display *****
MODE S SURV ALTITUDE	***** No display *****
MODE S SURV SHORT	Mode S Surv 100% Reply 148DC 3 10,500 Ft
UNDESIRED REPLIES	Undesired Replies No Replies
SQUITTER	Squitter Pass
DIVERSITY	Diversity Pass
MAX. TRUE AIRSPEED	MAX. TRUE AIRSPEED GT 75 & LE 150 KTS
VERTICAL STATUS (T-49C/T-49CF ONLY)	Vertical Status bit VS=1
POWER, Rcvr & Freq	395W -72dBm +0.1MHz
POWER, Rcvr & Freq (T-49CF only)	57dBM -72dBm +0 1MHz

Table 2-3

Typical Displays For Individual Sequence Of ATCRBS (Mode A/C) Transponder Tests

ATCRBS/A (Mode A)	ATCRBS/A 1234	100% Reply
ATCRBS/C (Mode C)	ATCRBS/C 10,500 Ft	100% Reply

2-10 Transponder Testing

Figure 2-2 shows the sequence of tests automatically performed when the INTERROGATE Switch is pressed The sequence will continue as long as normal indications are received for each test If abnormal results are obtained for a test, sequencing will stop and FAIL message will be displayed To continue testing after a FAIL message, the operator must press the TEST Switch to manually single step through each test. When single-stepping in the Test mode, detailed information describing the nature of the FAIL will be displayed in the data display window Figure 2-3 shows the TEST stepping sequence Table 2-4 outlines the procedure for testing operation of an ATCRBS (Mode A/C) transponder and Table 2-5 for a Mode-S Transponder

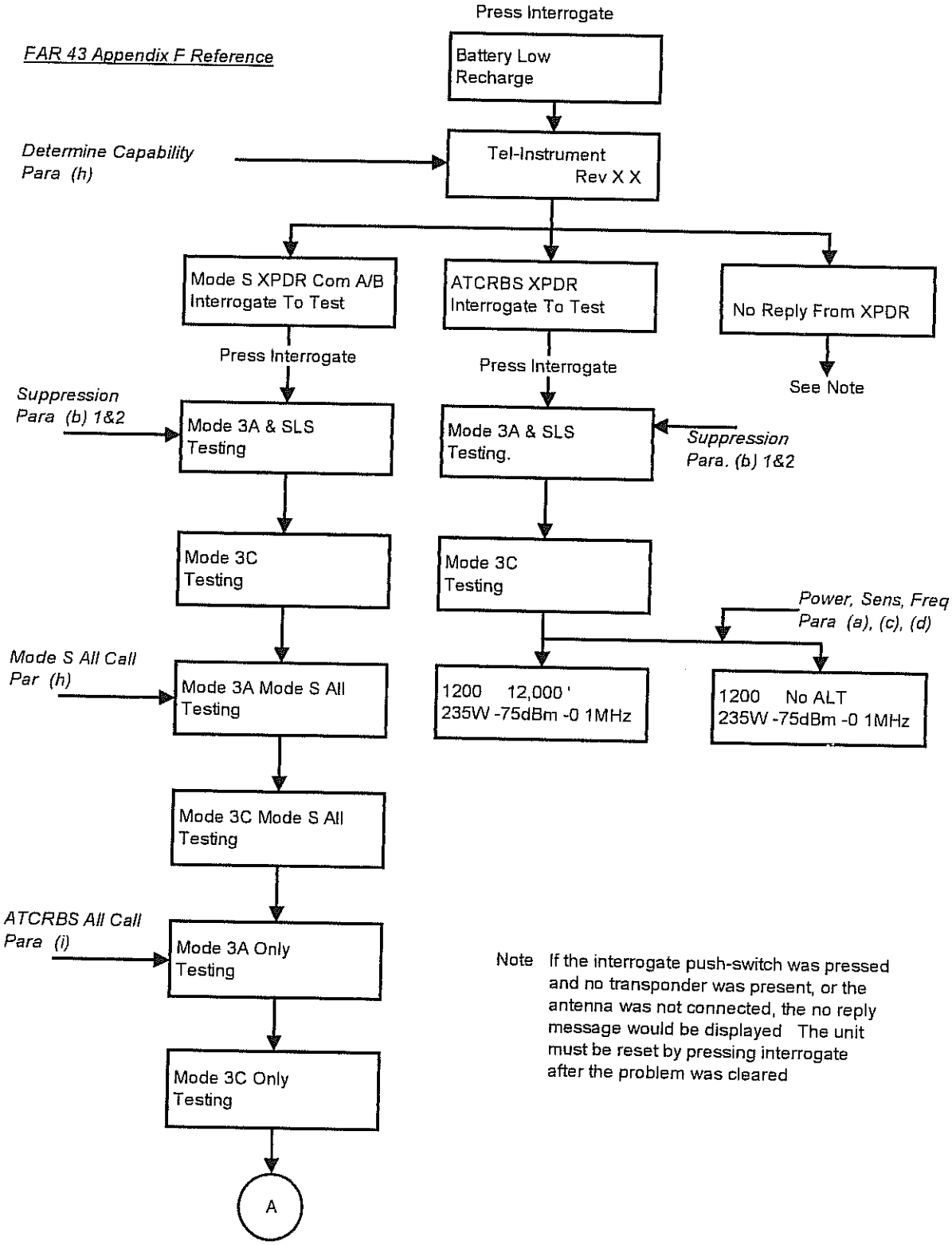


Figure 2-2A
INTERROGATE Switch Operational Flow Chart

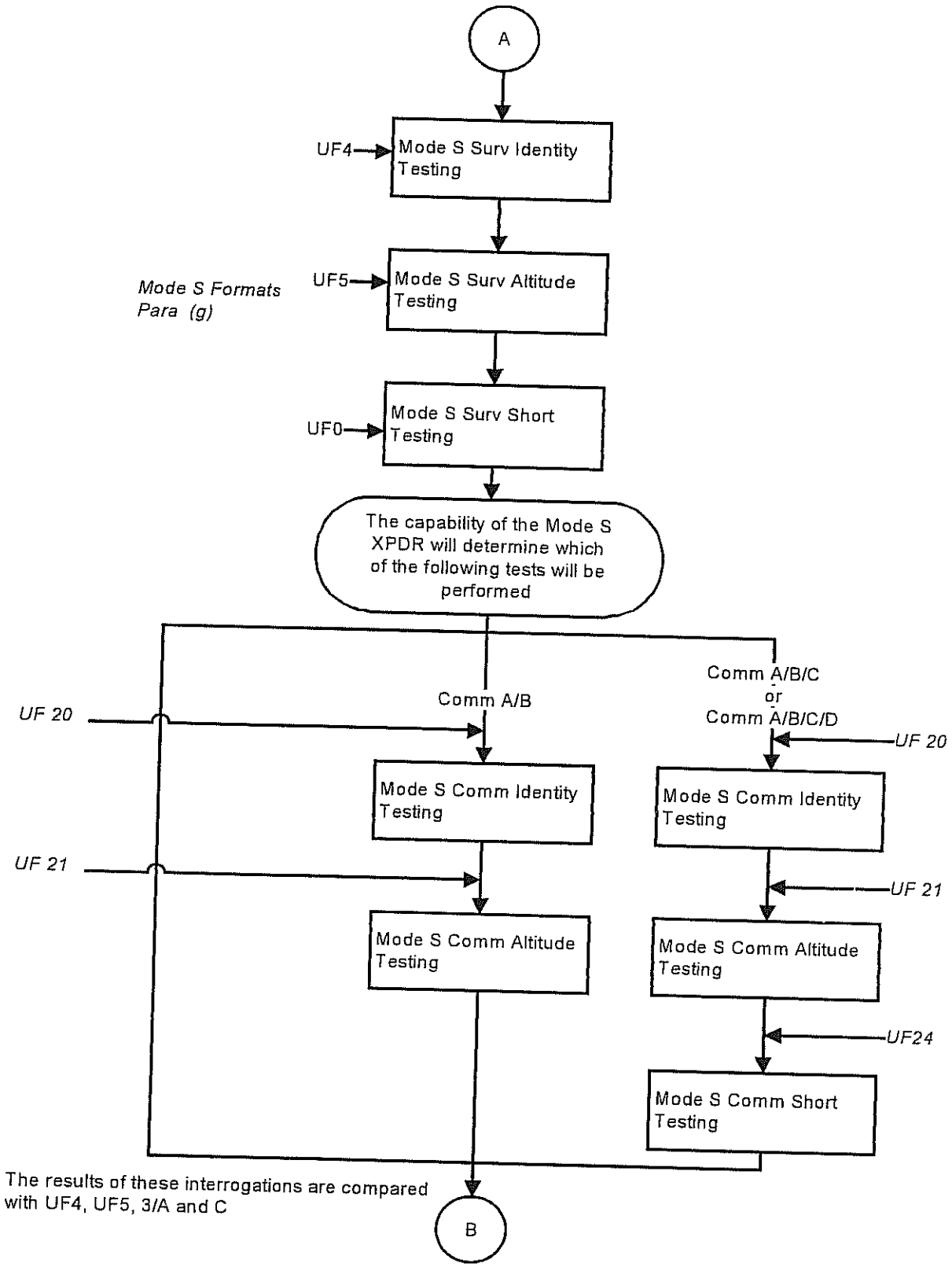


Figure 2-2B
INTERROGATE Switch Operational Flow Chart

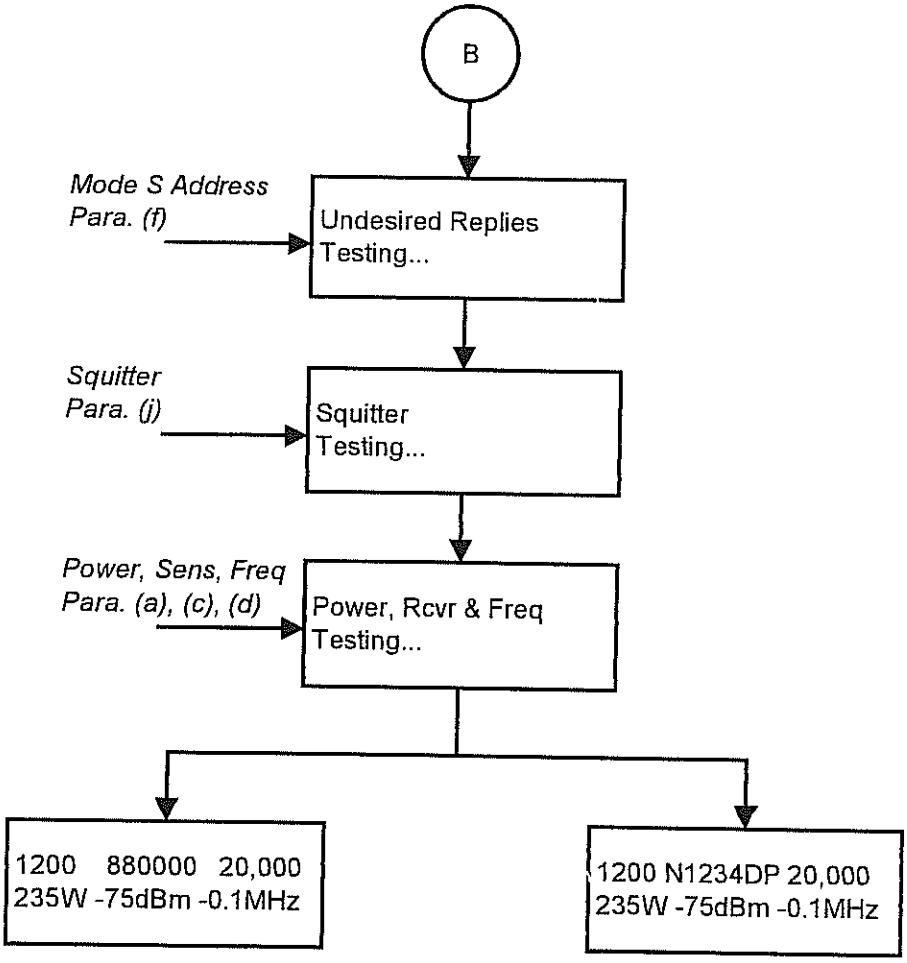


Figure 2-2C
INTERROGATE Switch Operational Flow Chart

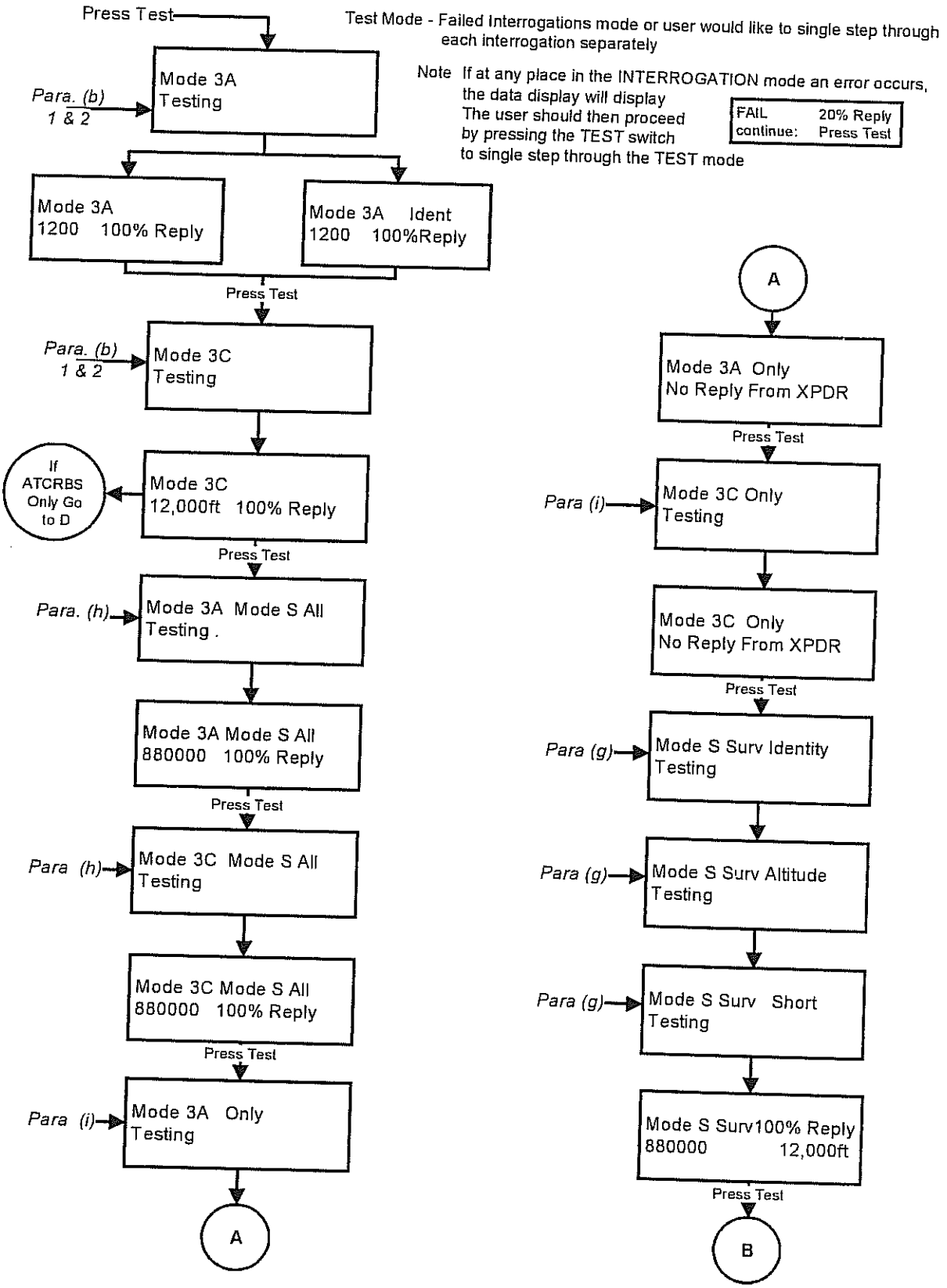


Figure 2-3A
TEST Switch Operational Flow Chart

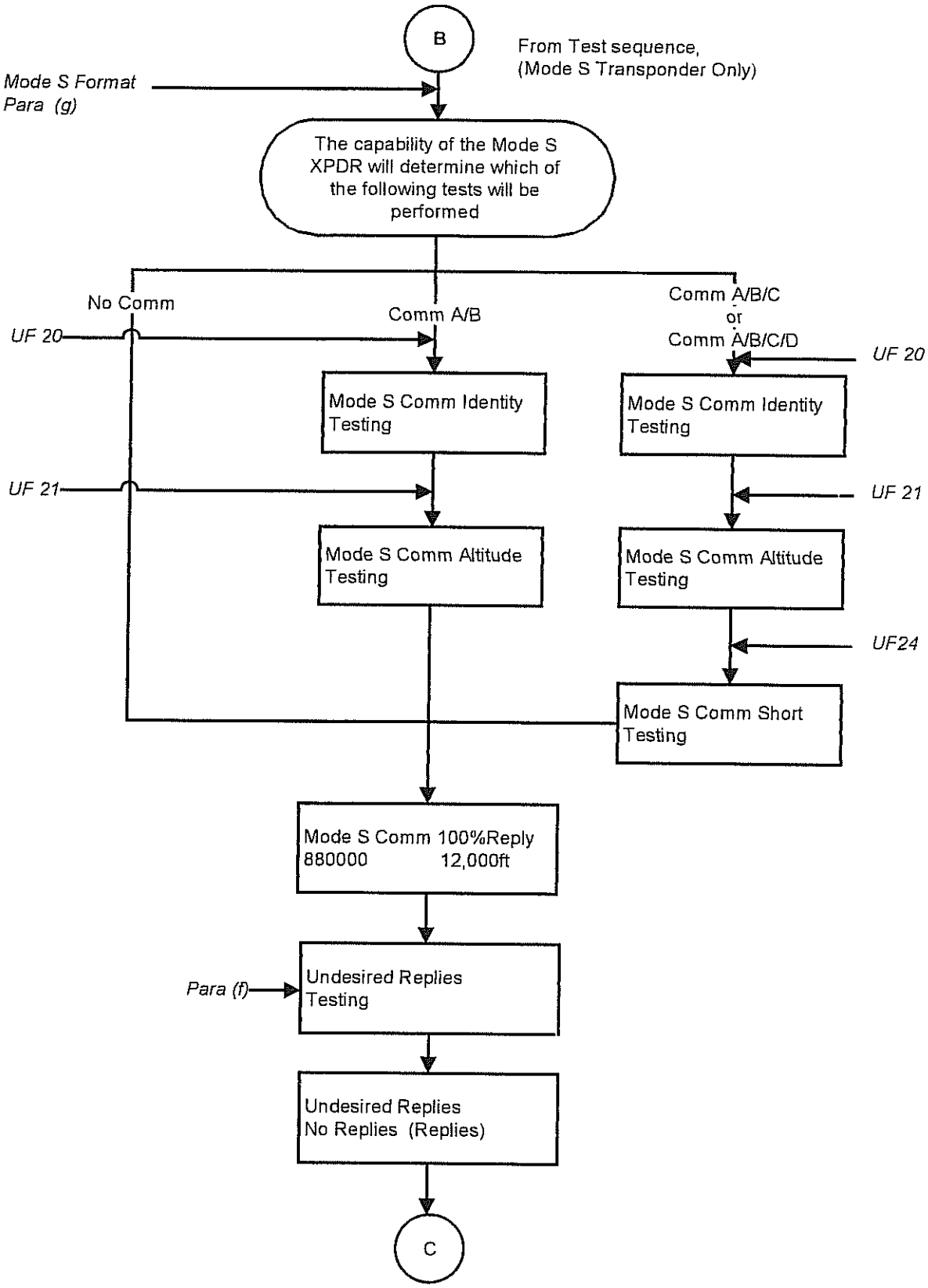


Figure 2-3B
TEST Switch Operational Flow Chart

Note If at any place in the TEST mode the INTERROGATE switch was pressed, the unit will jump to the top of the INTERROGATE mode and proceed with the interrogation tests And if the STORE switch is pressed any place in the TEST mode, the current test is run again

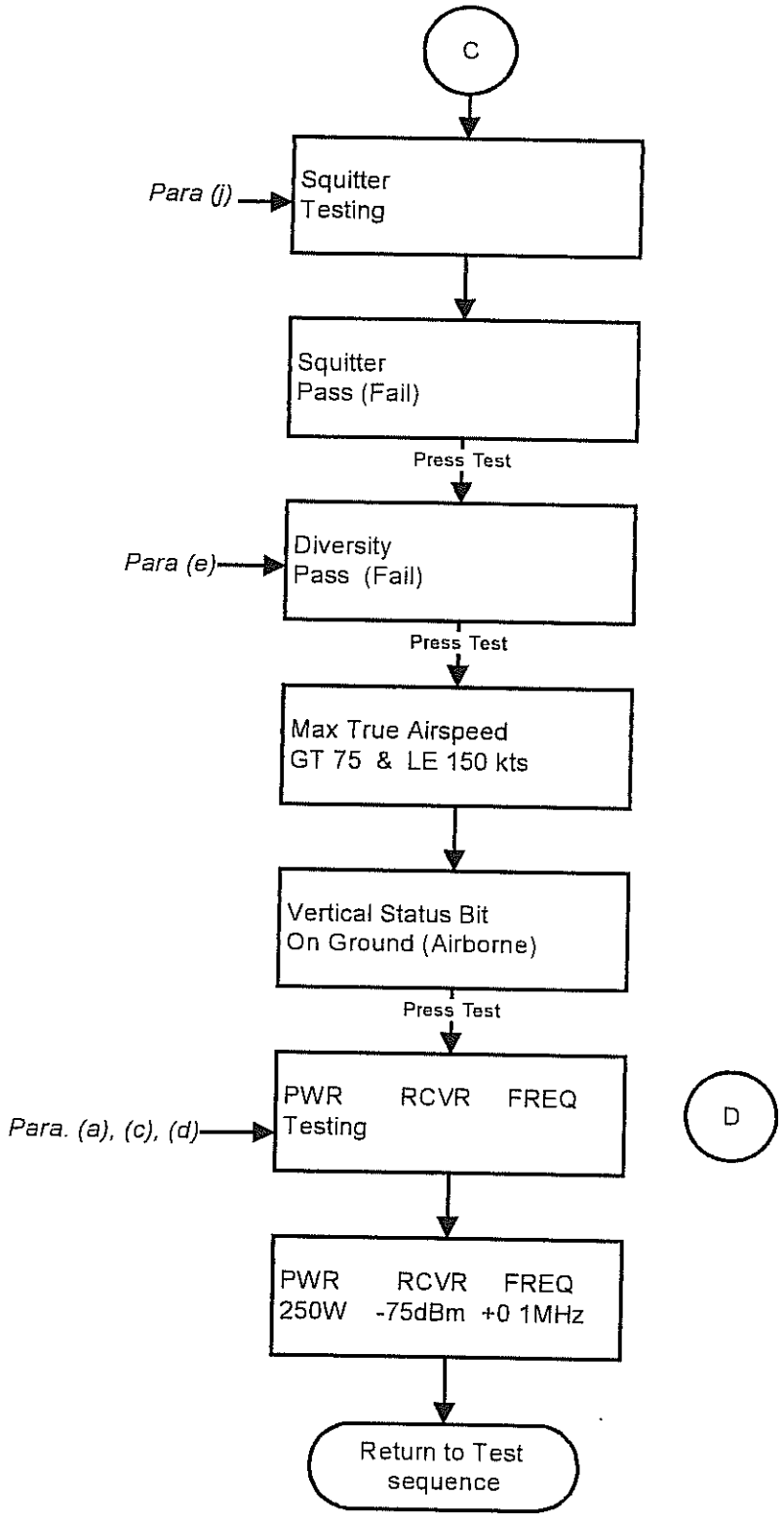


Figure 2-3C
TEST Switch Operational Flow Chart

Table 2-4

Testing An ATCRBS (Mode A/C) Transponder

STEP	PROCEDURE	NORMAL INDICATION
1	Perform preliminary procedure outlined in paragraph 2-2.	
2a	For quick checking of ATCRBS (Mode A/C) Transponders (power output, receiver sensitivity and frequency tests omitted) attach the dipole antenna Refer to paragraph 2-4	
2b	For performing all ATCRBS (Mode A/C) tests including power output, receiver sensitivity, and frequency measurement, attach the Antenna Coupler Refer to paragraph 2-6	
3	Disable the UUT "on-the-ground" switch if aircraft is so equipped.	
4	Activate UUT (Mode A/C) Transponder	
5	Set T-49 Function Switch to XPDR Test	
6	Press INTERROGATE Switch once	TEL-INSTRUMENT T-49 REV x x see Note 1 ATCRBS (Mode A/C) XPDR Interrogate To Test For other messages, See Notes 2 & 3 at end of section
7	If Battery Low or No Reply From Transponder message appears, clear the associated problem and then press INTERROGATE switch once	Tel-Instrument T-49 REV x.x (See Note 1 at end of section)
8	Press INTERROGATE	The T-49 will automatically perform tests outlined in Figure 2-2 After satisfactory completion of all tests, the "4096" code and the reported altitude will be displayed If the Antenna Coupler (Step 2b) was used,

	power, frequency and receiver sensitivity will be displayed
9 If a FAIL message is displayed, depress TEST switch to display failed test results	Details of failed test will appear on Data Display.
10 Clear associated problem and then press INTERROGATE switch once	The T-49 will automatically perform perform the test outlined in Figure 2-2
11 To store the data for future uploading to a PC, press the STORE/REPEAT switch once Data will remain in the RAM until the uploading procedure is completed This feature prohibits inadvertent loss of data.	The data is stored in the RAM ready for uploading via a serial connection Refer to paragraph 2-12
12 Enable the "on-the-ground" switch if disabled in Step 3	
13 Press OFF to de-energize the T-49 or after approximately 15 minutes of inactivity the T-49 will automatically de-energize.	

Table 2-5

Testing A Mode S Transponder

STEP PROCEDURE	NORMAL INDICATION
1 Perform preliminary procedure outlined in paragraph 2-2	
2a For quick checking of Mode-S transponders (power output, receiver sensitivity and frequency tests omitted) attach the dipole antenna Refer to paragraph 2-4	
2b For performing all Mode-S tests including power output, receiver sensitivity and frequency measurement, attach the Antenna Coupler Refer to paragraph 2-6.	

3	Disable the UUT "on-the-ground" switch if aircraft is so equipped	
4	Activate UUT Mode-S Transponder	
5	Set Function Switch to XPDR Test	
6	Press INTERROGATE Switch once	Mode S No Comm Interrogate To Test (For other messages, see Notes 2 & 3 at end of section)
7	Battery Low or No Reply From Transponder, clear the associated problem and then press INTERROGATE switch once.	
8	Press INTERROGATE	T-49 will automatically perform the tests outlined in Figure 2-2 After satisfactory completion of all tests, the "4096" code and the reported altitude will be displayed If the Antenna Coupler (Step 2B) was used, power frequency and receiver sensitivity will be displayed
9	If a FAIL message is displayed, depress TEST switch to display failed test results.	Details of failed test will appear on Data Display
10	Clear associated problem and then press INTERROGATE switch once.	The T-49 will automatically perform tests outlined in Figure 2-2
11	To store the data for future uploading to a PC, press the Store/Repeat switch once Data will remain in RAM until the uploading procedure is completed. This feature prohibits inadvertent loss of data	The data is stored in RAM ready for uploading Refer to paragraph 2-12
12	Enable the "on-the-ground" switch if disabled in Step 3	
13	Press OFF to de-energize the T-49 or, after approximately 15 minutes of inactivity, the T-49 will automatically de-energize	

2-11 TCAS Testing

Due to the nature of an operating TCAS system, there is the potential for creating false targets to aircraft flying in the terminal area The use of upper and lower TAP-125 anti-radiation antenna couplers during testing will alleviate the false target problems The following general considerations should be reviewed before performing TCAS tests

1 An aircraft with an operating transponder will reply to interrogations from ground-based interrogators and airborne TCAS systems Historically, this was not a problem because the aircraft was always located on the runway at an airfield and could only be interrogated by the on-field radar. The on-field radar would receive a reply only from the secondary radar while the primary return would be buried in ground clutter The secondary radar would indicate a distance of only a few miles, at most, and, therefore, the "pumped up" aircraft could be distinguished from a legitimate aircraft at the reported altitude

2 On the other hand, in the case of the TCAS, the geometry of an aircraft's position is determined from secondary radar replies only and the "pumped up" aircraft may appear as a legitimate intruder and possibly cause unwarranted issuance of resolution advisories The FAA is examining ways to minimize the false advisory problem

2-12 Testing Bearing Accuracy

1 Place the TCAS system on the aircraft into operation Defeat the "on the ground" switch on aircraft

2 Select any intruder type and initiate a fixed intruder scenario For the T-49CF, set AUT altitude as in Table 2 6. This provides an intruder at a fixed range and at either a positive or negative offset altitude When testing the UUT upper directional antenna, select the scenario which places the intruder above the aircraft When testing the UUT lower directional antenna, select the scenario, which places the intruder below the aircraft

3 Attach the directional antenna to the test set Refer to paragraph 2-6

4 Energize the test set by pressing the INTERROGATE switch. Press the INTERROGATE switch a second time to initiate the scenario. For T-49C and the T-49CF, press Test Switch at the desired range to get an intruder fixed at that range.

5 Place the test set to a position that is in clear view and a distance from 50 to 300 feet from the upper directional antenna The bearing of the test set must be measured from the actual physical geometry of the test set relative to the aircraft

6 Verify the bearing accuracy of the TCAS display

7 Place the test set in various locations to verify other directional antenna bearings

8 Repeat steps 5, 6, and 7 for the lower directional antenna, if one is installed
Note: See Appendix E (TCAS Testing Suggestions)

Table 2-6

Testing A TCAS System

STEP PROCEDURE	NORMAL INDICATION
1 Perform preliminary procedure outlined in paragraph 2-2.	
2 Verify proper operation of Mode-S Transponder.	
3 Attach the Directional Antenna	Refer to paragraph 2-5
4 In the UUT	
a Place TCAS Computer into operation	
b Defeat the "on-the-ground" switch	
c Depending on the aircraft altitude, pump up the altimeter or provide the simulated data to the air data computer as required.	
d Turn off DME interrogator.	
e Turn Mode-S Transponder on	See Table 2-5
5 Place the Function switch at ATCRBS (Mode A/C) (This position simulates approach of an intruder aircraft equipped with an ATCRBS transponder)	
Note: If during the TCAS testing the altitude of the aircraft is changed, it is necessary to connect a TAP-125 cable to the test set and repeat all transponder tests.	
6 Using the Scenario Selector, select one of the five intruder scenarios	
7 Press INTERROGATE	The T-49 will automatically perform tests outlined in Figure 2-4
For the T-49CF only, Press the INTERROGATE or TEST button for any TCAS operating mode	Enter the AUT

simulated altitude by using the TEST Button to increase altitude and the INTERROGATE Button to decrease altitude The altitude will change in 100' steps After the altitude is entered, push the STORE button to start the selected test *Note: for Transponder testing, no altitude has to be entered.*

8	Select each of the remaining intruder scenarios in turn After each selection, press INTERROGATE switch once.	As noted in Figure 2-4
9	Place the Function Switch at Mode-S (This position simulates approach on an intruder aircraft equipped with a Mode-S Transponder)	
10	In turn, select each of the intruder scenarios After each selection, press INTERROGATE	As noted in Figure 2-4
11	Place Function switch at TCAS (This position Simulates approach of an intruder aircraft equipped with a TCAS Transponder	As noted in Figure 2-4
12	In turn, select each of the intruder scenarios After each selection, press INTERROGATE	As noted in Figure 2-4

2-13 Message Down-Loading Procedure

To download data from the RAM proceed as follows

1 Switch the LIGHTS/OFF Switch to OFF

2 Insert diskette supplied with the test set into an IBM compatible PC disk drive

3 Enter A. T-49 (RETURN) to run program Refer to Appendix B for complete menu and synopsis of program.

4 Connect RS-232 cable from serial PC port to the ACCESSORIES connector

5 Press INTERROGATE button The test set will recognize the computer connection and will write the data to the PC.

6 If necessary, to save data stored in RAM for future use, press LIGHTS/OFF Switch OFF

7 To erase data stored in RAM press TEST

Notes: Apply to Tables 2-4, 2-5, and 2-6

1 "x.x" represents the version of firmware installed in the unit.

2 If battery is low and must be recharged, a Battery Low message will appear on the display

3 If, rather than a transponder type, the test set displays "No reply for XPDR",

a Either the transponder has failed, or is turned off

b The antenna was not attached to the test set.

c The test set was too far from the transponder antenna

d Two transponders replied causing garbling. Determine the source of the problem and retest

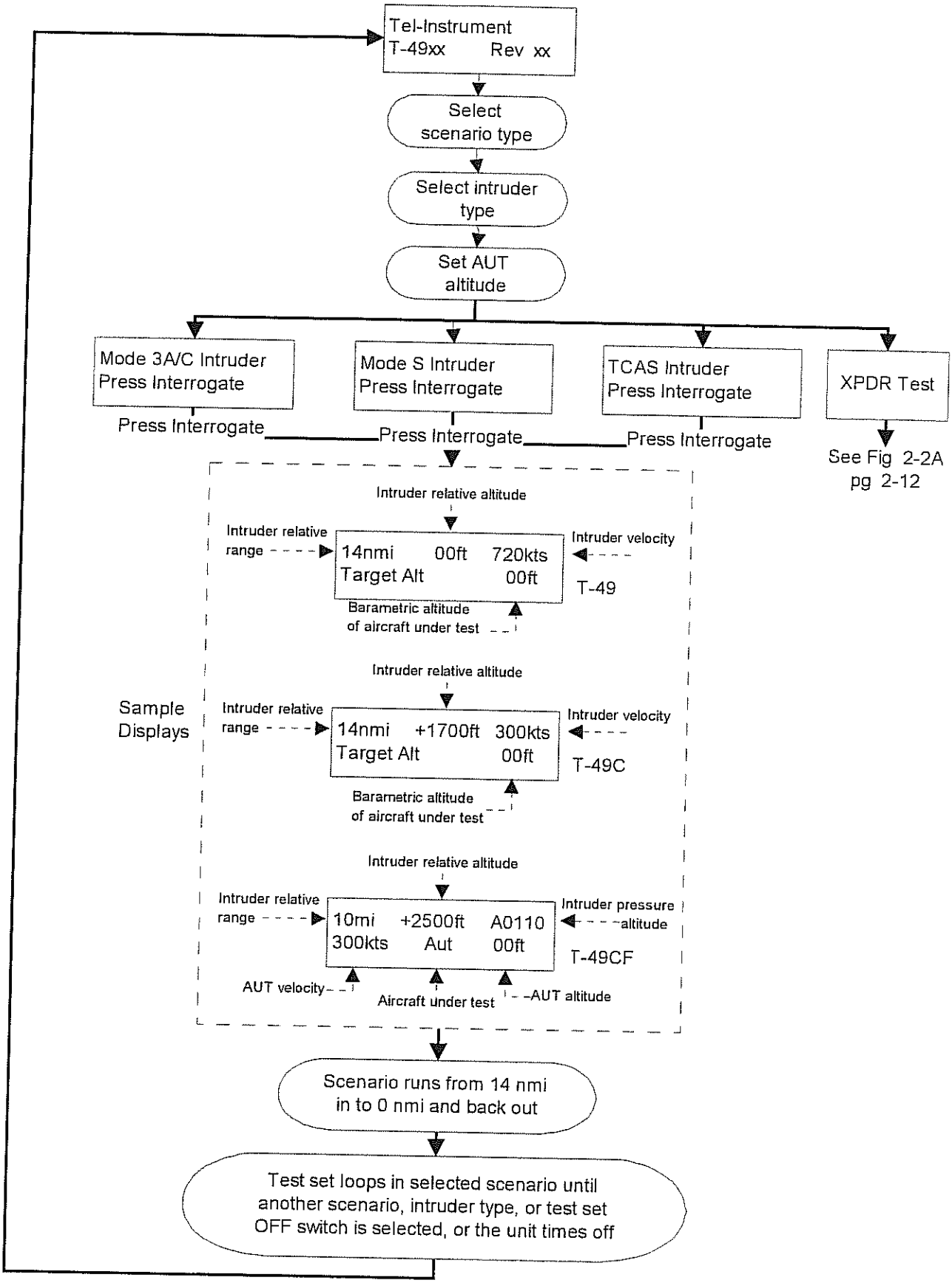


Figure 2-4
TCAS Mode of Operation Flow Chart

SECTION 3

THEORY OF OPERATION

3-1 Overview

The T-49 TCAS Ramp Test Set contains a transmitter and receiver which communicate with the TCAS or XPDR under test. Both transmitter and receiver are capable of operating on either 1030 MHz or 1090 MHz, with both pulse amplitude and DPSK modulation

3-2 RF Transmitter

The transmitter section generates the desired carrier frequency using a phase locked loop The oscillator, Q6, is a varactor-tuned oscillator which is followed by two stages of buffer amplifiers, U22 and U23 to insure minimal frequency modulation due to the pulse amplitude modulation applied to the carrier A divide-by-256 prescaler, U33, is fed from the second buffer amplifier and drives the phase detector, U36 The phase detector output drives a single-transistor loop filter/amplifier which in turn closes the loop by feeding the varactor diode of the VCO

The transmitter oscillator is operated on one of two frequencies, 1090 or 1030 MHz, by selecting on of two crystal oscillators at either 1090/256 = 4 2578125 MHz of 1030/256 = 4 0234225 MHz. The desired oscillator is selected by applying power to the oscillator

Modulation is applied to the transmitter carrier by using a combination of two methods First, a balanced mixer, U28, provides either amplitude modulation or phase shift keying modulation Second, since the balanced modulator alone would not provide a sufficient on/off ratio, the buffer amplifiers U25 and U26 following the balanced mixer are modulated to provide further amplitude modulation

The modulation to the balanced mixer is provided by an analog switch, U27, under digital control This analog switch provides both positive and negative current into the balanced mixer to provide both in phase and reverse phase for DPSK modulation This analog chip also provides the power switching for the buffer amplifiers through Q12 and Q13 R96 is used to adjust the SLS P2 power level.

3-3 RF Receiver

The receiver is a single-conversion superhetrodyne 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, enhancing the lock-up time In addition, the 45 MHz IF, rather than the conventional 50 MHz IF, prevents the receiver local oscillator from being present at the

transmit frequency and, therefore, presenting 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. This feeds an RF amplifier, U1 The mixer follows which is fed the local oscillator from the output of the two buffer amplifiers. The mixer output fees a two-pole IF filter tuned to 45 MHz.

The IF amplifier is a four-stage 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.

3-4 Power, Frequency, and Sensitivity Measurements

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 The output of the frequency discriminator is gated to an integrator whenever pulses are received. 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, an antenna coupler unit is required The antenna coupler provides a diode detector for rectifying the RF envelope from the UUT transmitter and provides RF coupling for UUT receiver sensitivity measuring

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

3-5 Diversity

Diversity is measured by comparing the magnitude of two successive squitter transmissions from a Mode-S transponder using the peak power circuits described above The TAP-125 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, as required by the FAR The use of the TAP-125 couplers also reduces external radiation by over 20dB, a requirement that the FAA is now considering.

3-6 Microprocessor

The digital board contains the microprocessor and all of the bus-connected peripheral chips The microprocessor, U4, is a CMOS 80C31IC. 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 which 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 test set is required to reply to an interrogation from a TCAS system in a very short time period Therefore, it is impossible for any analysis by the microprocessor to take place before the initiation of the reply. To circumvent this deficiency, the possible replies are loaded into a second FIFO, U37, at a slow rate prior to the receipt of an interrogation 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 by 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 FIFOS 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 same time constraints involving the microprocessor The Mode C and Mode-S decode circuitry are

clocked using a 20 MHz clock for 40 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 time delay is inserted before a reply is transmitted. This time delay is variable and programmed by the microprocessor U31 and U32 provide the time delay in steps of 1.45 microseconds, controlled by the master 20 MHz clock

3-7 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. Thus, operating the test set at 50% duty cycle, with the charge on, will result in 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 LED indicator which 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 in the return lead of the battery This is done so that if the fuse holders are touched by a tool 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 burning the interconnecting wires.

The battery charger has a separate fuse so that, if the battery fuse were open, the unit would not operate on the battery charger voltage which 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 either 110 or 220 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, U55. A switching regulator, U51, is provided to supply -10 volts for those circuits requiring a negative supply voltage A 200 second RC timer circuit energizes the unit and provides a shut-off after the unit has been operated. The output is fed to a 4096 counter U17 which in turn shuts the unit off if the time has expired This timer is reset each time an INTERROGATE or Test Switch is pressed. A 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 a -9VDC for this interface

SECTION 4

TEST, CALIBRATION, AND MAINTENANCE

4-1 General

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

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

4 1.2 **Sub Assembly Alignment Tests** - opening the test set will make accessible the RF and Digital printed circuit boards, and their test points and alignment controls; if these adjustments do not return the test set to specified function, the unit requires maintenance (see Appendix A for test report documentation format)

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

4-2 Final Assembly Acceptance And Annual Calibration Tests

4 2.1 Equipment Needed

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

4 2 2 Procedure

1 Battery Charging

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

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

b Remove the power cord from inside the cover and attach it to the correct AC power receptacle.

c Be sure the voltage change/fuse cartridge is set for the AC power to be used

d Connect the power cord to an appropriate AC outlet.

e Turn the AC power switch to the on position Verify charging by observing that the Red AC power lamp is lit.

f Remove AC power cord once finished charging.

2 **Display Operation**

a Select the XPDR TEST of the TCAS INTRUDER TYPE mode switch.

b After proper charging, press the INTERROGATE switch. Check the Data Display window for the following message

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

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

Immediately followed by:

No Reply from XPDR.

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

3 **Transmitter Frequency**

a Connect the output of the antenna connector directly to a spectrum analyzer

b Set the Spectrum Analyzer to the following settings.

Frequency:	**1030 MHz**
Power Level:	**-10 dBm**

c Set the XPDR/TCAS (HIGH/LOW) switch to low.

d Hold down the INTERROGATE switch on and verify the existence of a pulse modulated signal at a frequency of 1030 MHz +/- 1MHz

e Connect the output of the antenna connector directly to a power meter.

f Hold down the INTERROGATE switch on and verify a power level of -10dBm +/-2dB

g Set the XPDR/TCAS / (HIGH/LOW) switch to high Hold down the INTERROGATE switch and verify a level of +12 dBm +/-2dB

h Set the XPDR/TCAS/ (HIGH/LOW) switch back to low

4 **Receiver Local Oscillator**

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

Frequency:	**1045 MHz**
Power Level:	**-30 dBm**

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

5 **Mode S Pulse Modulated Signal**

a Set the TCAS INTRUDER TYPE to MODE S interrogation

b Set the T-49 for a +1000 feet interrogation

c Set the Spectrum Analyzer to the following settings

Frequency:	**1090 MHz**
Power Level:	**-10 dBm**

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

6 **Omni Directional Antenna XPDR Test**

a Disconnect the UUT from the Spectrum Analyzer.

b Connect the omni directional antenna to the output connector

c Make sure the XPDR which is being tested is functional and powered on See Figure 4-1 for transponder system setup.

d Set the TCAS INTRUDER TYPE to XPDR TEST

e Press the INTERROGATE switch to communicate to the XPDR and identify the transponder type.

f Press the INTERROGATE switch once again to begin a series of test to the XPDR.

g Successful completion of XPDR test should result in the following displayed information:

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

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

a Disconnect the omni directional antenna.

b Connect the TAP-115 coupler to a 3' X 3' Blade mounted antenna plate and the UUT If testing TAP-121, connect it directly to transponder. See Figure 4-1

c Make sure the XPDR which is being tested is functional and powered on

d Press the INTERROGATE switch to communicate to the XPDR and identify the transponder type.

e Press the INTERROGATE switch once again to begin a series of test to the XPDR

f Successful completion of the XPDR test should result in the following displayed information:

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

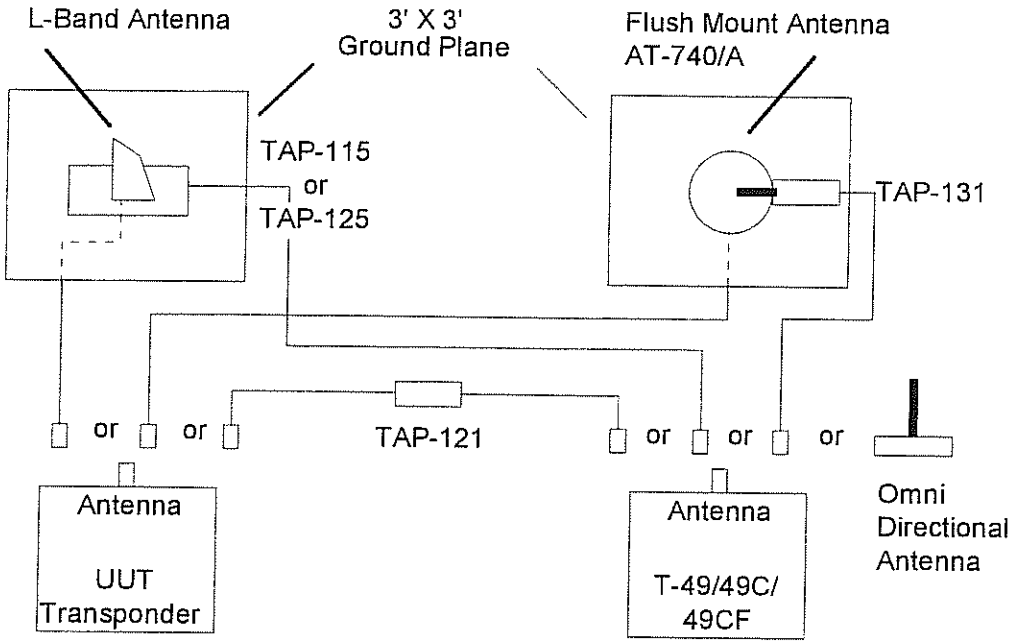


Figure 4-1
Transponder/Test Set Setup

4-3 Sub-Assembly Adjustment Tests

4 3 1 Equipment Needed

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

4 3 2 RF PCB Procedure

1 Voltage Settings

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

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

U1	pin 3	+5V +/-0.5V
U34	pin 3	+6V +/-0.5V
Neg Lead C76	-4V +/-0 5V	

c Set the +10V supply available at pin 5 of U21 on the RF board for 10V +/-0 1V by adjusting R52

2. **Frequency Settings**

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

ATCRBS (Mode A/C) Intruder Press Interrogate

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

b Measure the frequency at TP1 using a frequency counter with an oscilloscope probe

c Adjust C99 for a frequency of 4 023423 MHz +/-45Hz

d Measure the frequency at pin 1 of U17 using the frequency counter with an oscilloscope probe

e Adjust C70 for a frequency of 8.164063 MHz +/-45Hz

f Turn off the T-49 using the OFF switch Place the function switch in the "ATCRBS Intruder" position and energize the T-49 using the INTERROGATE switch The T-49 should display the following message

ATCRBS (Mode A/C) Intruder Press Interrogate

Note: Press the INTERROGATE switch a second time.

g Place the frequency counter with the oscilloscope probe at TP1.

h Adjust C106 for 4.257813 MHz +/-45Hz

i Place the frequency counter at pin 1 of U17

j Adjust C65 for 8 398438 MHz +/-45Hz.

k Turn off the T-49 using the OFF switch

3 **1030 MHz Receiver Sensitivity**

a Feed a pulse modulated signal at 1030 MHz at a level of 0 dBm from a signal generator into the Antenna input/output connector. Use a 1 us pulse width with a PRF of about 1 KHz.

b Energize the T-49 with the function switch in the "ATCRBS (Mode A/C) intruder" position The following message should be displayed on the front panel

ATCRBS (Mode A/C) Intruder Press Interrogate

Note: Press the INTERROGATE switch.

c Monitor the demodulated pulses at pin 10 of U13, while triggering the oscilloscope from the pulse generator.

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

4 **1090 MHz Receiver Sensitivity**

a Feed a pulse modulated RF signal at 1090 MHz from a signal generator into the Antenna input/output connector using the same pulse width and repetition rate as in step 3a above

b Energize the T-49 in the ATCRBS (Mode A/C) Intruder mode. The front panel should display the following·

ATCRBS (Mode A/C) Intruder Press Interrogate

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

c Monitor the demodulated pulses at pin 10 of U13, while triggering the oscilloscope from the pulse generator

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

5 **RF Output Power Level Setting**

a Activate the T-49 in the "XPDR TEST" mode and place the STORE/REPEAT switch in the repeat mode. This causes the T-49 to transmit on a frequency of 1030 MHz Connect the Antenna input/output of the T-49 to a peak power meter. Set the XPDR/TCAS (high/low) switch to low

b Adjust C12 for a maximum peak power output of the P1 pulse. This value should be -10 dBm +/-1 dB Changes in power may be affected by adjusting C12

c Connect the T-49 Antenna input/output to a spectrum analyzer Connect Vertical Output of the spectrum analyzer to the oscilloscope and measure P2 as -9dB +/-1dB relative to P1. If out of this spec then do the remaining steps in this section.

d Adjust R96 full counter-clockwise Adjust R101 for a minimum amplitude of the P2 pulse

e Adjust R96 for a power level of -9dB from the peak power of the P1 pulse

6 **RF Power Measurement Calibration Setting**

a Remove 5 screws that hold the RF case to the chassis. On the Digital Board, ground TP4 to the chassis

b Turn on T-49 by pressing STORE/REPEAT switch to place the T-49 in the calibration mode

c Provide a pulse generator signal at a 1 KHz PRF with 1 us pulses at the following amplitudes into the Antenna input/output connector of the T-49 Verify the calibration of the power measurement as shown in the table below

Pulse Amplitude	**Power Reading**
1 26V	500 watts +/-75 watts
800mV	200 watts +/-30 watts
500 mV	100 watts +/-15 watts

4 3 3 **Digital PCB Procedure:**

1 **Frequency & Voltage Settings**

a Remove T-49 body from the case.

b Remove five screws that hold RF case to the chassis.

c Leave the coax RF cable from the RF board to the front panel and the ribbon cable from the RF board to the Digital board both connected

d Place the rotary switch in "XPDR TEST" position and then power on the T-49 by pressing the STORE/REPEAT switch.

e The front panel should display the following

CALIBRATION xxx W x.x MHz

f Using a voltmeter check for the following voltages

+10 V (+/-0.2V) at TP8
-10 V(+/-0.5V) at TP7
+5V (+/-0.2V) at Pin 3 of U55 (7805CTH)

Note: Ground is on TP10.

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

TP3	0.20us +/-0 05us period
TP2	0.25 us+/-0 05us period

h Turn off the T-49 unit.

2 ATCRBS/C Interrogation Test

a Connect an L-Band Pulse Generator to the RF connector on the front panel The L-Band Pulse Generator must be able to generate pulse forms similar to an ATCRBS/A, ATCRBS/C, and a Mode S interrogation at 1030 MHz with an RF output of -10 dBm. See Figure 4-2

b Input from the pulse generates a signal that represents an ATCRBS/C interrogation at 1030 MHz, at -10 dBm

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

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

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

ATCRBS (Mode A/C) Intruder Press Interrogate

e Start the scenario by pressing the INTERROGATE switch.

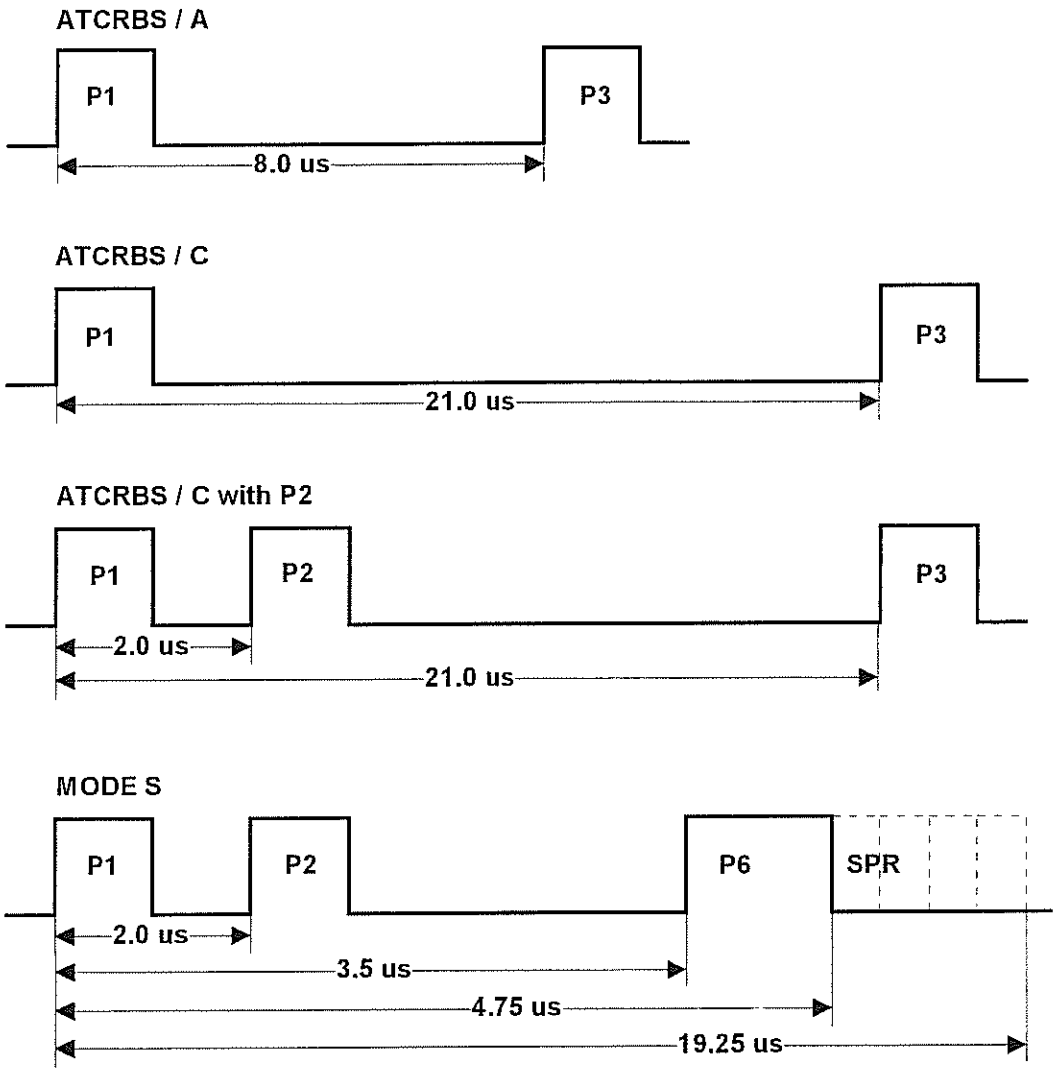
f Trigger the oscilloscope off of P2 pin 25 or U18 pin 3. With another scope probe monitor P2 pin 8.

g Verify at P2 pin 8 an ATCRBS/C reply approximately 190 us from the trigger of the ATCRBS/C interrogation This reply is 21 us long and has a changing pattern (simulates the changing altitude of an intruder aircraft) The reply moves in time from 190 us to 28 us When the reply reaches 28 us the scenario reverses and moves out in time

h Vary the ATCRBS/C interrogation to the following individual settings

-ATCRBS/A Interrogation
-Mode S Simulated Interrogation
-ATCRBS/C Interrogation with full P2 pulse (SLS)

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



Note:

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

Figure 4-2
Interrogation Waveforms

3 Mode S Interrogation Test

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

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

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

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

Mode S Intruder Press Interrogate

d Start the scenario by pressing the INTERROGATE switch

e Trigger the oscilloscope off of P2 pin 25 or U18 pin 3 With another scope probe monitor P2 pin 8.

f Verify at P2 pin 8 a Mode S reply approximately 300 us from the trigger of the Mode S interrogation This reply is 64 us long and has a changing pattern (simulates the changing altitude of an intruder aircraft) The reply moves in time from 300 us to 130 us When the reply reaches 130 us the scenario reverses and moves out in time

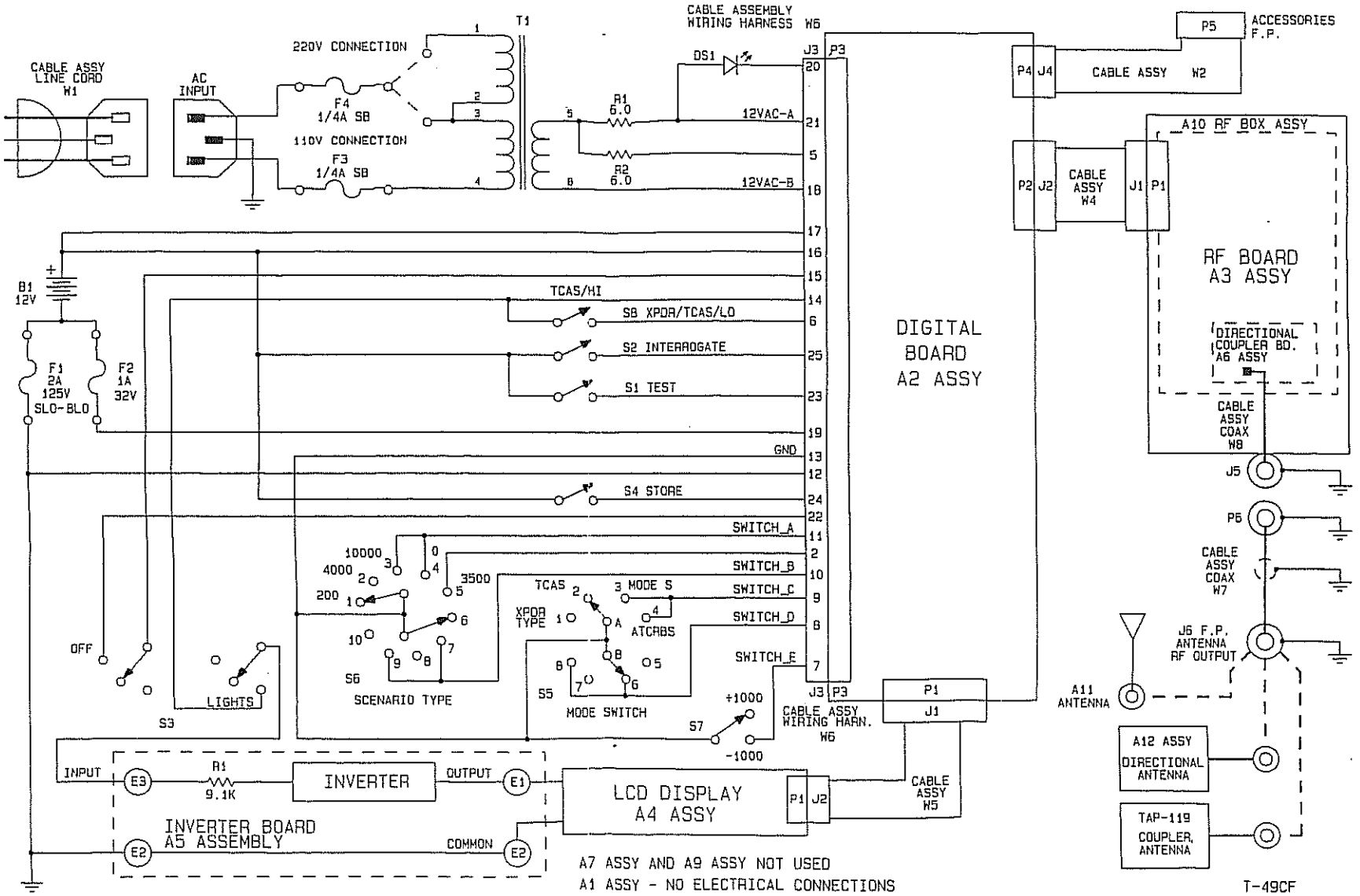
g Vary the Mode S interrogate to the following individual settings

-ATCRBS/A Interrogation
-ATCRBS/C Interrogation

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

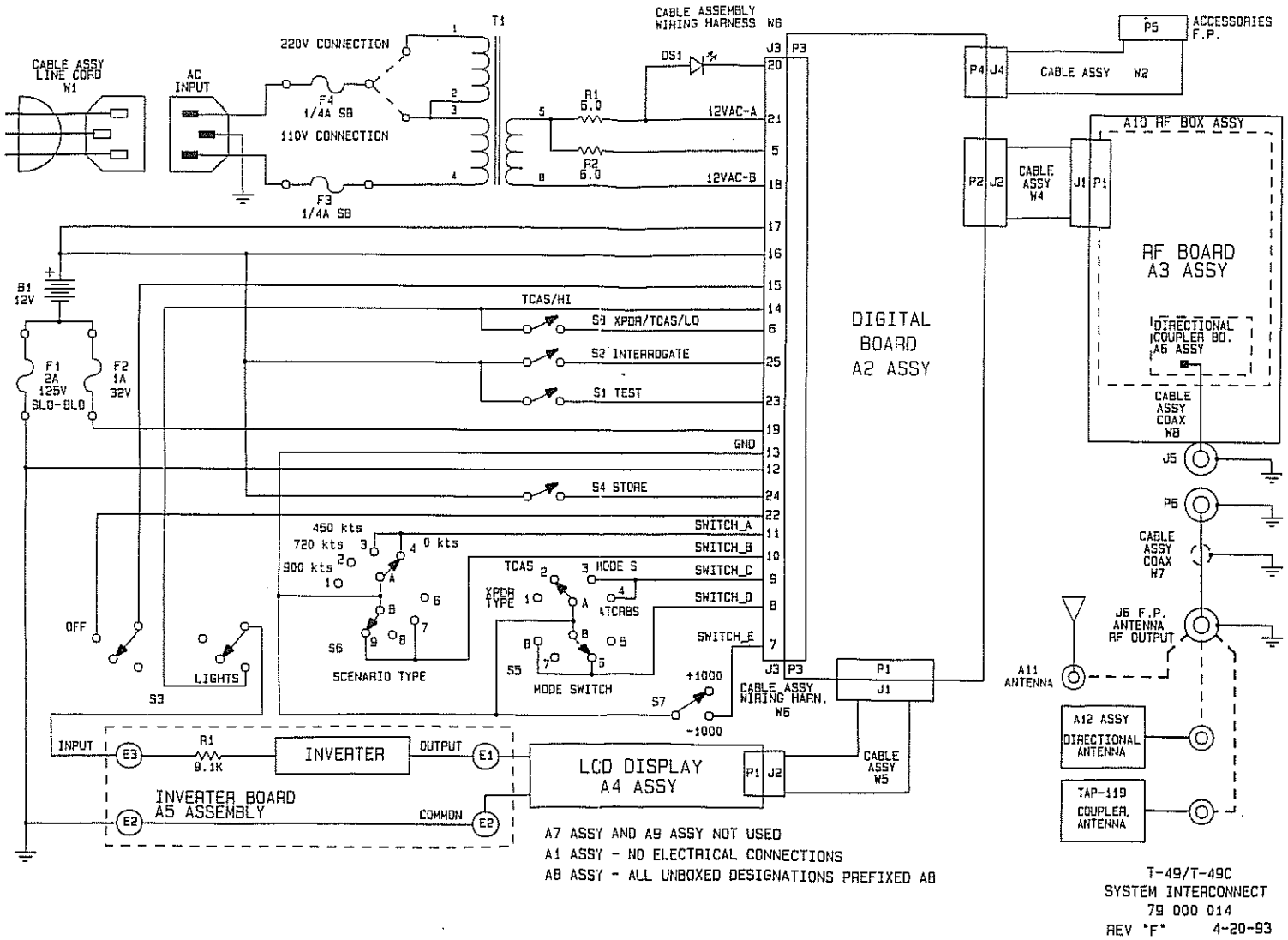
Section 5

SCHEMATICS



T-49CF
SYSTEM INTERCONNECT
79 000 014
REV "F" 4-20-93

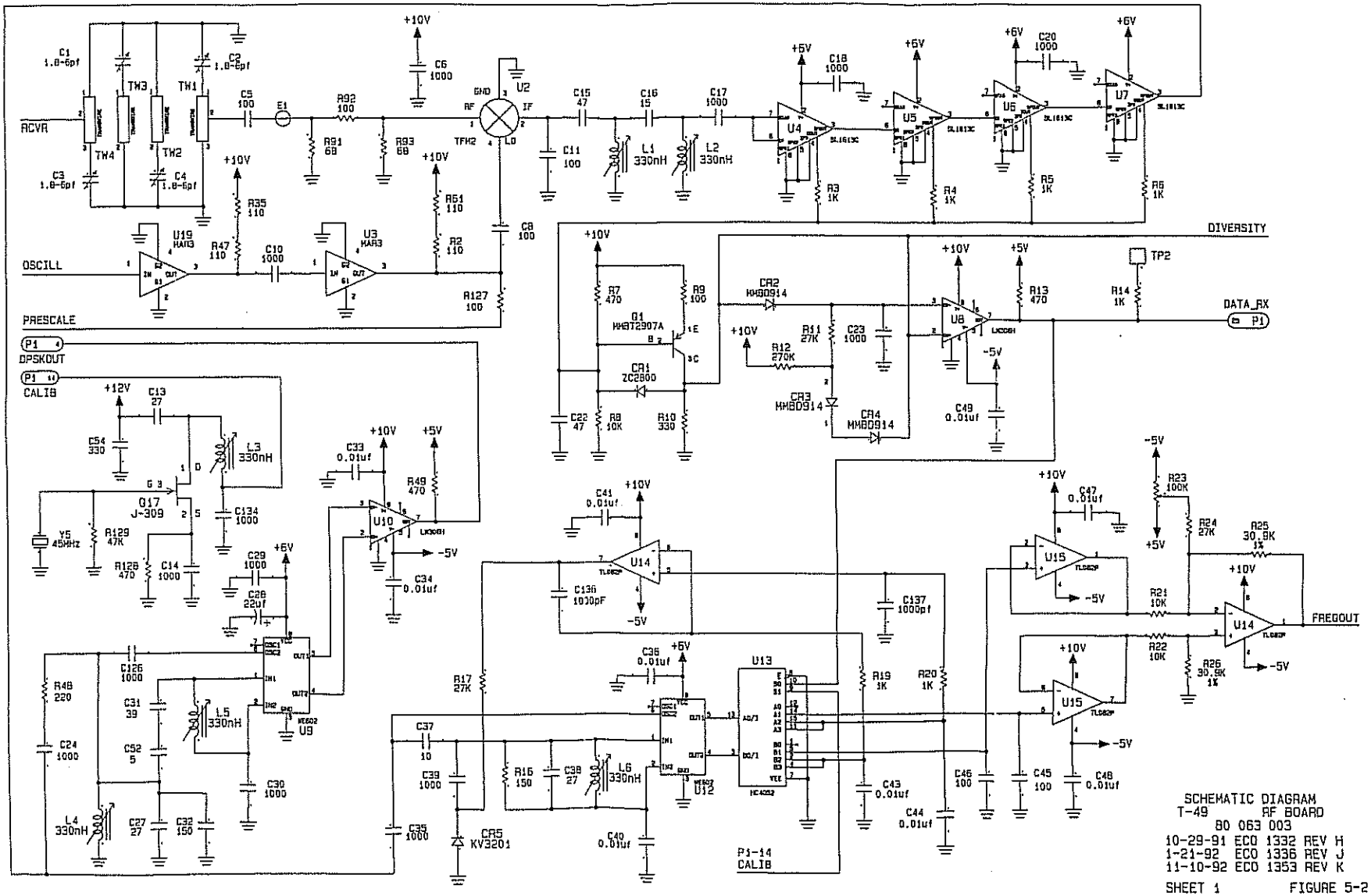
FIGURE 5-1A

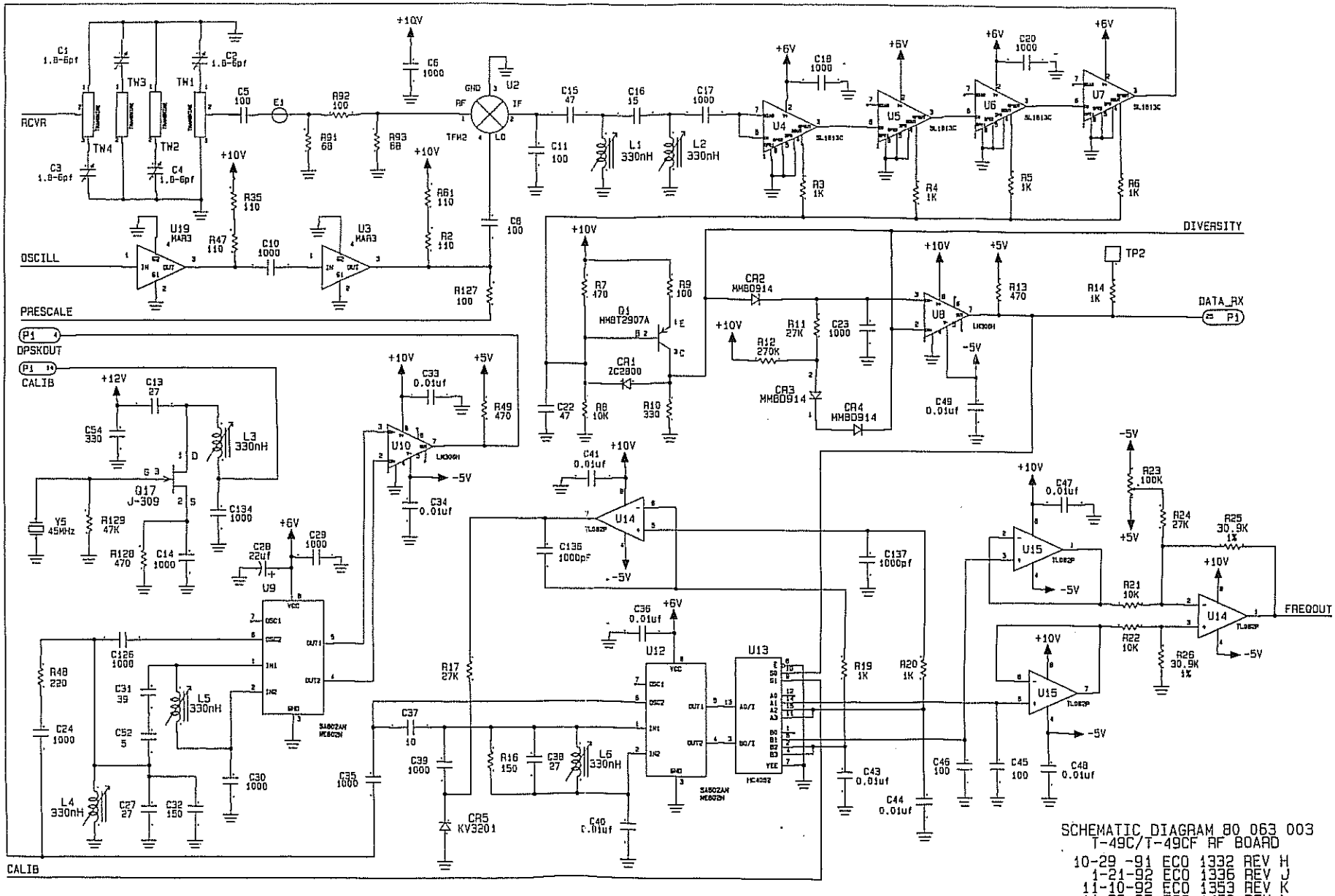


A7 ASSY AND A9 ASSY NOT USED
A1 ASSY - NO ELECTRICAL CONNECTIONS
A8 ASSY - ALL UNBOXED DESIGNATIONS PREFIXED A8

T-49/T-49C
SYSTEM INTERCONNECT
79 000 014
REV "F" 4-20-93

Figure 5-1

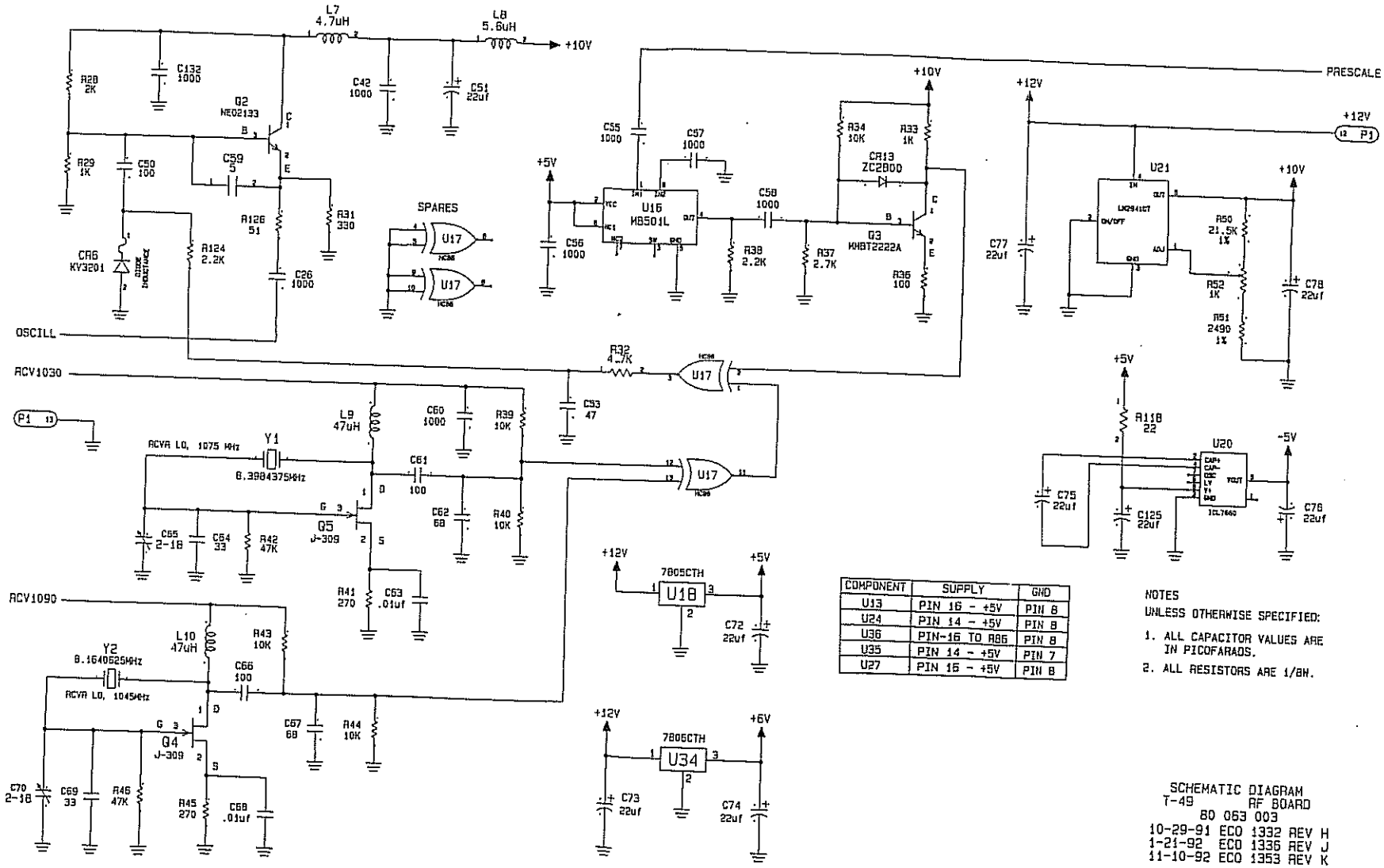

RCVR
OSCILL
PRESCALE
DPSKOUT
CALIB
DIVERSITY
DATA_RX
FREQOUT
P1-14
CALIB
TP2
SCHEMATIC DIAGRAM
T-49 RF BOARD
80 063 003
10-29-91 ECO 1332 REV H
1-21-92 ECO 1336 REV J
11-10-92 ECO 1353 REV K
SHEET 1 FIGURE 5-2



SCHEMATIC DIAGRAM 80 063 003
T-49C/T-49CF RF BOARD

10-29 -91 ECO 1332 REV H
1-21-92 ECO 1336 REV J
11-10-92 ECO 1353 REV K
11-26-97 ECO 1450 REV L
5-6-98 ECO 1463 REV M

SHEET 1 FIGURE 5-2A



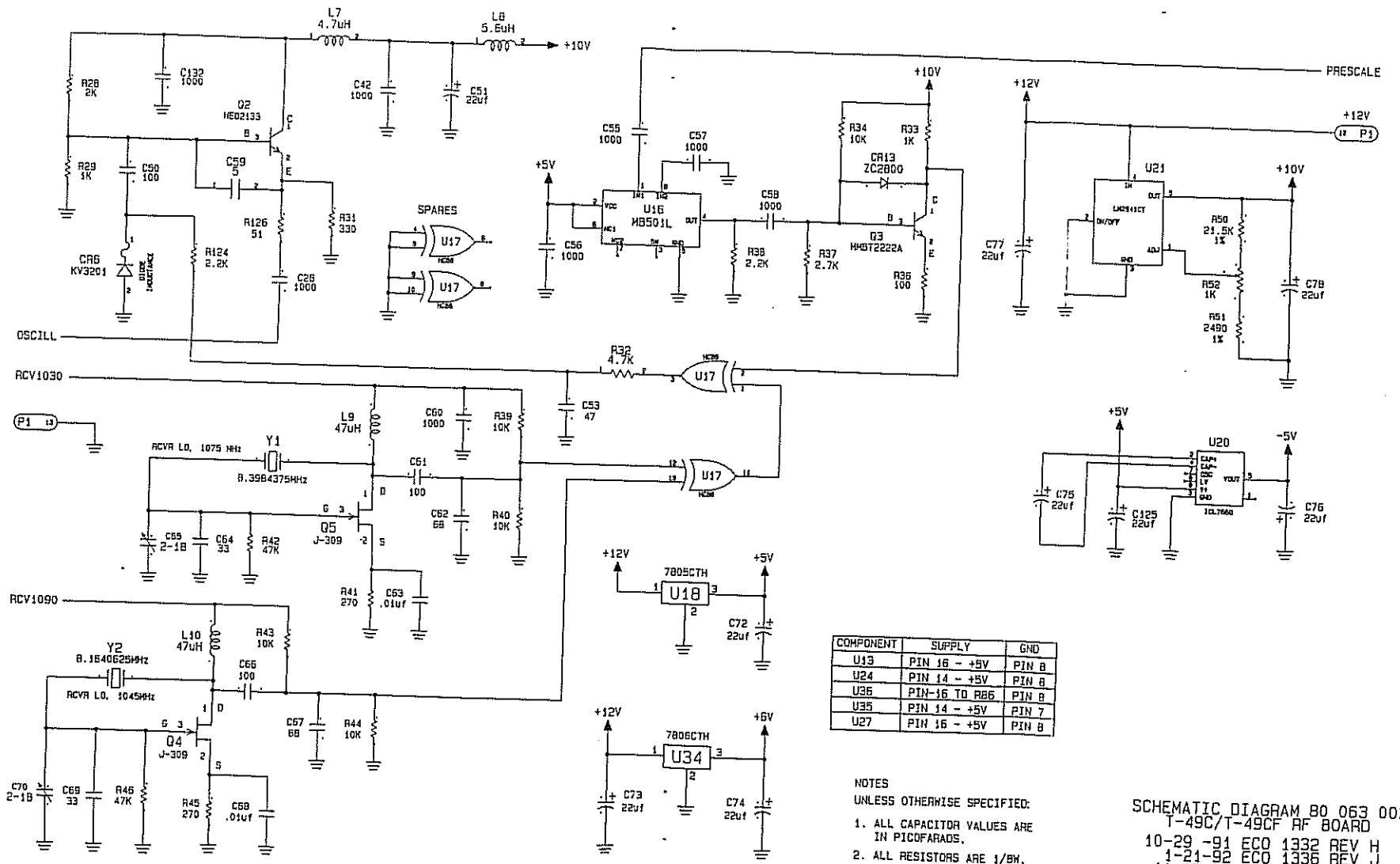
COMPONENT	SUPPLY	GND
U13	PIN 16 - +5V	PIN 8
U24	PIN 14 - +5V	PIN 8
U36	PIN-16 TO R86	PIN 8
U35	PIN 14 - +5V	PIN 7
U27	PIN 16 - +5V	PIN 8

NOTES
UNLESS OTHERWISE SPECIFIED:

1. ALL CAPACITOR VALUES ARE IN PICOFARADS.
2. ALL RESISTORS ARE 1/8W.

SCHEMATIC DIAGRAM
T-49 RF BOARD
80 063 003
10-29-91 ECO 1332 REV H
1-21-92 ECO 1336 REV J
11-10-92 ECO 1353 REV K

SHEET 2 FIGURE 5-3



COMPONENT	SUPPLY	GND
U13	PIN 16 - +5V	PIN 8
U24	PIN 14 - +5V	PIN 8
U36	PIN 16 TO R86	PIN 8
U35	PIN 14 - +5V	PIN 7
U27	PIN 16 - +5V	PIN 8

NOTES

UNLESS OTHERWISE SPECIFIED:

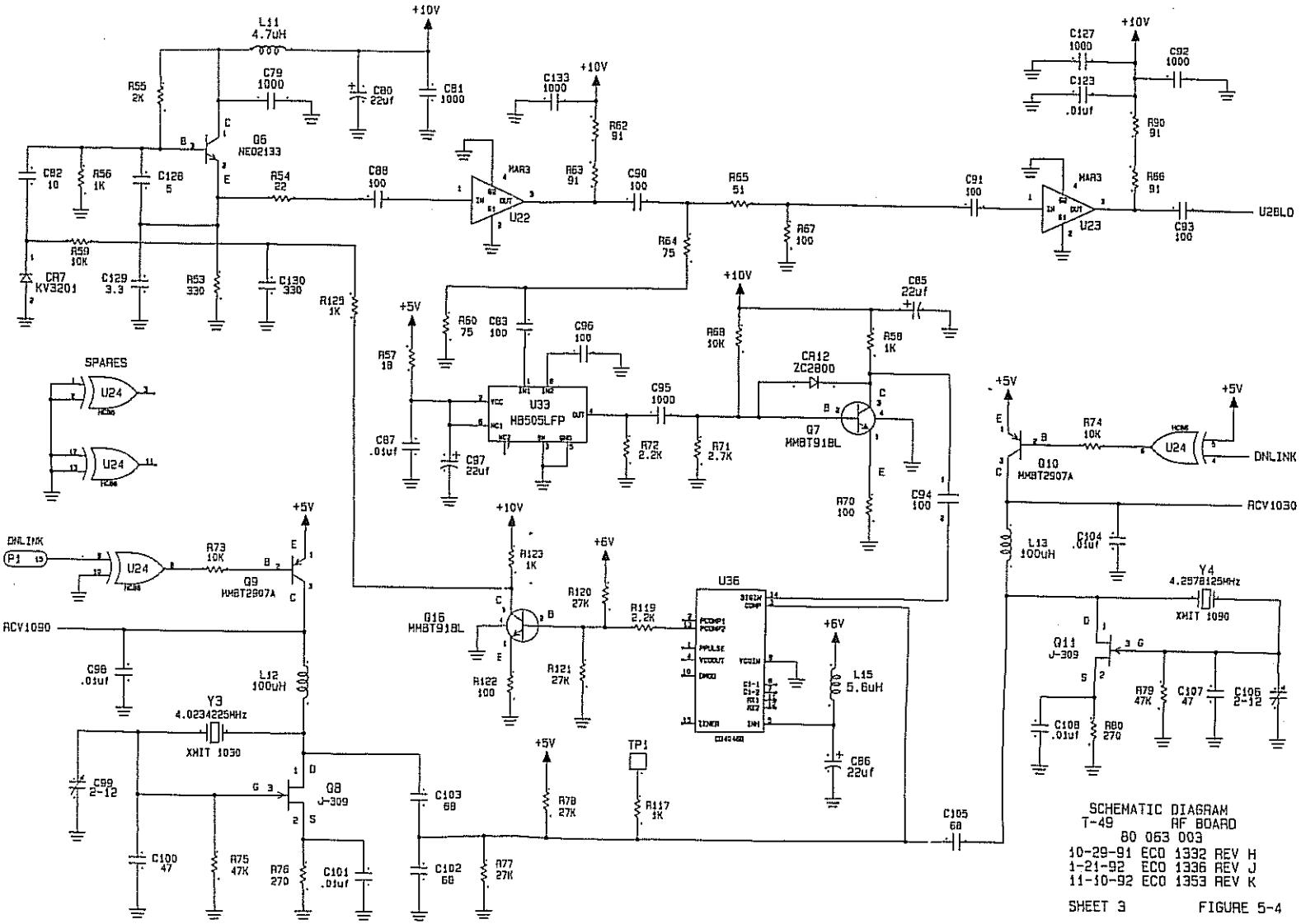
1. ALL CAPACITOR VALUES ARE IN PICOFARADS.
2. ALL RESISTORS ARE 1/8W.

SCHEMATIC DIAGRAM 80 063 003
T-49C/T-49CF RF BOARD

10-29 -91 ECO 1332 REV H
1-21-92 ECO 1336 REV J
11-10-92 ECO 1353 REV K
11-26-97 ECO 1450 REV L
5-6-98 ECO 1463 REV M

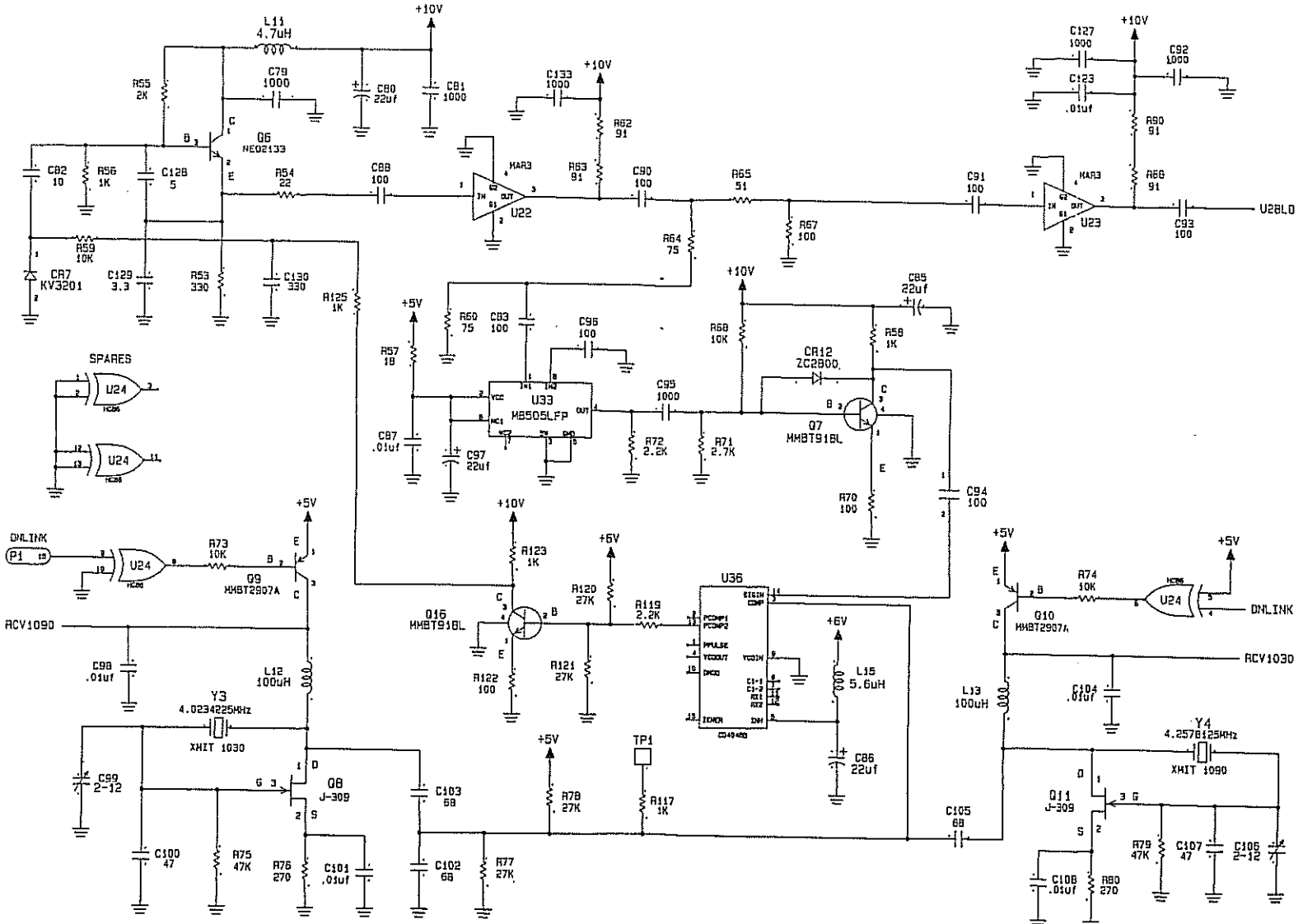
SHEET 2

FIGURE 5-3A



SCHEMATIC DIAGRAM
T-49 RF BOARD
80 063 003
10-29-91 ECO 1332 REV H
1-21-92 ECO 1336 REV J
11-10-92 ECO 1353 REV K

SHEET 3 FIGURE 5-4

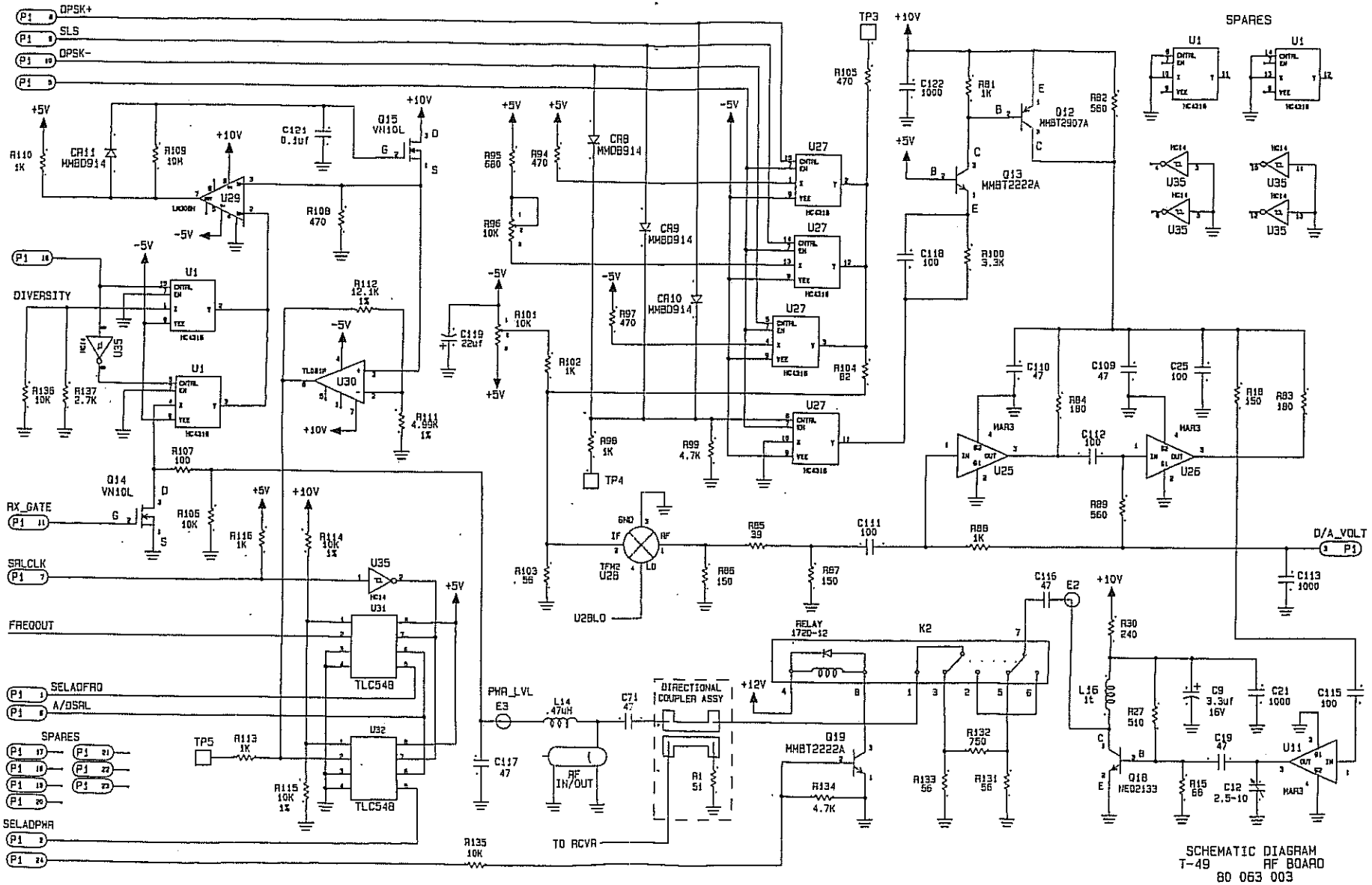


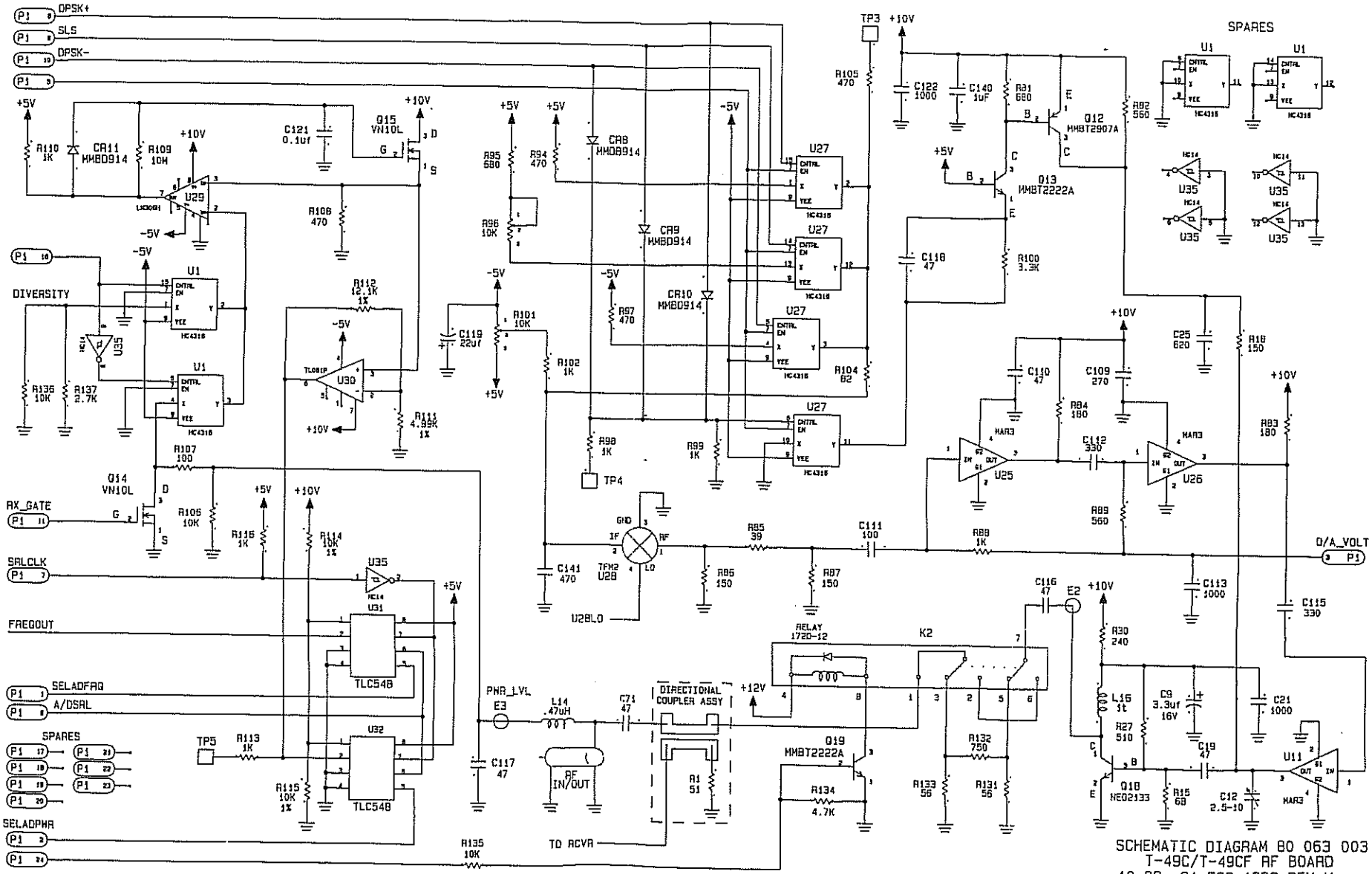
SCHEMATIC DIAGRAM 80 063 003
T-49C/T-49CF RF BOARD

10-29 -91 ECO 1332 REV H
1-21-92 ECO 1336 REV J
11-10-92 ECO 1353 REV K
11-26-97 ECO 1450 REV L
5-6-98 ECO 1463 REV M

SHEET 3

FIGURE 5-4A

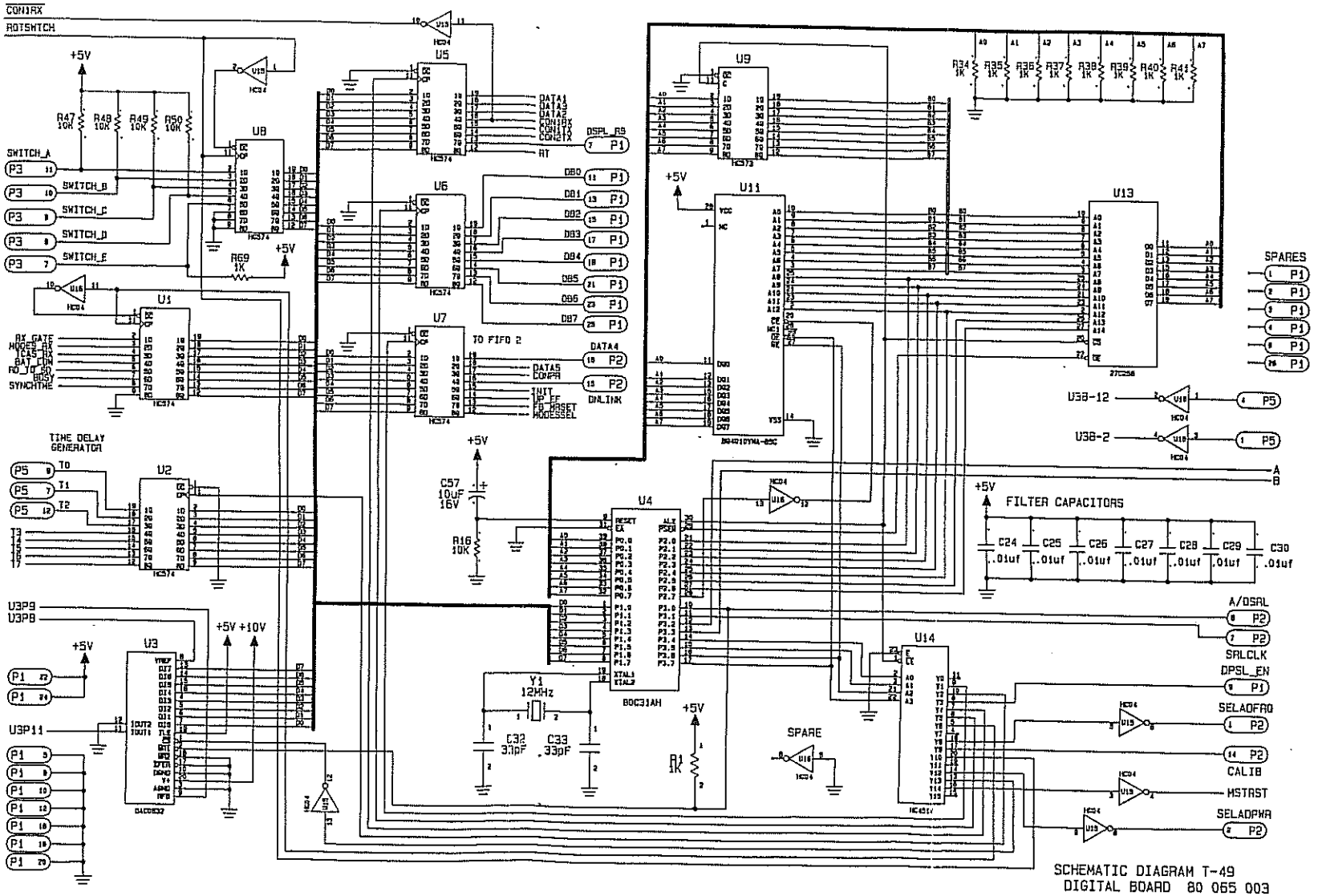

DPSK+
SLS
DPSK-
SPARES
DIVERSITY
RX_GATE
SALCLK
FREQOUT
SELADFRQ
A/DSAL
SELADPWR
SPARES
PWR_LVL
DIRECTIONAL COUPLER ASSY
TO RCVR
RELAY 1720-12
K2
D/A_VOLT
SCHEMATIC DIAGRAM
T-49 RF BOARD
80 063 003
10-29-91 ECO 1332 REV H
1-21-92 ECO 1336 REV J
11-10-92 ECO 1353 REV K
SHEET 4 FIGURE 5-5



SCHEMATIC DIAGRAM 80 063 003
T-49C/T-49CF RF BOARD

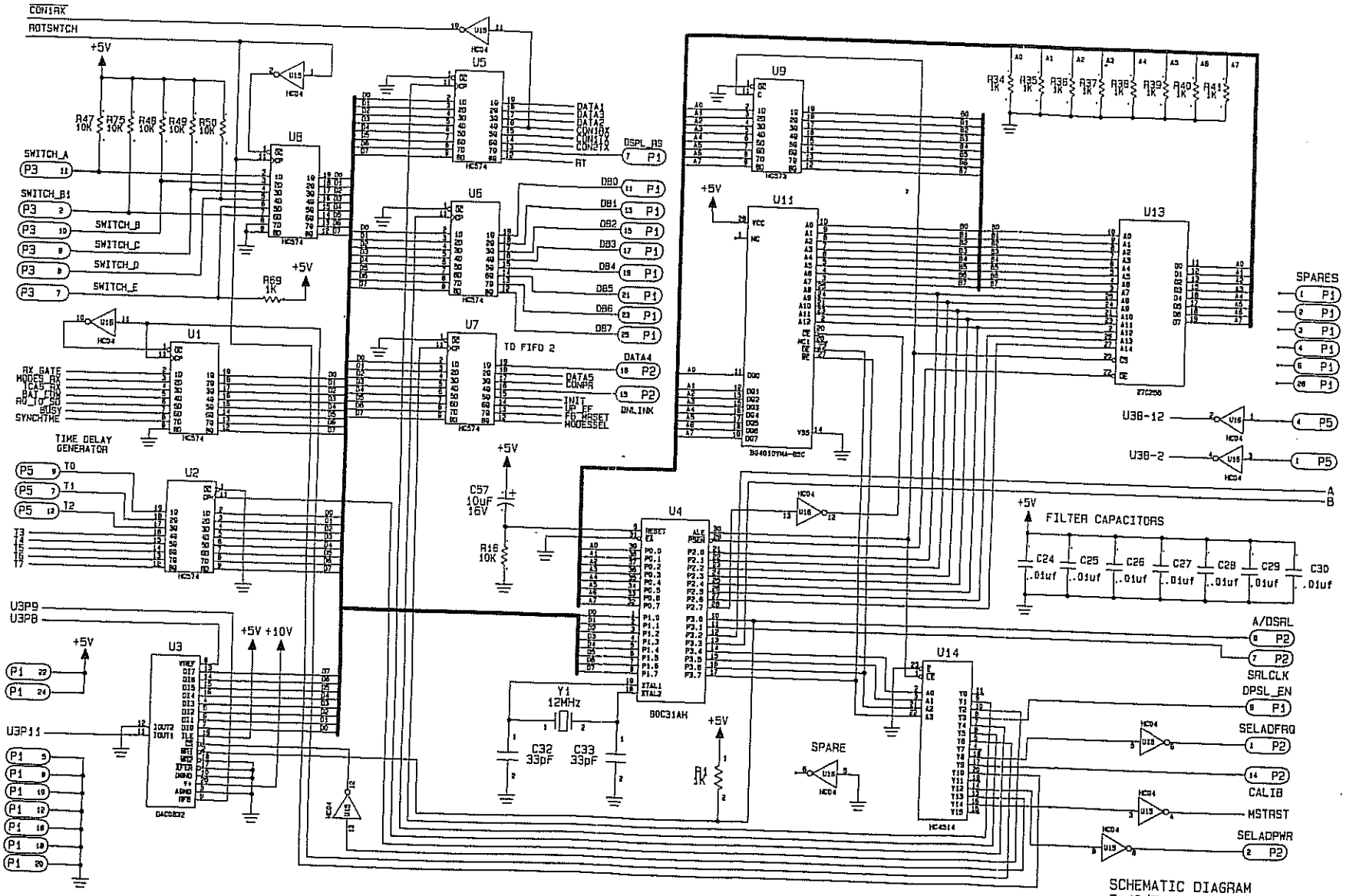
10-29 -91 ECO 1332 REV H
1-21-92 ECO 1336 REV J
11-10-92 ECO 1353 REV K
11-26-97 ECO 1450 REV L
5-6-98 ECO 1463 REV M

SHEET 4 FIGURE 5-5A



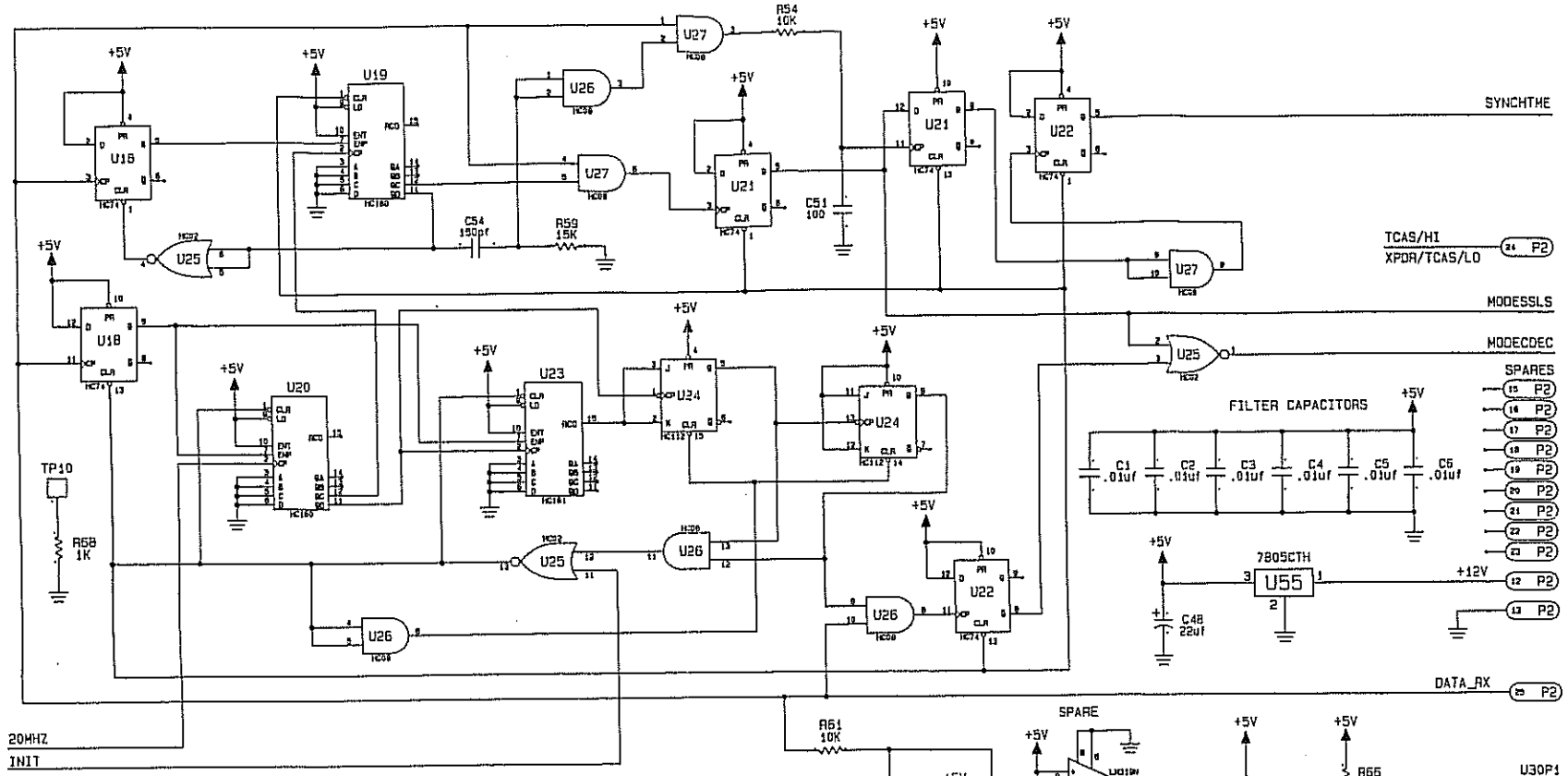
SCHEMATIC DIAGRAM T-49
DIGITAL BOARD 80 065 003
REV E ECO 1332 10-29-91
REV F ECO 1353 7-31-92
REV G ECO 1374 4-26-93

SHEET 1 FIGURE 5-6



SCHEMATIC DIAGRAM
T-48/T-49C/T-49CF
80 065 003
REV H ECO 1450 11-26-97
REV J ECO 1464 6-5-98

SHEET 1 FIGURE 5-6A



COMPONENT	SUPPLY	GND
U24	PIN 16 - +5V	PIN 8
U19, U20	PIN 16 - +5V	PIN 8
U23, U43, U44	PIN 16 - +5V	PIN 8
U30	PIN 16 - +5V	PIN 8
U33, U34, U52	PIN 16 - +5V	PIN 8
U39	PIN 16 - +5V	PIN 8
U29	PIN 16 - +5V	PIN 8
U47	PIN 14 - +5V	PIN 7
U17	PIN 16 - BATTERY	PIN 8
U10, U12	PIN 14 - BATTERY	PIN 7
U9	PIN 20 - +5V	PIN 10

COMPONENT	SUPPLY	GND
U1, U2, U5, U6 U8, U54	PIN 20 - +5V	PIN 10
U4	PIN 40 - +5V	PIN 20
U14	PIN 24 - +5V	PIN 12
U13	PIN 28 - +5V	PIN 14
U15, U16, U48	PIN 14 - +5V	PIN 7
U25, U42, U49	PIN 14 - +5V	PIN 7
U26, U27	PIN 14 - +5V	PIN 7
U35, U40	PIN 14 - +5V	PIN 7
U18, U21, U22, U38 U41, U50, U53, U58	PIN 14 - +5V	PIN 7

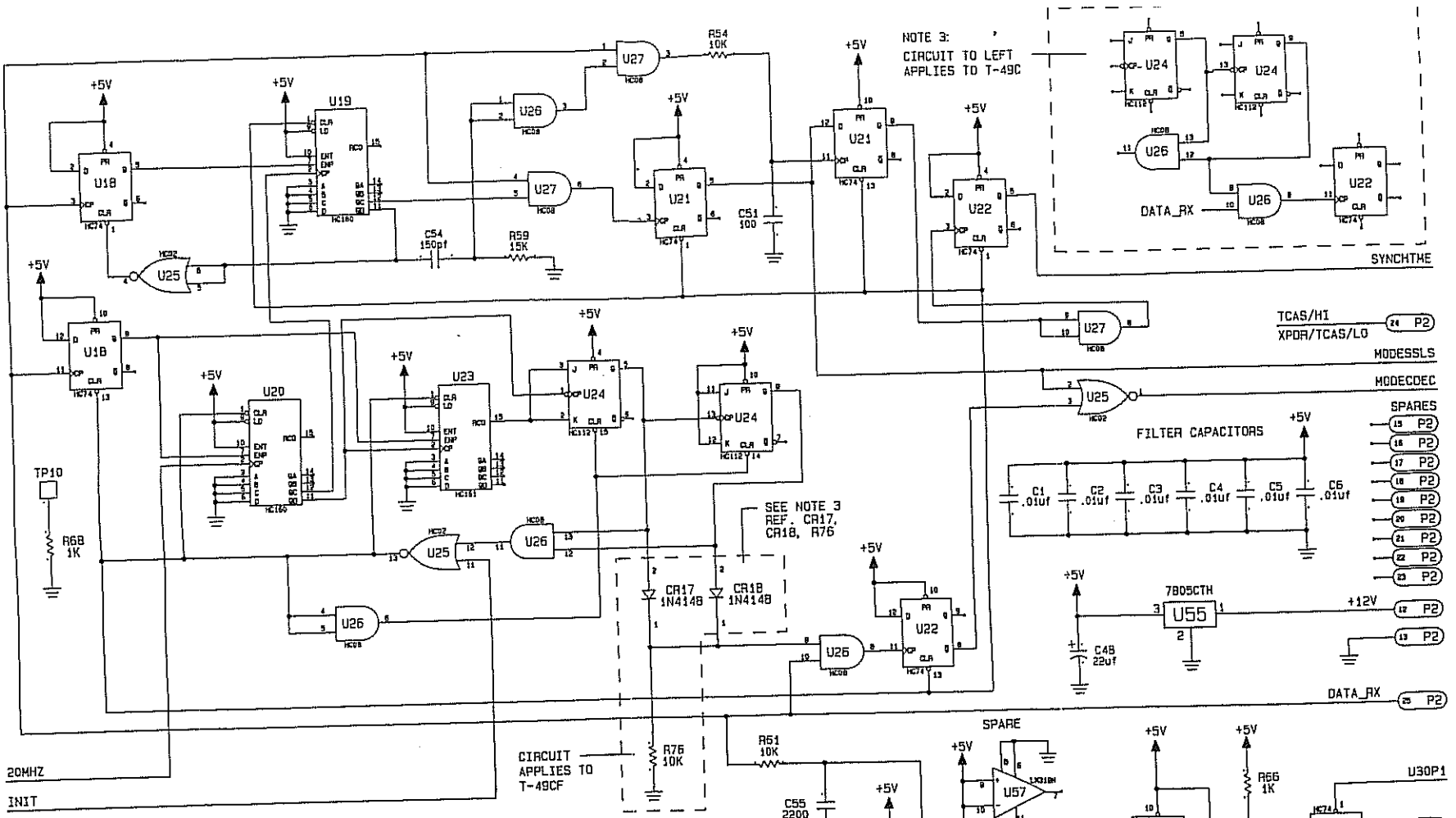
NOTES
UNLESS OTHERWISE SPECIFIED :

1. ALL RESISTORS ARE 1/8W.
2. ALL CAPACITOR VALUES ARE IN PICOFARADS.

SCHEMATIC DIAGRAM T-49
DIGITAL BOARD 80 065 003

REV E ECO 1332 10-29-91
REV F ECO 1353 7-31-92
REV G ECO 1374 4-26-93

SHEET 2 FIGURE 5-7



COMPONENT	SUPPLY	GND
U24	PIN 16 - +5V	PIN 8
U19, U20	PIN 16 - +5V	PIN 8
U23, U43, U44	PIN 16 - +5V	PIN 8
U30	PIN 16 - +5V	PIN 8
U33, U34, U52	PIN 16 - +5V	PIN 8
U39	PIN 16 - +5V	PIN 8
U29	PIN 16 - +5V	PIN 8
U47	PIN 14 - +5V	PIN 7
U17	PIN 16 - BATTERY	PIN 8
U10, U12	PIN 14 - BATTERY	PIN 7
U9	PIN 20 - +5V	PIN 10

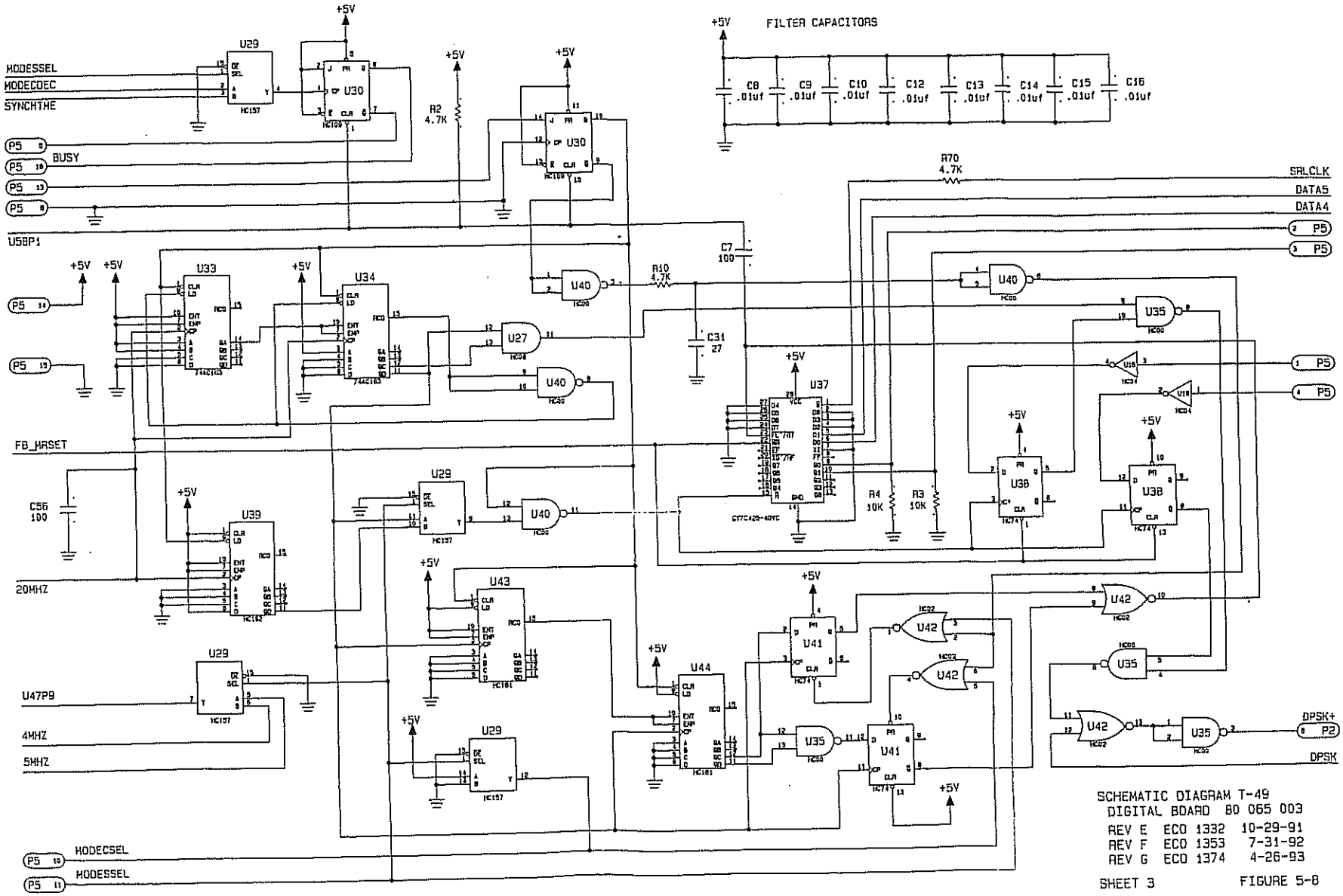
COMPONENT	SUPPLY	GND
U1, U2, U5, U6 U8, U54	PIN 20 - +5V	PIN 10
U4	PIN 40 - +5V	PIN 20
U14	PIN 24 - +5V	PIN 12
U13	PIN 28 - +5V	PIN 14
U15, U16, U48	PIN 14 - +5V	PIN 7
U25, U42, U49	PIN 14 - +5V	PIN 7
U26, U27	PIN 14 - +5V	PIN 7
U35, U40	PIN 14 - +5V	PIN 7
U18, U21, U22, U38 U41, U50, U53, U58	PIN 14 - +5V	PIN 7

NOTES
UNLESS OTHERWISE SPECIFIED :

1. ALL RESISTORS ARE 1/8W.
2. ALL CAPACITOR VALUES ARE IN PICOFARADS.

SCHEMATIC DIAGRAM
T-48/T-49C/T-49CF
80 065 003
REV H ECO 1450 11-26-97
REV J ECO 1464 6-5-98

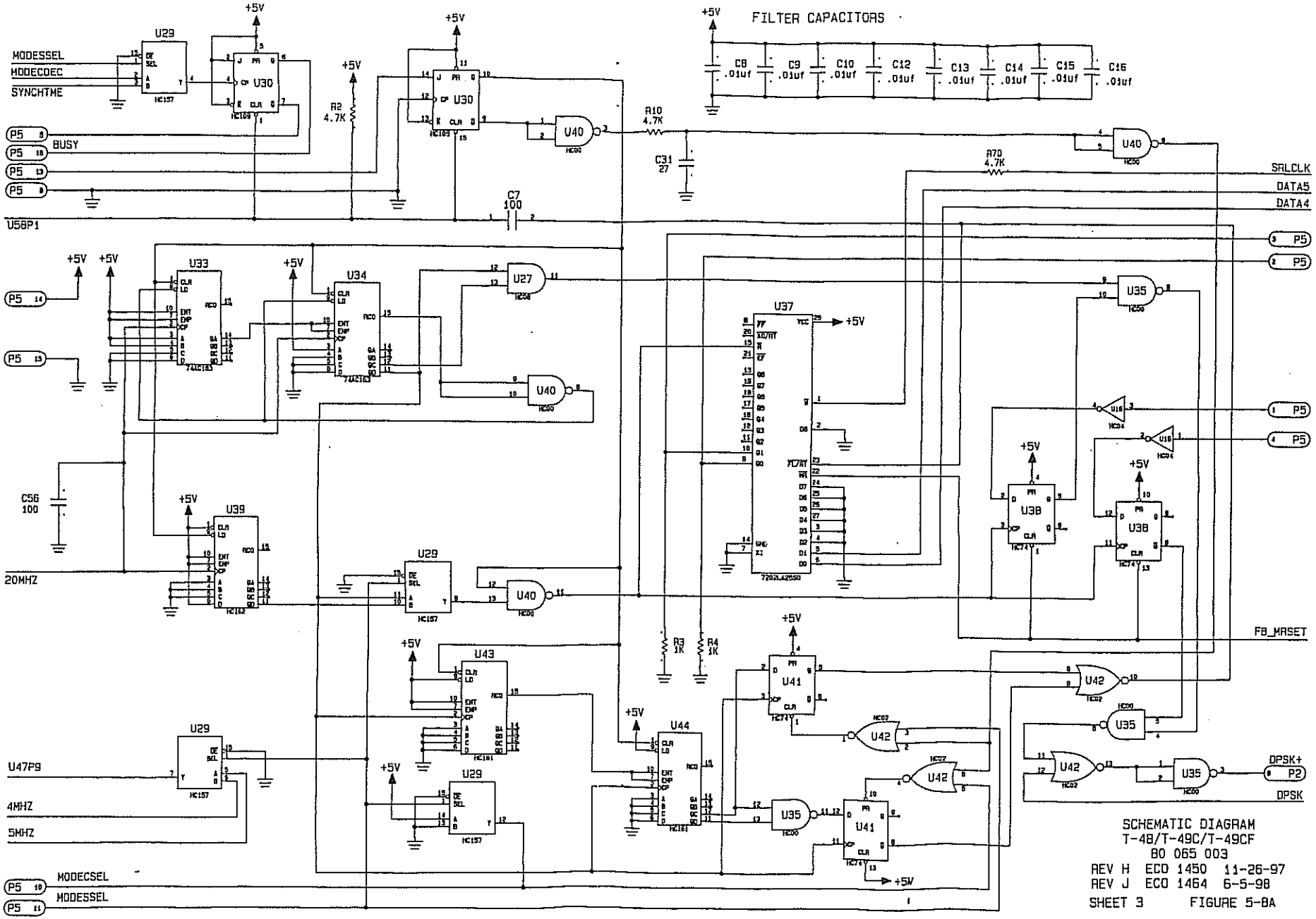
SHEET 2 FIGURE 5-7A

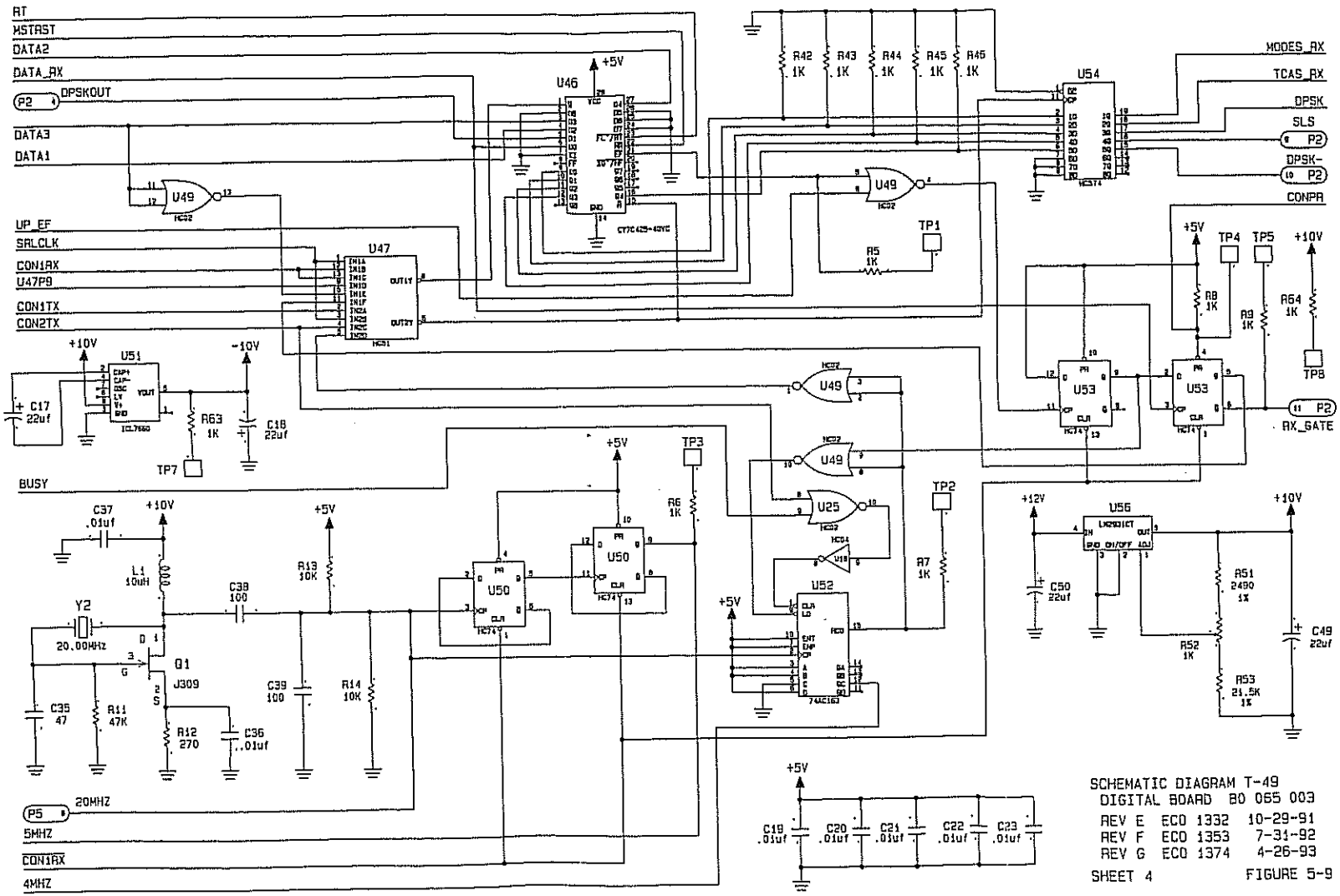


SCHEMATIC DIAGRAM T-49
DIGITAL BOARD 80 065 003

REV E	ECO 1332	10-29-91
REV F	ECO 1353	7-31-92
REV G	ECO 1374	4-26-93

SHEET 3 FIGURE 5-8

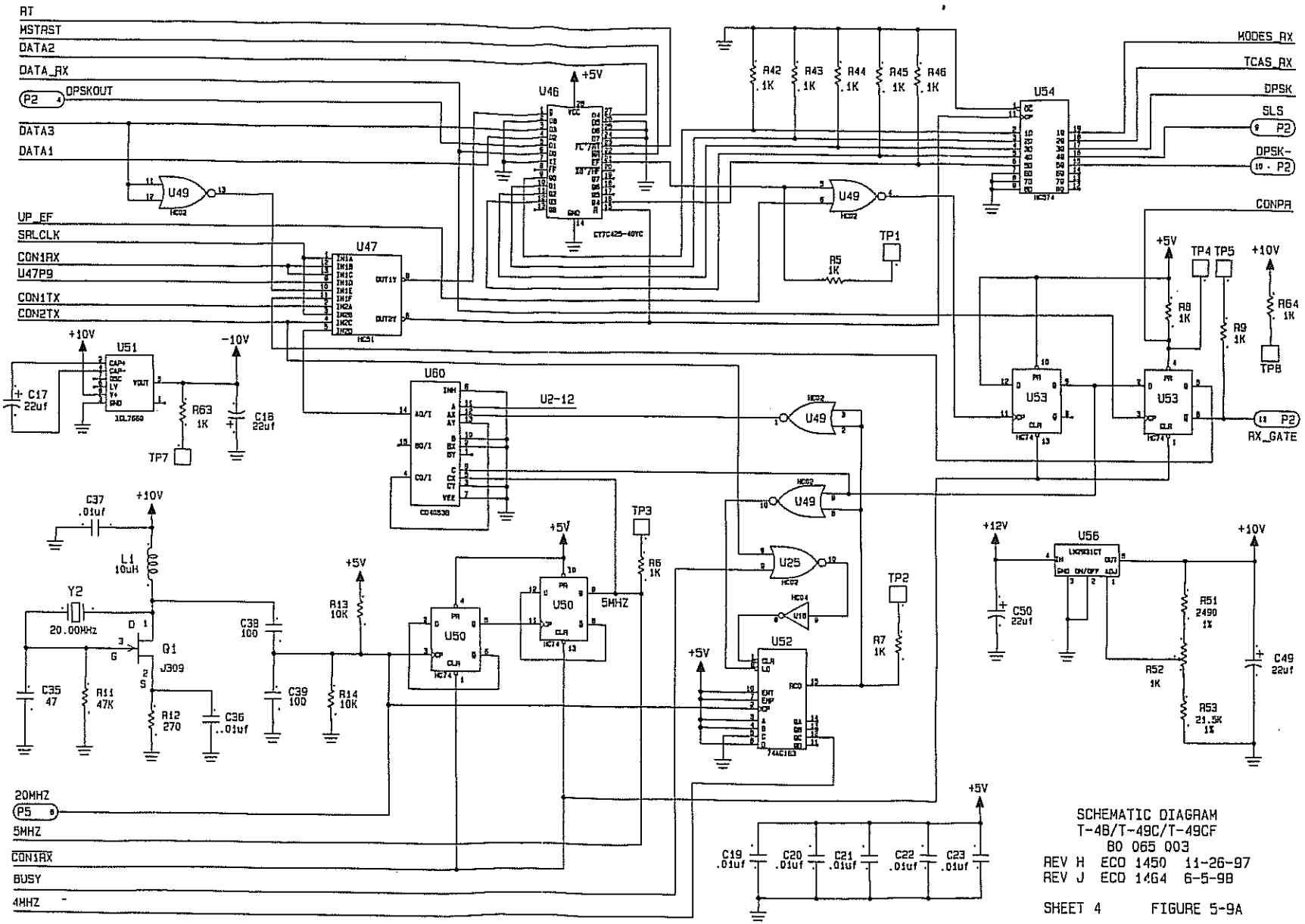

FILTER CAPACITORS
C8 .01uf
C9 .01uf
C10 .01uf
C12 .01uf
C13 .01uf
C14 .01uf
C15 .01uf
C16 .01uf
MODESSEL
MODECOEC
SYNCHTME
BUSY
U58P1
20MHZ
U47P9
4MHZ
5MHZ
MODECSEL
MODESSEL
SRLCLK
DATA5
DATA4
FB_MRSET
DPSK+
DPSK
SCHEMATIC DIAGRAM
T-48/T-49C/T-49CF
80 065 003
REV H ECO 1450 11-26-97
REV J ECO 1464 6-5-98
SHEET 3 FIGURE 5-8A



SCHEMATIC DIAGRAM T-49
DIGITAL BOARD 80 065 003

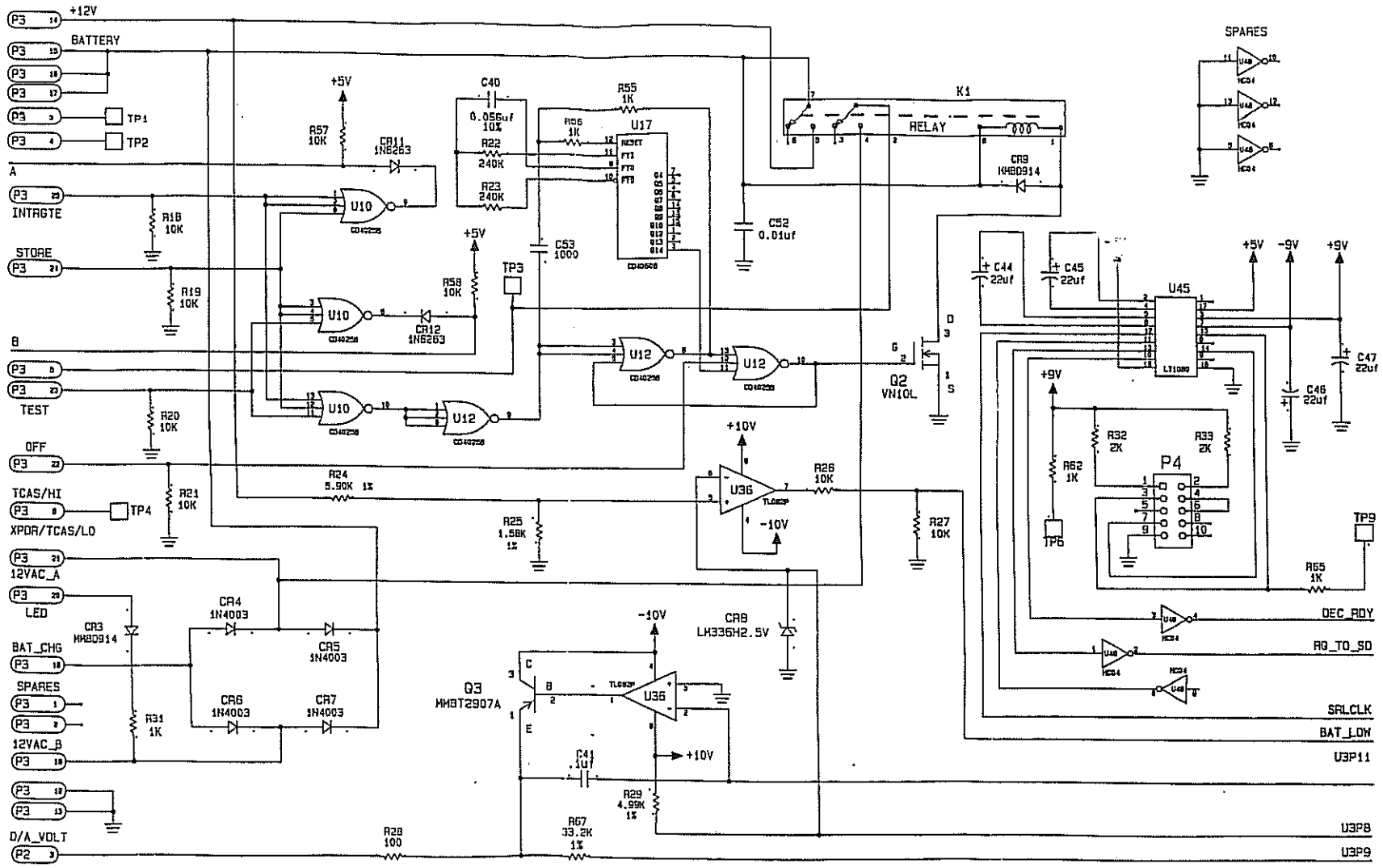
REV E	ECO 1332	10-29-91
REV F	ECO 1353	7-31-92
REV G	ECO 1374	4-26-93

SHEET 4 FIGURE 5-9



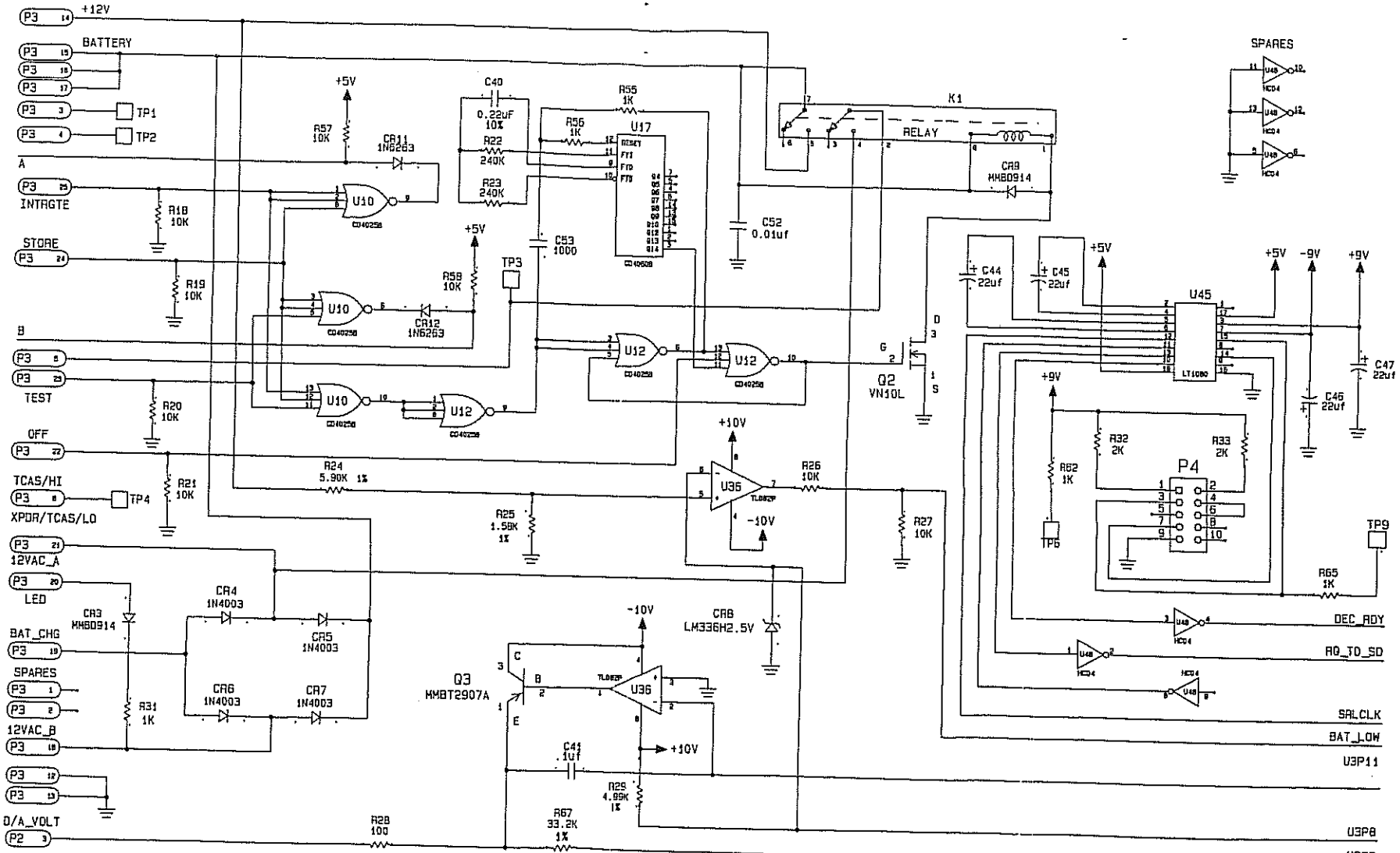
SCHEMATIC DIAGRAM
T-4B/T-49C/T-49CF
80 065 003
REV H ECO 1450 11-26-97
REV J ECO 1464 6-5-98

SHEET 4 FIGURE 5-9A



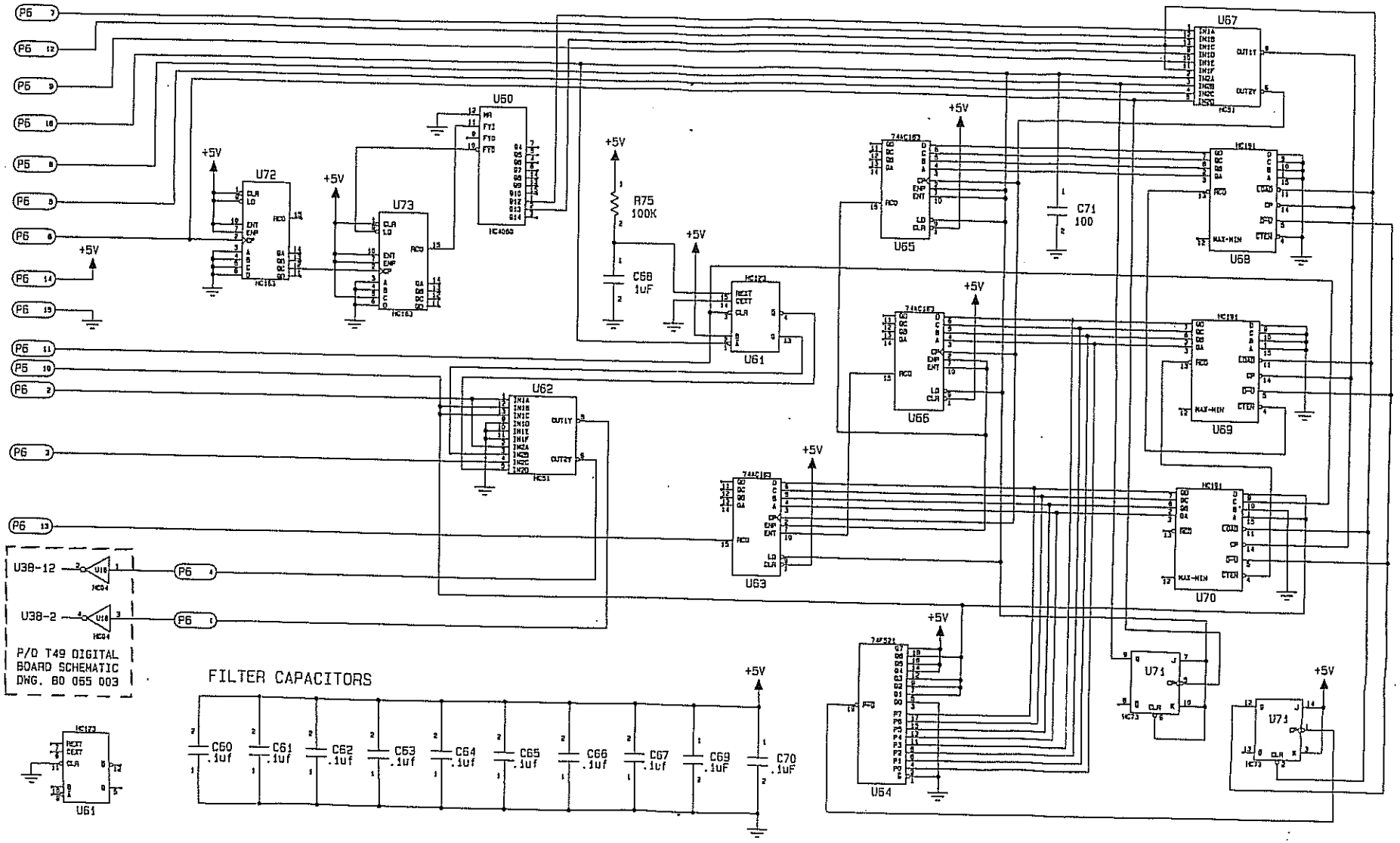
SCHEMATIC DIAGRAM T-49
DIGITAL BOARD 80 065 003
REV E ECO 1332 10-29-91
REV F ECO 1353 7-31-92
REV G ECO 1374 4-26-93

SHEET 5 FIGURE 5-10



SCHEMATIC DIAGRAM
T-48/T-49C/T-49CF
80 065 003
REV H ECO 1450 11-26-97
REV J ECO 1464 6-5-98

SHEET 5 FIGURE 5-10A



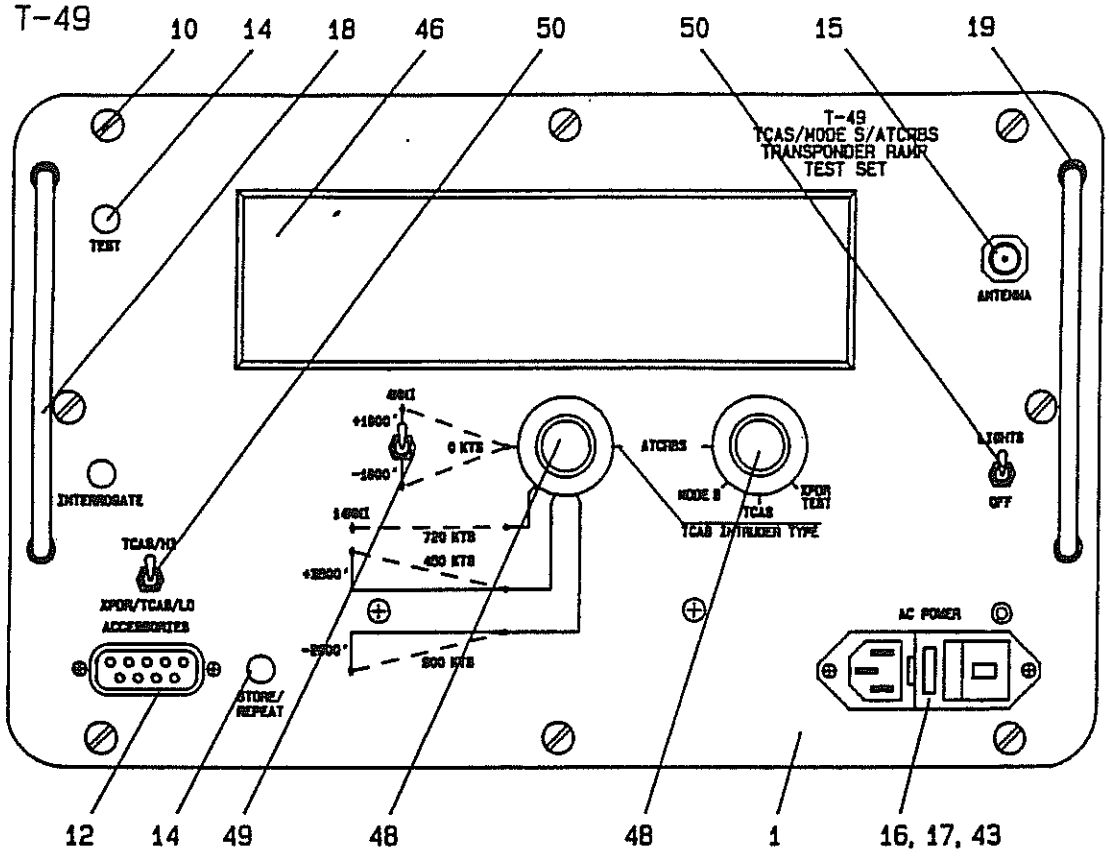
T-49/T-49C/T-49CF
DIGITAL RANGE BOARD
80 087 003 REV C
SHEET 1 FIGURE 5-11

Section 6

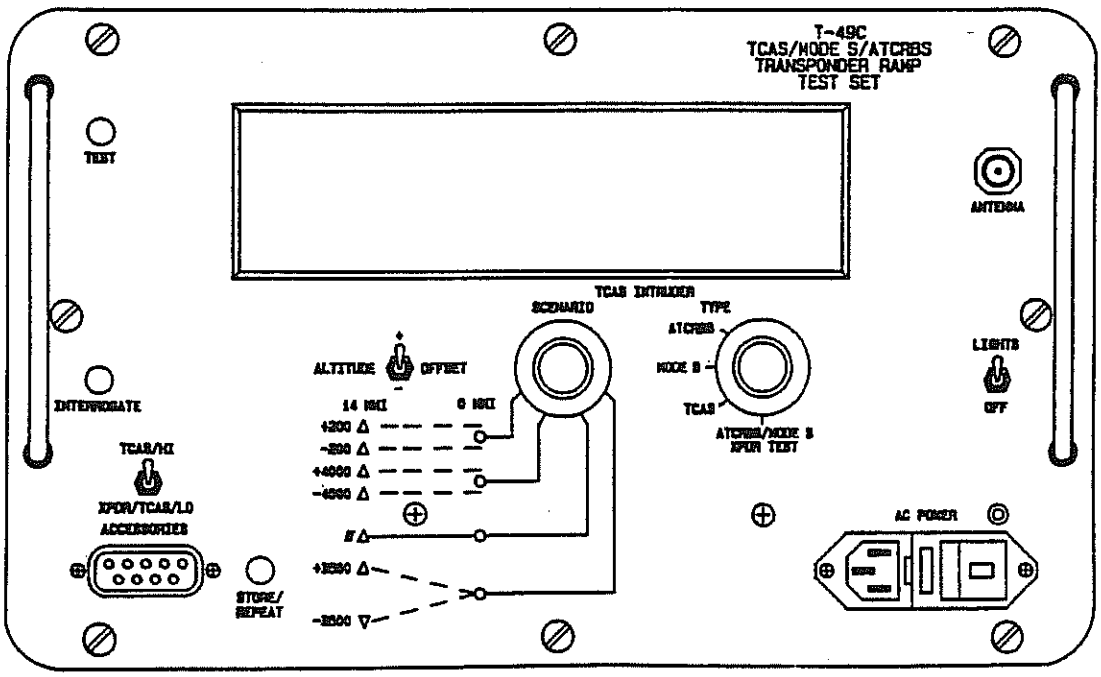
PARTS BREAKDOWN

T-49/T-49C
FRONT PANEL
ASSEMBLY

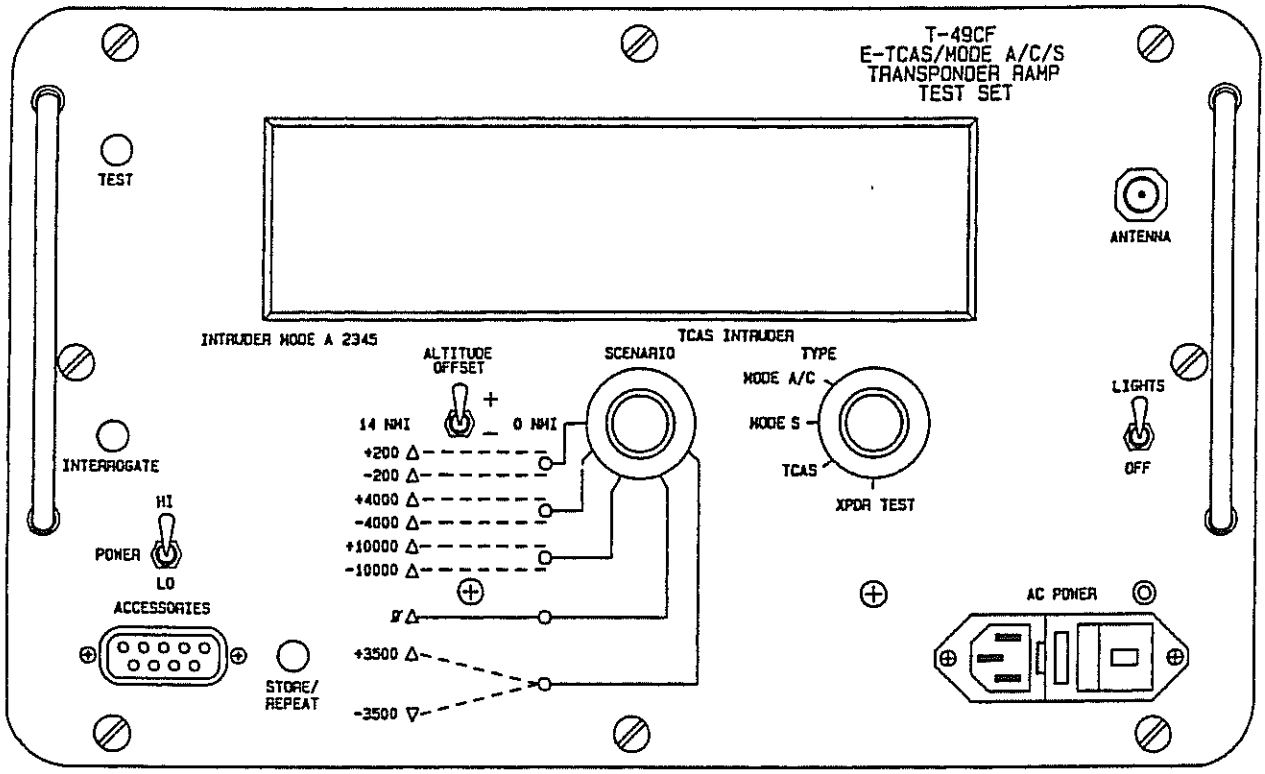
T-49



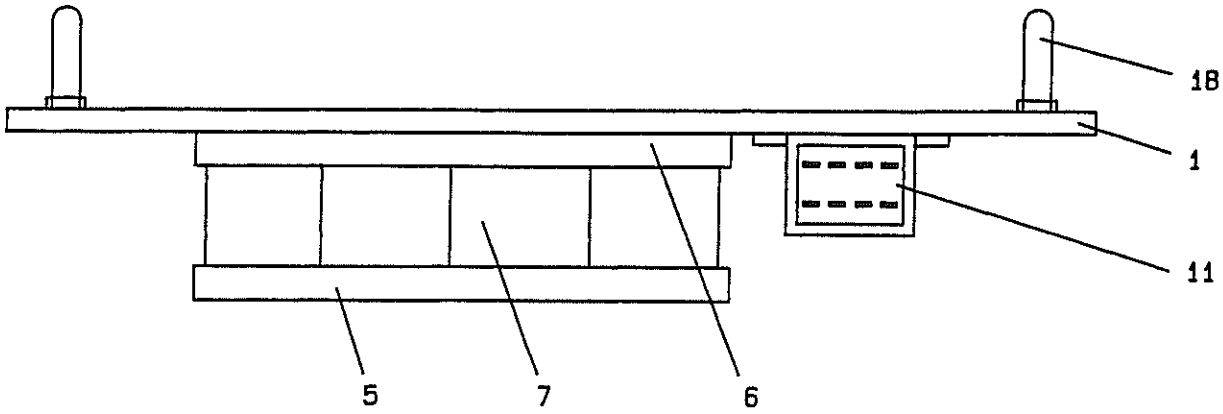
T-49C

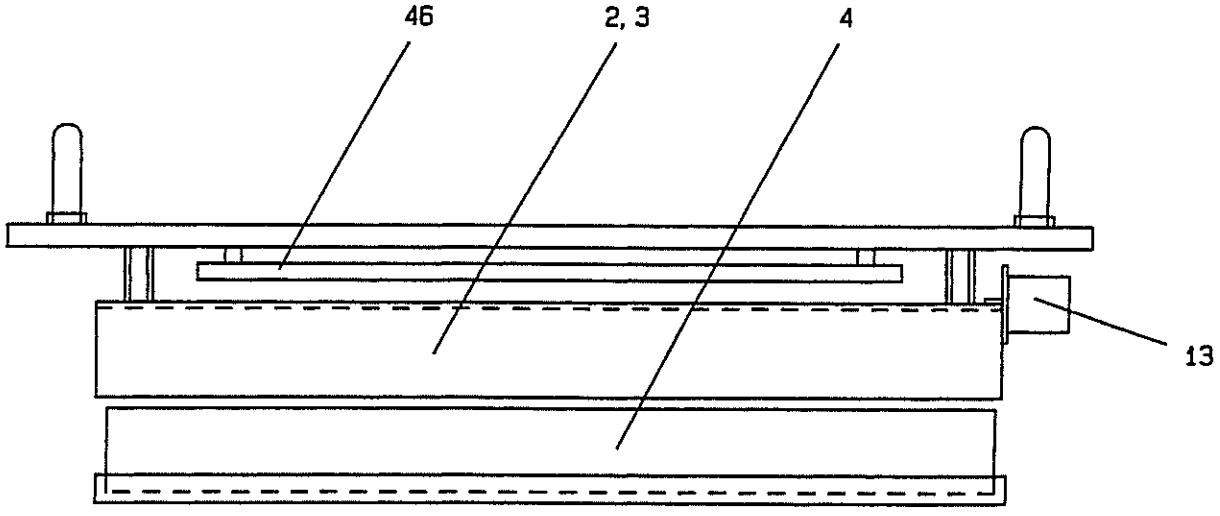


T-49CF
FRONT PANEL
ASSEMBLY



T-49/T-49C/T-49CF
FRONT PANEL
ASSEMBLY



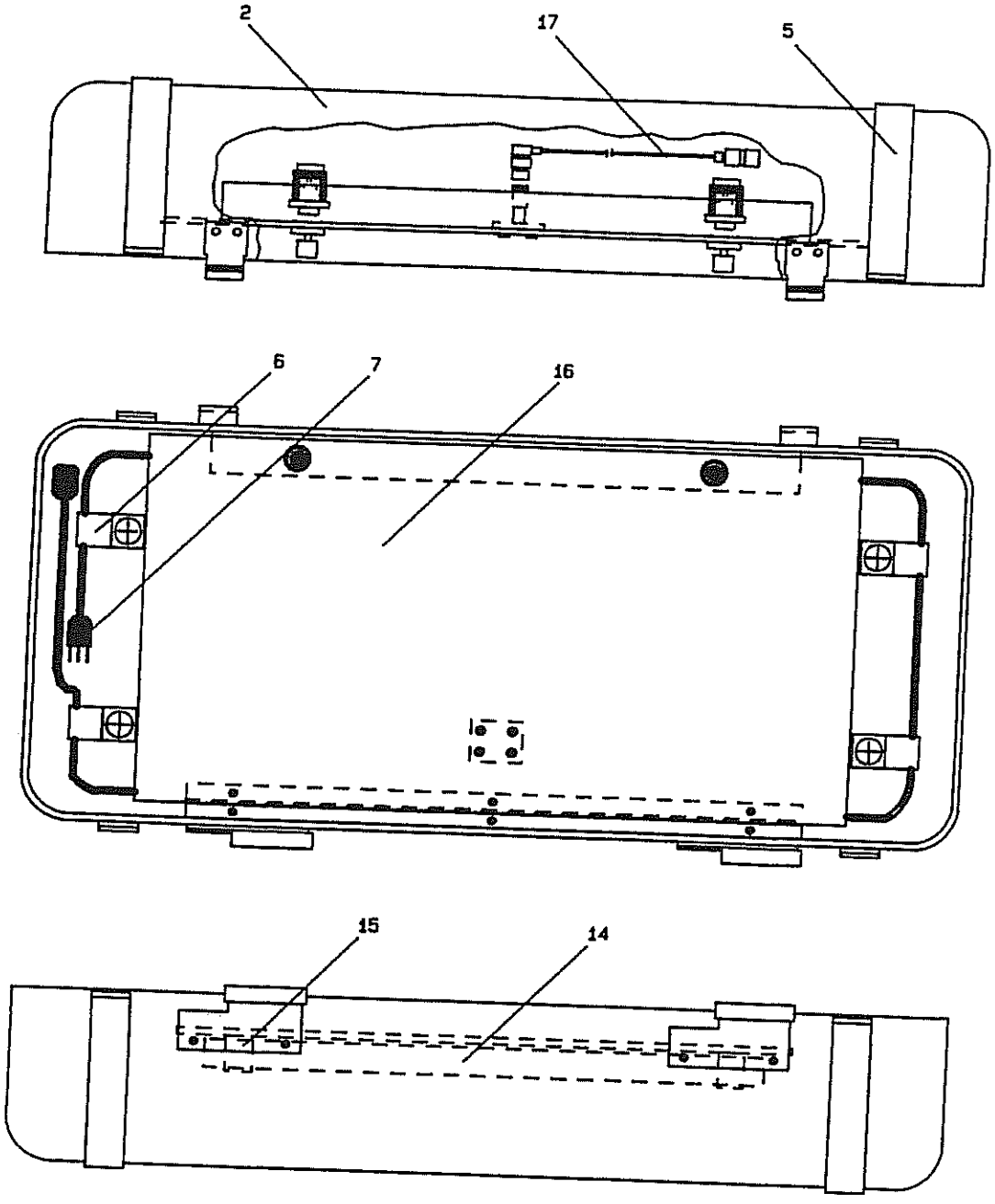


T-49/T-49C/T-49CF
FRONT PANEL
PARTS LIST

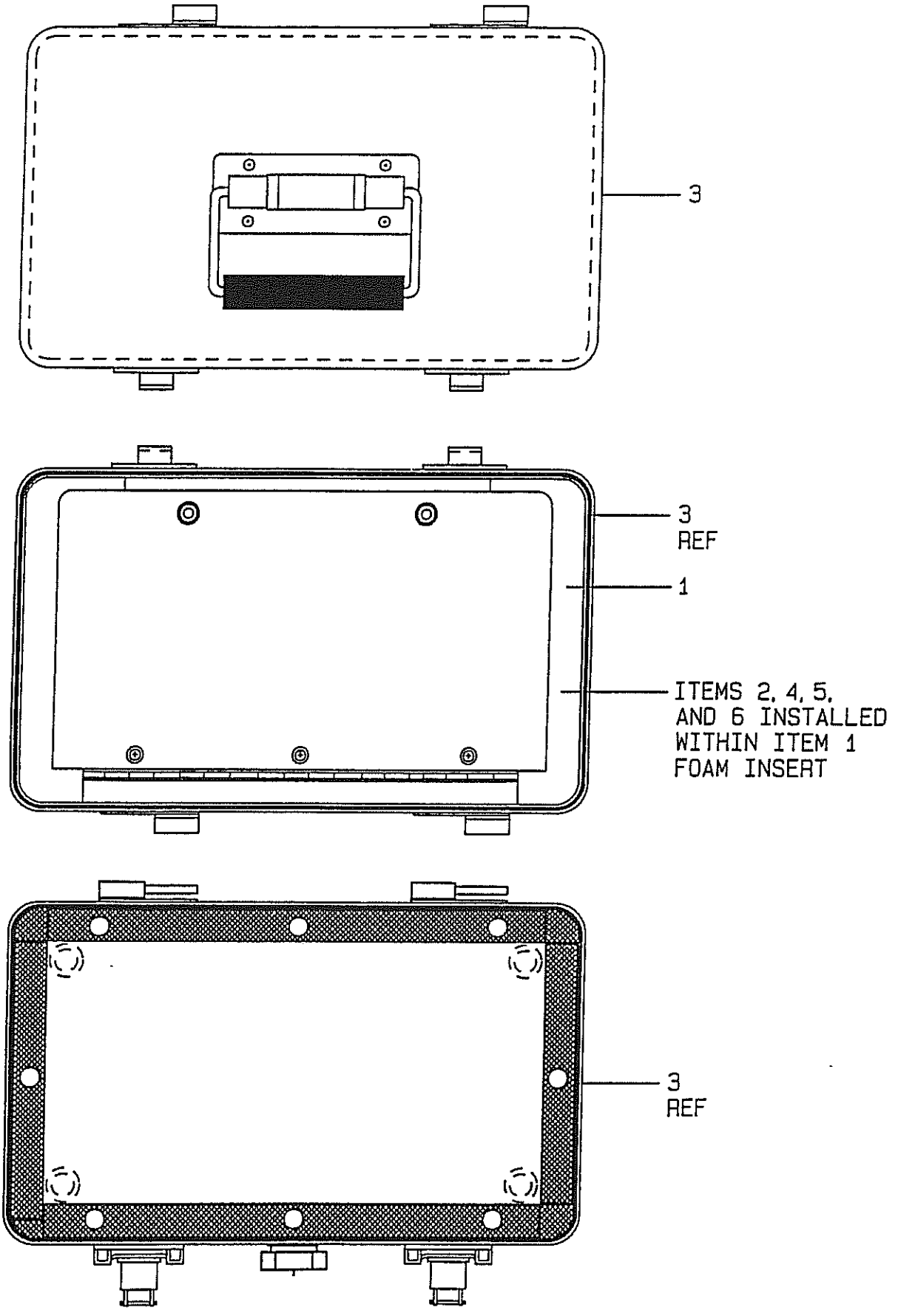
89000023 REV "H"

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	61060015	PANEL, FRONT	1
2	62000014	CHASSIS, DIGITAL	1
3	80065001	PCB ASSEMBLY, DIGITAL	1
4	89000022	RF BOX ASSEMBLY	1
5	62020033	BRACKET, BATTERY MTG., BOTTOM	1
6	62020038	BRACKET, BATTERY MTG., TOP	1
7	48071001	BATTERY PACK	1
8	62020039	BRACKET, BATTERY SUPPORT	1
9	80087001	PCB ASSEMBLY, DIGITAL RANGE	1
10	56020001	FASTENER, PANEL	8
11	43000001	TRANSFORMER	1
12	75010030	CABLE ASSEMBLY, ACCESSORIES	1
13	80067001	PCB ASSEMBLY, INVERTER	1
14	46027506	SWITCH, PUSHBUTTON, SPDT	3
15	75010029	CABLE ASSEMBLY, COAX	1
16	48035001	AC RECEPTACLE, CASING	1
17	48035002	FUSEDRAWER	1
18	56025006	HANDLE	2
19	31020035	FERRULE	4
20	75001003	CABLE, WIRING HARNESS	1
21	52400009	STANDOFF, 1/4 HEX, 6-32 X 7/8LG	5
22	52400010	STANDOFF, 1/4 HEX, 6-32 X 3/16LG	6
23	52400001	STANDOFF, 1/4 HEX, 8-32 X 2-1/2LG	2
24	75010027	CABLE ASSEMBLY, DIGITAL TO RF	1
25	50140003	SCREW, FLAT HD. 8-32 X 7/16LG	2
26	50140005	SCREW, FLAT HD. 4-40 X 3/8LG	2
27	52020002	WASHER, LOCK, NO.4	8
28	53010002	NUT, HEX, NO.4	2
29	50140002	SCREW, FLAT HD. 8-32 X 3/8LG	4
30	50110007	SCREW, P.H. 4-40 X 1/4LG	4
31	50110001	SCREW, P.H. 6-32 X 5/16LG	9
32	52020001	WASHER, LOCK, NO.6	11
33	50110013	SCREW, P.H. 8-32 X 3/8LG	2
34	53010001	NUT, HEX NO.6	6
35	50110009	SCREW, P.H. 4-40 X 5/16LG	2
36	75010028	CABLE ASSEMBLY, LCD TO DIGITAL	1
37	62030006	BRACKET, FUSE MOUNTING	1
38	48063001	FUSE BLOCK	1
39	45100004	FUSE, 1A	1
40	45100005	FUSE, 2A, SLO-BLO	1
41	45001002	INDICATOR, LED	1
42	46027507	SWITCH, TOGGLE	1
43	45100001	FUSE, 1/4A, SLO-BLO	2
44	41400002	RESISTOR, POWER, 6 OHMS	2
45	51010001	EYELET	4
46	89000026	LCD MODULE ASSEMBLY	1
47	46020011	SWITCH, ROTARY	1
48	57025007	KNOB	2
49	46020012	SWITCH, ROTARY	1
50	46027508	SWITCH, TOGGLE	2
51	48063003	COVER, FUSE	2

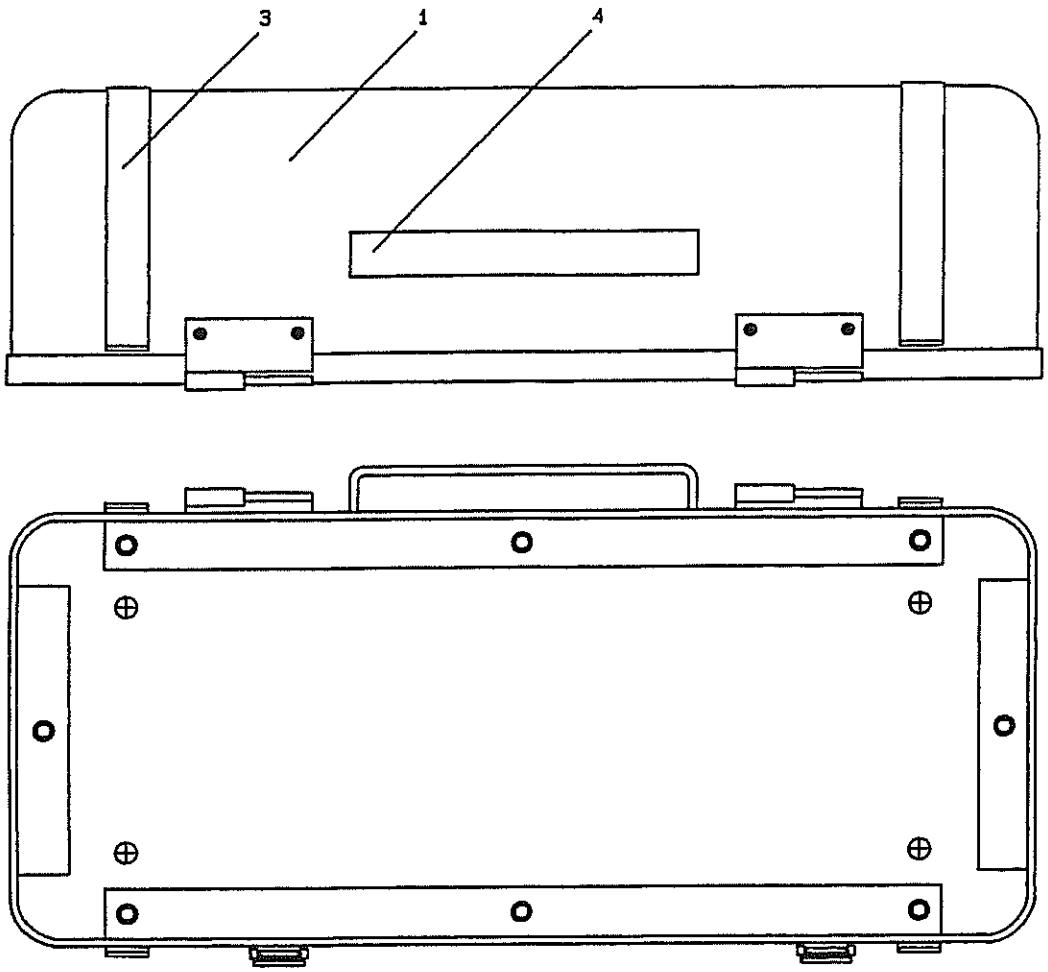
T-49/T-49C
CASE ASSEMBLY
(TOP)



T-49C/T-49CF
CASE ASSEMBLY



T-49/T-49C
CASE ASSEMBLY
(BOTTOM)



89000025 REV "D"

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	64030012	CASE, BOTTOM	1
2	64030013	CASE, TOP	1
3	31020038	RAIL, CASE, BOTTOM	2
4	56025005	HANDLE, CASE	1
5	31020037	RAIL, CASE, TOP	2
6	62020040	BRACKET, POWER CORD	4
7	75010025	CABLE ASSY, LINE CORD	1
8	50110014	SCREW, P.H. 10-32 X 7/16LG	2
9	52020004	WASHER, LOCK, NO.10	2
10	50110015	SCREW, P.H. 6-32 X 1/4LG	13
11	52020001	WASHER, LOCK, NO.6	17
12	50110001	SCREW, P.H. 6-32 X 5/16LG	3
13	43008002	DISK, COMPUTER RS232 PROGRAMS	1
14	89000021	ANTENNA ASSY, TSP-1	1
15	56012002	CLIP, MOUNTING	2
16	89000028	DIRECTIONAL ANTENNA ASSY	1
17	75010036	CABLE ASSY, COAX	1
18	51008003	RIVET, 120 DEGREE C'SINK	2
19	51008005	RIVET, DOME HEAD	3

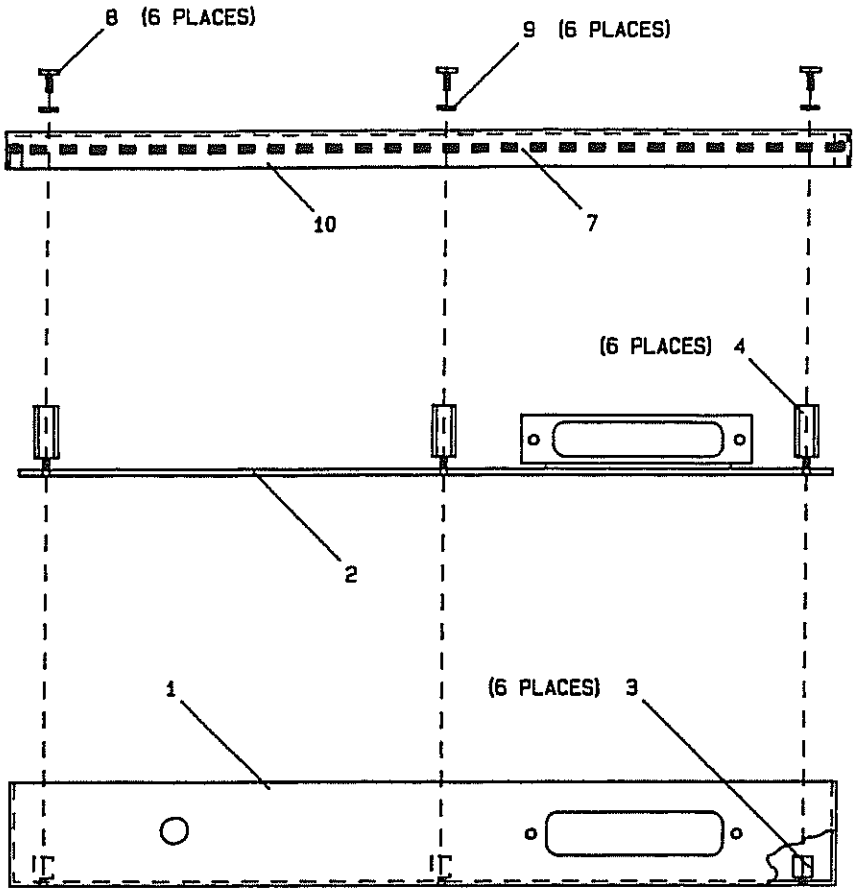
T-49C CASE ASSEMBLY

ITEM #	P/N	STOCK #	DESCRIPTION	U	UNITS
1	31000007	I-900	Insert, Case	ea	1
2					
3	64030026	C-700-A	Case, Assembly	ea	1
4	89000043		Coupler, Antenna, Anti-radition, TAP-125	ea	1
5	75010025	L-6-A	Line Cord, Belden # 17250	ea	1
6	40030009	TSP-1A	Antenna	ea	1

T-49CF CASE ASSEMBLY

ITEM #	P/N	STOCK #	DESCRIPTION	U	UNITS
1	31000007	I-900	Insert, Case	ea	1
2	89000051		Direct Connect Assy, TAP-121	ea	1
3	64030026	C-700-A	Case, Assembly	ea	1
4	89000065		Coupler, Antenna, TAP-131	ea	1
5	75010025	L-6-A	Line Cord, Belden # 17250	ea	1
6	40030009	TSP-1A	Antenna	ea	1

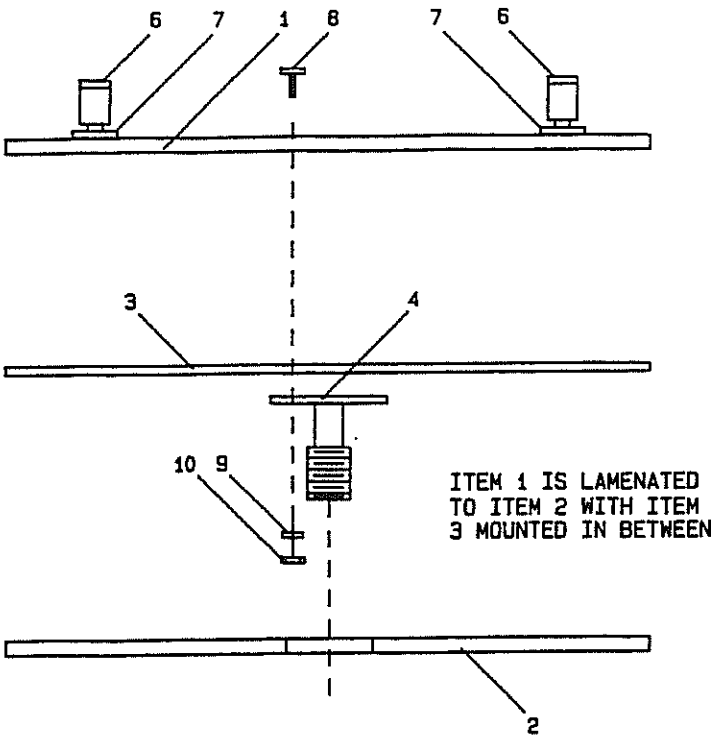
T-49/T-49C/T-49CF
RF BOX
ASSEMBLY



89000022 REV "A"

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	62000015	CHASSIS, RF	1
2	80063001	PCB ASSEMBLY, RF	1
3	52300001	STANDOFF, 1/4 ROUND SWAGE	6
4	52700001	STANDOFF, 1/4 HEX, (M-FM)	6
5	52020002	WASHER, LOCK, NO.4	2
6	50110002	SCREW, P.H. 4-40 X 1/4LG	2
7	55060001	SHIELDING, SPIROL	3FT
8	50110015	SCREW, P.H. 6-32 X 1/4LG	6
9	52020001	WASHER, LOCK NO.6	6
10	62040004	COVER ASSEMBLY	1

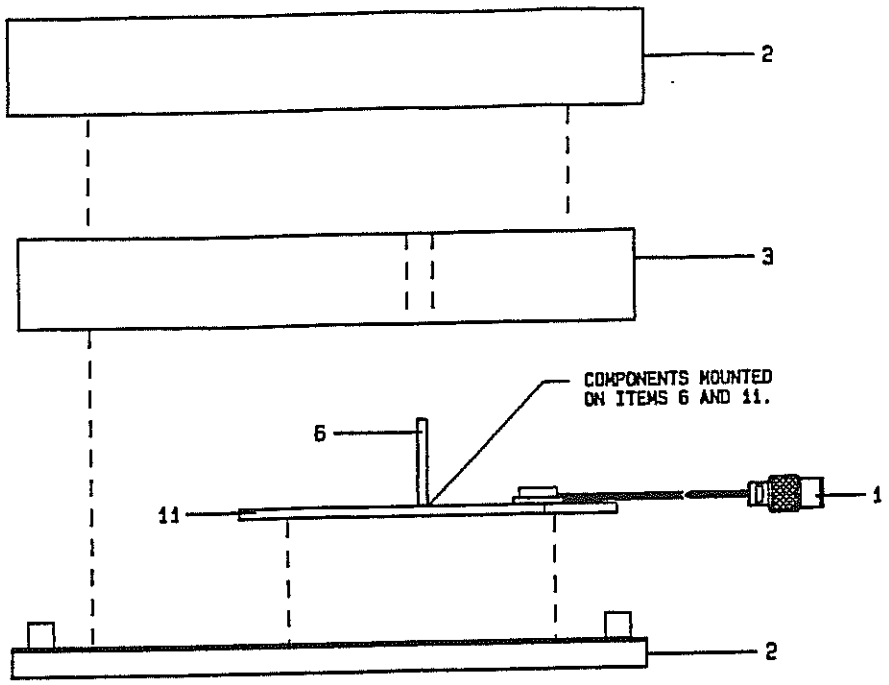
T-49/T-49C/T-49CF
DIRECTIONAL ANTENNA
ASSEMBLY



89000028 REV "E"

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	62070017	COVER,PROTECTIVE,TOP	1
2	62070018	COVER,PROTECTIVE,BOTTOM	1
3	80068001	PCB ASSEMBLY REV "A" DIRECTIONAL ANTENNA	1
4	48040017	CONNECTOR,FLANGE MTG.	1
5	56032007	HINGE,MODIFIED	1
6	50700001	STUD	2
7	53700001	RETAINER RING	2
8	50110018	SCREW,P.H. 3-48 X 5/16LG	4
9	52020005	WASHER,LOCK NO.3	4
10	53010003	NUT,PLAIN,HEX NO.3	4
11	51008004	RIVET,DOME HEAD	2
12	52020002	WASHER,LOCK NO.4	1
13	53010002	NUT,PLAIN,HEX NO.4	1
14	56000004	CLAMP,CABLE	1
15	50110017	SCREW,P.H. 4-40 X 5/8LG	1

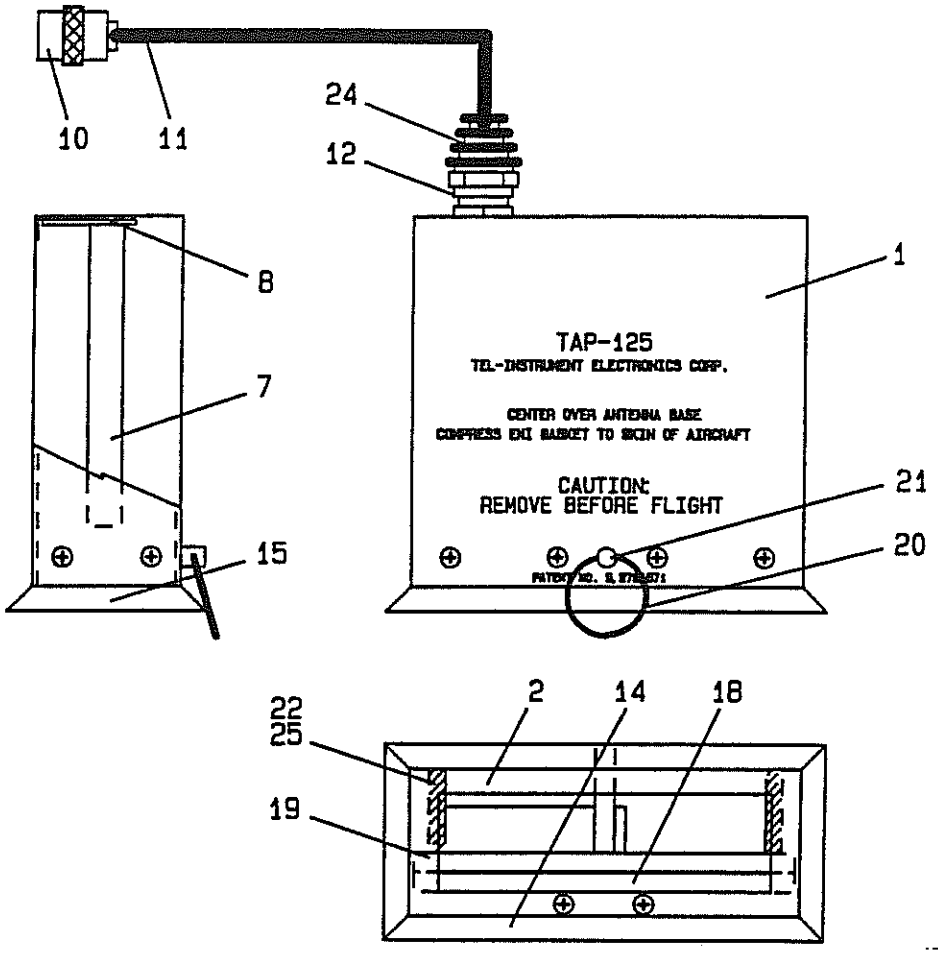
T-49
TAP-115
COUPLER
ASSEMBLY



90 000 038 REV "B"

ITEM NO.	PART NO.	DESCRIPTION	QTY	REF. DESIG.
1	75010035	CABLE ASSEMBLY	1	
2	64030015	CASE, PLASTIC	1	
3	31000003	FOAM, INSULATING	1	
4	40010007	DIODE, 1N6263	1	
5	55001001	STRAP, COPPER	1	
6	31003002	TEFLON-FG, 2.5 DIELECTRIC	1	
7	41160011	RES.CHIP,RC1206, 100 OHMS	1	R3
8	41141046	RES.C.C.,1/8W, 39 OHMS	1	R2
9	41160001	RES.CHIP,RC1206, 270 OHMS	1	R4
10	41141047	RES.C.C.,1/8W, 240 OHMS	1	R1
11	62070016	PLATE, GROUND	1	
12	42020017	CAP.CHIP, 3.3pF	1	C1

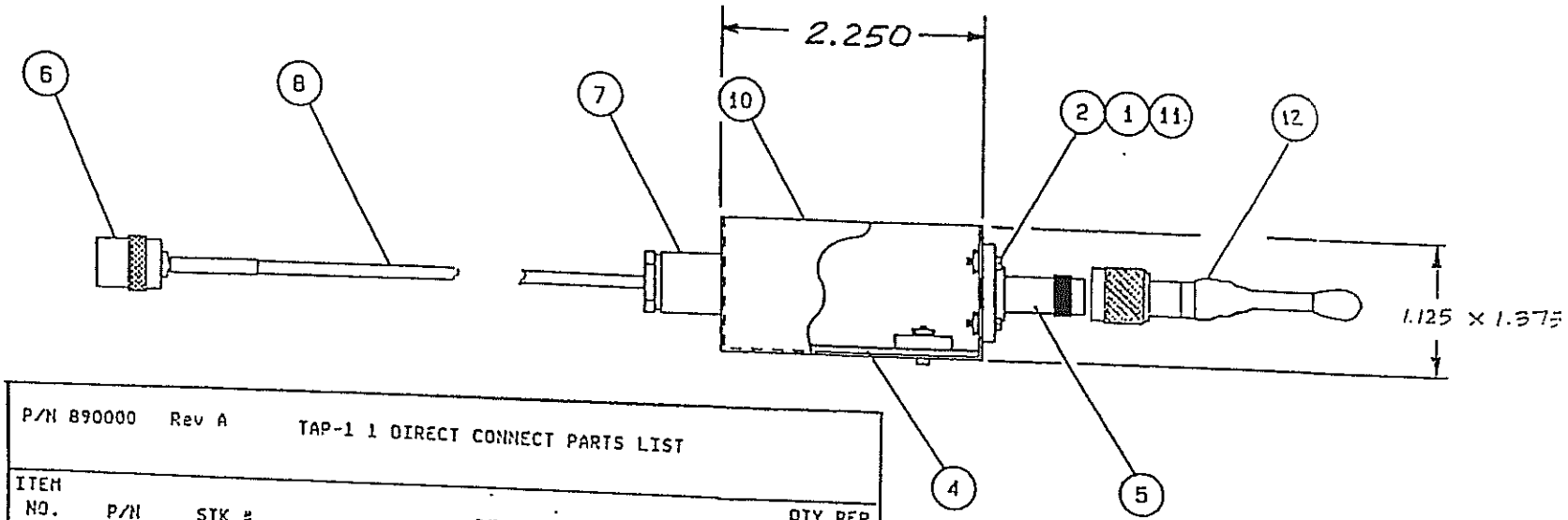
T-49/T-49C
TAP-125
ARC COUPLER
ASSEMBLY



89 000 043 REV "A"

ITEM NO.	PART NO.	DESCRIPTION	QTY
1	64050014	CAN	1
2	64050015	FRAME, INNER	1
3	52020002	WASHER, LOCK, NO.4	13
4	50110002	SCREW, P.H., 4-40 X 1/2 LG.	2
5	50110009	SCREW, P.H., 4-40 X 5/16 LG.	11
6	44002003	ATTENUATOR, 125W, 20dB	1
7	40030006	ANTENNA, TUBE ASSEMBLY	1
8	80094001	PCB ASSEMBLY, ARC	1
9	64030021	BAG, CARRY NO.18677	1
10	48040018	CONNECTOR, COAX	1
11	71110001	CABLE, COAX, RG-58C/U	10FT
12	48040033	CONNECTOR, COAX, 1/2 HEX	1
13	31020071	FERRULE, CRIMP SLEEVE	1
14	55082007	GASKET, RF FILTER, LARGE	2
15	55082009	GASKET, RF FILTER, SMALL	2
16		GASKET, CARBON TECHNIT	REF
17	55082010	GASKET, DURO 50, 1/2 X 1/4	1.5FT
18	62070026	PLATE, FIXED, PHENOLIC	1
19	62070027	PLATE, MOVABLE, PHENOLIC	1
20	53700002	RING, KEY	1
21	51009002	ROD, PULL	1
22	52400017	STANDOFF, 3/16 HEX	2
23	31016001	STREAMER, WARNING	1
24	55001002	STRAIN RELIEF, MODIFIED	1
25	56023001	SPRING	2

REV	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE	12-16-96	DH



P/N 890000 Rev A TAP-1 1 DIRECT CONNECT PARTS LIST

ITEM NO.	P/N	STK #	DESCRIPTION	U	QTY PER UNIT
1	52020002		Lockwasher,#4,MS35338-135	ea	6
2	50110009		Screw,PH,#4-40X5/16,MS51957-14	ea	6
3	44002004	A-522	Attenuator,Sm, 10db,JFW #A-210-010-125	ea	1
4	80094008		PCB Assy,Modifify B-234 (80094001)	ea	1
5	48040009	C-242	Connector,Coax,TNC,Amph #31-2300	ea	1
6	48040018	C-241-2	Connector,Coax,TNC,Amph #31-2367	ea	1
7	48040024	C-258	Connector,Coax,Amph #24968 (713-0-3-4)	ea	1
8	71110001	C-6-A	Cable,Coax,RG-58C/U	ft	10
9	55075002	F-7-A	Contact Strip,16",Inst Spec #97-110-01	ea	0.125
10	62000029	Z-612	Chassis,Direct Connect	ea	1
11	53010002		Nut,Hex,#4,MS35649-244	ea	6
12	40030009	AT5P-1A	ANTENNA C-1000-TNC	ea	1

WT. - 4 OZ.

SEE ASSOCIATED PARTS LIST

	T-49CF
NEXT ASSY	USED ON

MATERIAL

FINISH

CONTRACT NO.

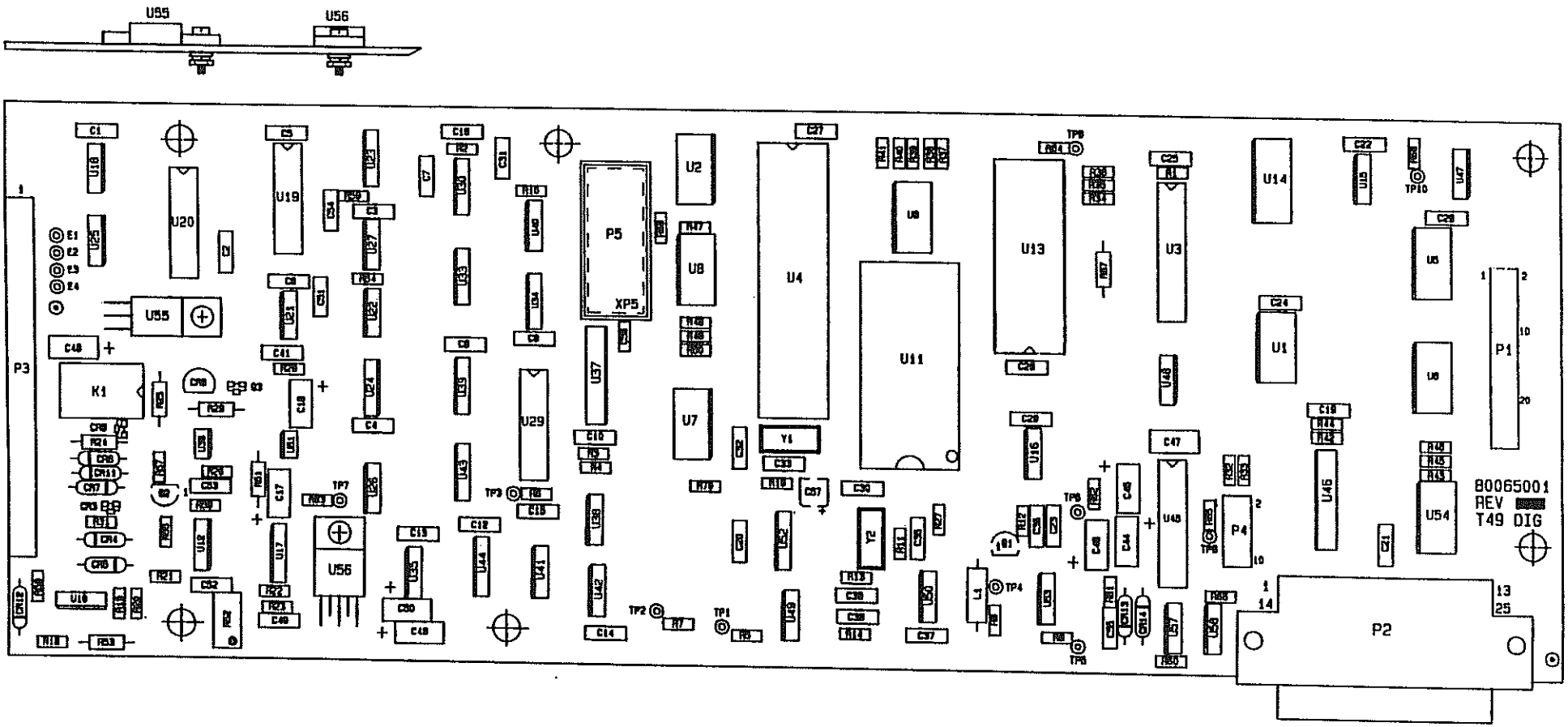
APPROVALS	DATE
DRAWN D.McMAHON	12-16-96
CHECKED	12-16-96
ISSUED	

TEL-INSTRUMENT ELEC. CORP.

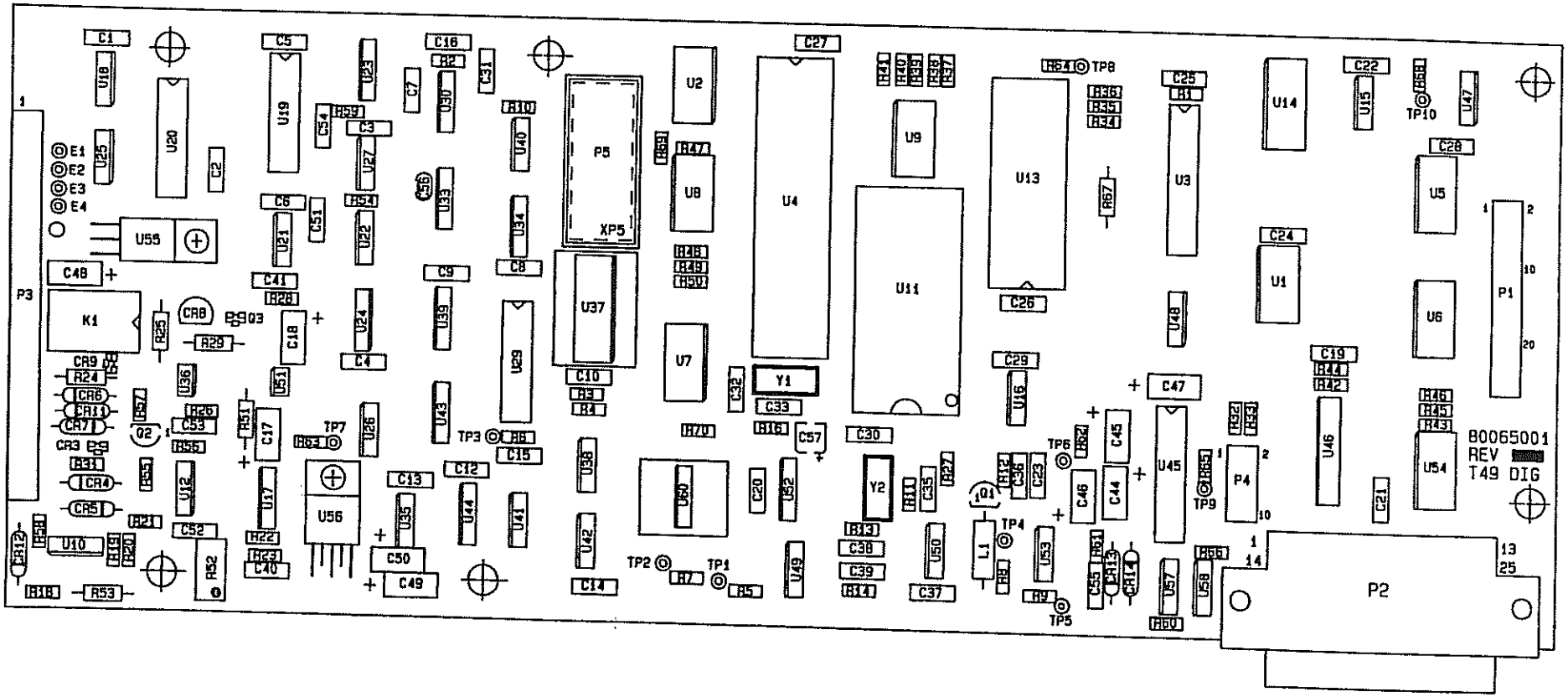
ASSEMBLY
DIRECT CONNECT
TAP-131

SIZE	FSCM NO.	DWG. NO.	REV
A	92606	89 000 065	A
SCALE NONE			SHEET 1 OF 1

T-49/T-49C
DIGITAL BOARD
ASSEMBLY



T-49/T-49C/T-49CF
DIGITAL BOARD
ASSEMBLY



T-49/T-49C
DIGITAL BOARD
PARTS LIST

80065001 REV "M"

PART NO.	DESCRIPTION	QTY	REF. DESIG.
80065002	DRILLING AND FAB. REV "E"	1	A2
40201013	I.C.-SM MM74HC574WM	7	U1,U2,U5-U8,U54
40200036	I.C. DAC0832LCN	1	U3
40200027	I.C. 80C31BH	1	U4
40201015	I.C.-SM CD4025BCM	2	U10,U12
40200103	I.C. BQ4010YMA-85C	1	U11
48069002	PROGRAM MEMORY	1	U13
40201018	I.C.-SM MM74HC4514WM	1	U14
40201019	I.C.-SM MM74HC04M	3	U15,U16,U48
40201020	I.C.-SM CD4060BCM	1	U17
40201021	I.C.-SM MM74HC74AM	8	U18,U21,U22,U38, U41,U50,U53,U58
40200077	I.C. MM74HC160N	2	U19,U20
40201022	I.C.-SM MM74HC161M	3	U23,U43,U44
40201033	I.C.-SM MC74HC112D	1	U24
40201034	I.C.-SM MM74HC02M	3	U25,U42,U49
40201035	I.C.-SM MM74HC08M	2	U26,U27
40200082	I.C. MM74HC157N	1	U29
40201036	I.C.-SM MC74HC109D	1	U30
40201037	I.C.-SM MM74ACT163SC	3	U33,U34,U52
40201038	I.C.-SM MM74HC00M	2	U35,U40
40201008	I.C.-SM TL082CD	1	U36
40201039	I.C.-SM CY7C425-40VC	2	U37,U46
40201040	I.C.-SM MM74HC162M	1	U39
40200025	I.C. LT1080CN	1	U45
40201041	I.C.-SM MM74HC51M	1	U47
40201014	I.C.-SM MM74HC573WM	1	U9
40201012	I.C.-SM ICL7660CSA	1	U51
40201044	I.C.-SM LM319M	1	U57
56060001	VOLT. REG. LM2931CT	1	U56
56060003	VOLT. REG. LM7805CTH	1	U55
48064001	SOCKET, I.C. 28 PIN	1	XU13
48000025	CONNECTOR 25 PIN	1	P2
48000021	CONNECTOR 26 PIN	1	P1
48000022	CONNECTOR 10 PIN	1	P4
48000026	CONNECTOR 25 PIN	1	P3
48000044	CONNECTOR, 16 PIN SOCKET	1	P5
55050003	HEADER 16 PIN	1	XP5
40040016	CRYSTAL 12.000 MHZ	1	Y1
40040006	CRYSTAL 20.000 MHZ	1	Y2
55080002	CRYSTAL MOUNT	2	XY1,XY2
46005001	RELAY FBR46ND012-P	1	K1
43011013	INDUCTOR 10mH	1	L1
40010005	DIODE 1N4148	2	CR13,CR14
40010007	DIODE 1N6263	2	CR11,CR12
40010014	DIODE,SM MMBD914	2	CR3,CR9
40010012	DIODE 1N4003	4	CR4-CR7
40200040	DIODE, REF. LM336BZ2.5	1	CR8
40001005	TRANSISTOR J-309	1	Q1
40001012	TRANSISTOR VN10LM	1	Q2
40001014	TRANSISTOR,SM MMBT2907A	1	Q3
41160041	RES.CHIP,RC1206,15K OHMS	1	R59

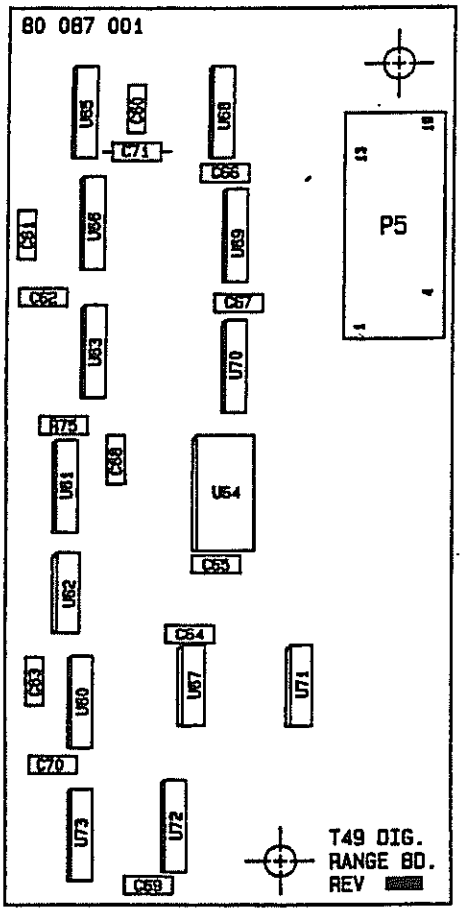
T-48/T-49C/T-49CF DIGITAL PCB ASSEMBLY PARTS LIST
80 065 001 REV P ECO 1464 6-4-98

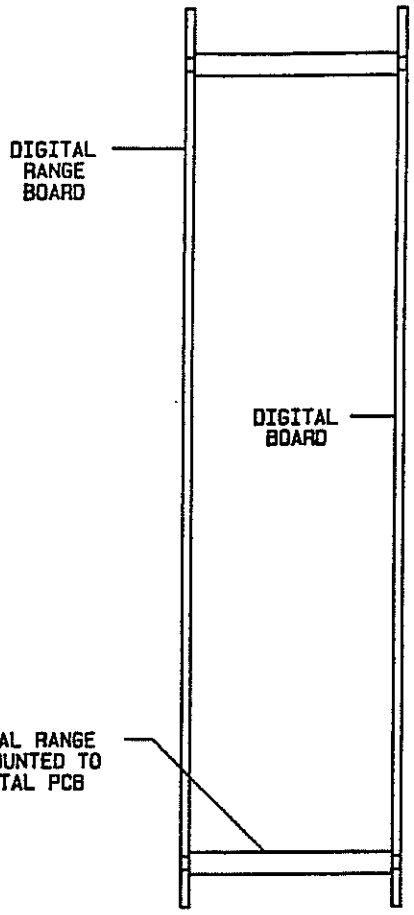
ITEM NO.	PART NO.	DESCRIPTION	QTY	REF.DESIG.
1	80065002	BLANK BD. DRILLING & FAB	1	A2
2	40201013	I.C.-SM MM74HC574WM	7	U1,U2,U5,U6, U7,U8,U54
3	40201036	I.C.-SM DAC0832LCN	1	U3
4	40200027	I.C. 80C31BH	1	U4
5	40201015	I.C.-SM CD4025BCM	2	U10,U12
6	40200103	I.C. BQ4010YMA-85C	1	U11
7	48069012	I.C.PROGRAM MEMORY (T49C) (REF. I.C. 40200072)	1	U13
8	40201018	I.C.-SM MM74HC4514WM	1	U14
9	40201019	I.C.-SM MM74HC04M	3	U15,U16,U48
10	40201020	I.C.-SM CD4060BCM	1	U17
11	40201021	I.C.-SM MM74HC74AM	8	U18,U21,U22,U38, U41,U50,U53,U58
12	40200077	I.C. MM74HC160N	2	U19,U20
13	40201022	I.C.-SM MM74HC161M	3	U23,U43,U44
14	40201033	I.C.-SM MC74HC112D	1	U24
15	40201034	I.C.-SM MM74HC02M	3	U25,U42,U49
16	40201035	I.C.-SM MM74HC08M	2	U26,U27
17	40201151	I.C.-SM 7202LA25SO	1	U37
18	40200082	I.C. MM74HC157N	1	U29
19	40201036	I.C.-SM MC74HC109D	1	U30
20	40201037	I.C.-SM 74AC163SC	3	U33,U34,U52
21	40201038	I.C.-SM MM74HC00M	2	U35,U40
22	40201008	I.C.-SM TL082CD	1	U36
23	40201039	I.C.-SM CY7C425-40VC	1	U46
24	40201040	I.C.-SM MM74HC162M	1	U39
25	40200025	I.C. LT1080CN	1	U45
26	40201041	I.C.-SM MM74HC51M	1	U47
27	40201014	I.C.-SM MM74HC573WM	1	U9
28	40201012	I.C.-SM ICL7660CSA	1	U51
29	40001005	TRANSISTOR J-309	1	Q1
30	40001012	TRANSISTOR VN10LM	1	Q2
31	40001014	TRANSISTOR-SM MMBT2907A	1	Q3
32	40010007	DIODE 1N6263	2	CR11,CR12
33	40201049	I.C.-SM CD4053D	1	U60
34	40010014	DIODE-SM MMBD914	2	CR3,CR9
35	40010012	DIODE 1N4003	4	CR4-CR7
36	40200040	DIODE LM336BZ2.5	1	CR8
37	40040016	CRYSTAL 12.000MHZ	1	Y1
38	40040006	CRYSTAL 20.000MHZ	1	Y2
39	42020001	CAP.CHIP X7R 0.01uF	29	C1-C6,C8-C10, C12-C16,C19-C30, C36,C37,C52
40	42020002	CAP.CHIP X7R 100pF	4	C7,C38,C39,C51
41	42020004	CAP.CHIP X7R 47pF	1	C35
42	42020006	CAP.CHIP X7R 33pF	2	C32,C33
43	42020007	CAP.CHIP X7R 27pF	1	C31
44	42020013	CAP.CHIP X7R 0.1uF	1	C41
45	42480001	CAP.ELECT 22uF/16V PAN.(DIGIKEY PCT-3226-ND)	9	C17,C18,C44-C50
46	42185030	CAP.ELECT 10uF/16V PAN. ECE-V1CA100R	1	C57
47	41160001	RES.CHIP 5% 270 OHM	1	R12
48	41160003	RES.CHIP 5% 1K	31	R1,R3-R9,R31, R34-R46,R55,R56, R62-R66,R68,R69

41160001	RES.CHIP,RC1206,270 OHMS	1	R12
41160003	RES.CHIP,RC1206, 1K OHMS	29	R1,R5-R9,R31,R55 R34-R46,R56,R62-R65 R66,R68,R69
41160011	RES.CHIP,RC1206,100 OHMS	1	R28
41160030	RES.CHIP,RC1206, 2K OHMS	2	R32,R33
41160031	RES.CHIP,RC1206,47K OHMS	1	R11
41160035	RES.CHIP,RC1206,240K OHMS	2	R22,R23
41160013	RES.CHIP,RC1206,4.7K OHMS	4	R2,R10,R60,R70
41160015	RES.CHIP,RC1206,10K OHMS	19	R3,R4,R13,R14,R18-R21, R26,R27,R47-R50,R54, R16,R57,R58,R61
41000029	RES.M.F.1% 4.99K OHMS	1	R29
41000030	RES.M.F.1% 5.90K OHMS	1	R24
41000031	RES.M.F.1% 1.58K OHMS	1	R25
41000014	RES.M.F.1% 2.49K OHMS	1	R51
41000004	RES.M.F.1% 21.5K OHMS	1	R53
41000034	RES.M.F.1% 33.2K OHMS	1	R67
41700013	RES.VARIABLE 1K OHMS	1	R52
42480001	CAP.TANT.S-M 22uF,16V	9	C17,C18,C44-C50
42185030	CAP.ELECT.S-M 10uF,16V	1	C57
42020016	CAP.CHIP,CC1206 0.056UF	1	C40
42020015	CAP.CHIP,CC1206 2200PF	1	C55
42020005	CAP.CHIP,CC1206 1000PF	1	C53
42020010	CAP.CHIP,CC1206 150PF	1	C54
42020001	CAP.CHIP,CC1206 0.01UF	29	C1-C6,C8-C10,C12-C16, C19-C30,C36,C37,C52
42020002	CAP.CHIP,CC1206 100PF	5	C7,C38,C39,C51,C56
42020004	CAP.CHIP,CC1206 47PF	1	C35
42020006	CAP.CHIP,CC1206 33PF	2	C32,C33
42020007	CAP.CHIP,CC1206 27PF	1	C31
42020013	CAP.CHIP,CC1206 0.1UF	1	C41
55025002	TERMINAL, DOUBLE TURRET	14	E1-E4,TP1-TP10
52062003	WASHER, FIBER, BLACK	1	
50110009	SCREW,P.H. 4-40 X 5/16LG	2	
52010002	WASHER, FLAT, NO.4	2	
52020002	WASHER, LOCK, NO.4	2	
53010002	NUT, PLAIN, HEX, NO.4	2	

49	41160011	RES.CHIP 5% 100 OHM	1	R28
50	41160030	RES.CHIP 5% 2K	2	R32,R33
51	41160031	RES.CHIP 5% 47K	1	R11
52	42000031	CAP.CERM 100pF CN15C101J	1	C56
53	41160035	RES.CHIP 5% 240K	2	R22,R23
54	41140014	RES.CARB 5% RCRO7G 10K	1	R75
55	41000029	RES. MF 1% RN55C 4.99K	1	R29
56	41000030	RES. MF 1% RN55C 5.90K	1	R24
57	41000031	RES. MF 1% RN55C 1.58K	1	R25
58	48000025	CONN. RT. ANGLE 25 PIN 3M 927M21-01-25-30	1	P2
59	48000021	CONN. 26 PIN T & B ANSLEY 622-2614ES	1	P1
60	48000022	CONN. 10 PIN SPECTRA 842-800-560-005	1	P4
61	48000026	CONN. 25 PIN AMP 2-103670-4	1	P3
62	48064001	SOCKET-I.C. 28 PIN ROB-NUGENT RN-ICN-286-S5T	1	XU13
63	46005001	RELAY FUJITSU FBR46NDO12P	1	K1
64	43011013	INDUCTOR 10uH DELEVAN 1641-103	1	L1
65	41160013	RES.CHIP 5% 4.7K	4	R2,R10,R60,R70
66	41160015	RES.CHIP 5% 10K	17	R13,R14,R16, R18-R21,R26,R27, R47-R50,R54,R57, R58,R61
67	56060001	VOLTAGE REG. LM2931CT	1	U56
68	56060003	VOLTAGE REG. LM7805CTH	1	U55
69	41000014	RES. MF 1% RN55C 2.49K	1	R51
70	41000004	RES. MF 1% RN55C 21.5K	1	R53
71	41700013	RES. VAR RT24C2W102 1K	1	R52
72	55025002	TERMINAL DOUBLE-TURRET CAMBION 160-2043-02-01	14	E1-E4,TP1-TP10
73	42025044	CAP.CHIP 5% NPO 0.22uF	1	C40
74	42020015	CAP.CHIP 5% X7R 2200pF	1	C55
75	42020005	CAP.CHIP 5% X7R 1000pF	1	C53
76	41160041	RES.CHIP 5% 15K	1	R59
77	42020010	CAP.CHIP 5% X7R 150pF	1	C54
78	40010005	DIODE 1N4148	2	CR13,CR14
79	40200091	I.C. LM319M	1	U57
80	41000034	RES. MF 1% RN55C 33.2K	1	R67
81	50110009	SCREW P.H. 4-40 X 5/16LG MS-51957-14	2	N/A
82	52010002	WASHER FLAT NO.4 MS-15795-804	2	N/A
83	52020002	WASHER LOCK NO.4 MS-35338-135	2	N\A
84	53010002	NUT HEX NO.2 MS-35649-244	2	N\A
85	31007502	SOLDER 60\40 SN60BS	A\R	
86	55080002	MOUNT CRYSTAL BIVAR 470-025	2	XY1,XY2
87	52062003	WASHER BLACK FIBER	1	N\A
88	48000044	CONN. SOCKET 16 PIN T & B ANSLEY 609-F161M	1	P5
89	55050003	HEADER 16 PIN T & B ANSLEY 609-1678	1	XP5
90	48069022	I.C.PROGRAM MEMORY (T49CF) (REF. I.C. 40200072)	1	U13
91	40010005	DIODE 1N4148 (ITEM 91 USED FOR T-49CF)	2	CR17,CR18
92	41140014	RES.CARB 5% (RCRO7G) 10K (ITEM 92 USED FOR T-49CF)	1	R76

T-49/T-49C/T-49CF
DIGITAL RANGE
BOARD ASSEMBLY



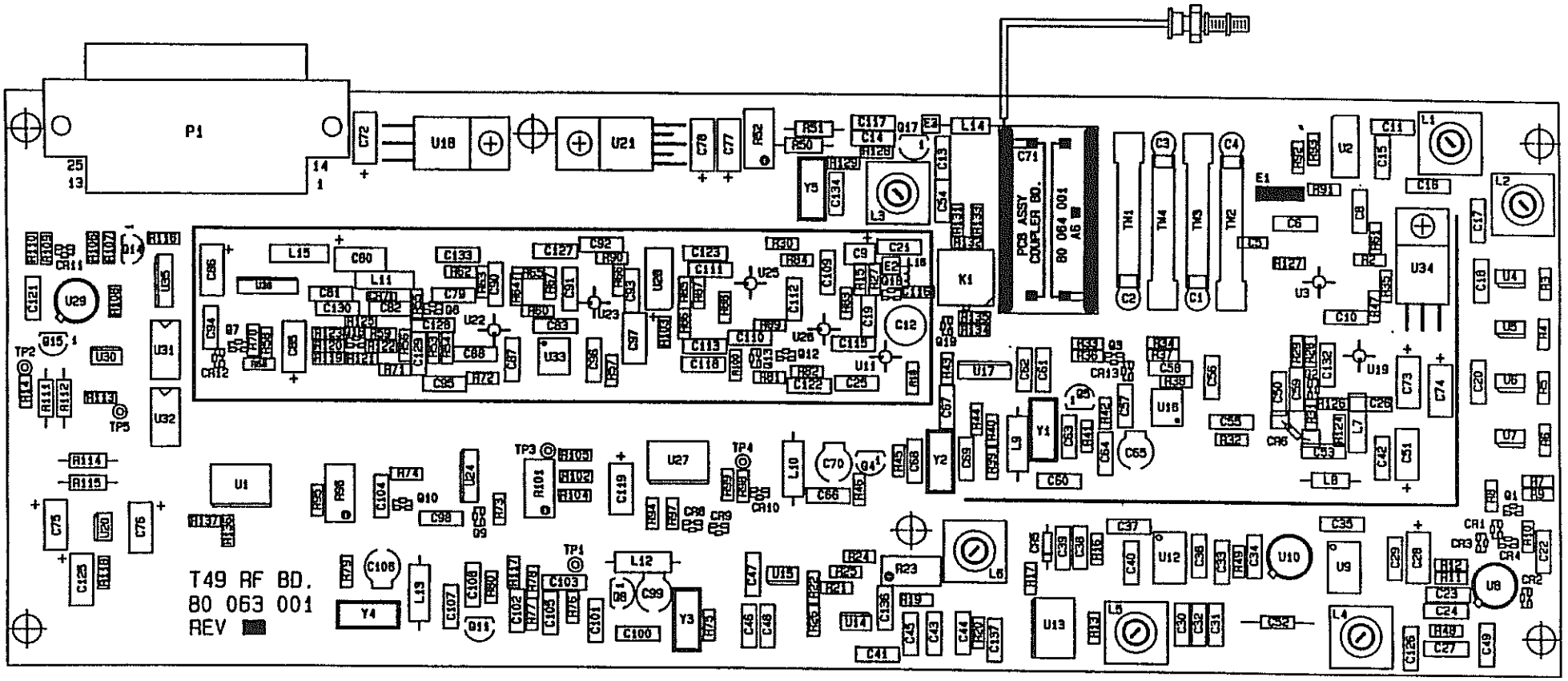


80087001 REV B"

ITEM NO.	PART NO.	DESCRIPTION	QTY	REF.DESIG.
1	80087002	DRILLING AND FAB. REV "B"	1	
2	75000016	CABLE,FLAT,16 CONDUCTOR	A/R	
3	48000043	CONNECTOR 16 PIN	1	P6
4	42000019	CAP.CERM. 100PF	1	C71
5	42020013	CAP.CHIP,CC1206 0.1UF	10	C60-C67,C69,C70
6	42026001	CAP.CHIP,CC1210 1UF	1	C68
7	41160025	RES.CHIP,RC1206 100K OHMS	1	R75
8	40201041	I.C.-SM MM74HC51M	2	U62,U67
9	40201069	I.C.-SM MM74HC191D	3	U68,U69,U70
10	40201070	I.C.-SM MM74HC73M	1	U71
11	40201056	I.C.-SM MM74AC163D	3	U63,U65,U66
12	40201071	I.C.-SM MM74HC4060M	1	U60
13	40201096	I.C.-SM MM74HC688WM	1	U64
14	40201002	I.C.-SM MM74HC163M	2	U72,U73
15	40201074	I.C.-SM MM74HC123AM	1	U61
16	48069006	PROGRAM MEMORY (40200072)	1	U13

T-49/T-49C/T-49CF

RF BOARD
ASSEMBLY



T-49C/T-49CF RF PCB ASSEMBLY PARTS LIST
80 063 001 REV P 5-6-98

ITEM NO.	PART NO.	DESCRIPTIOM	QTY	REF.DESIG.
1	80063002	BLANK BD. DRILLING REV F	1	A3
2	40201004	I.C.-SM MAR-3	7	U3,U11,U19,U22, U23,U25,U26
3	40201006	I.C.-SM SL1613C/MP	4	U4,U5,U6,U7
4	40201007	I.C.-SM TLO81CD	1	U30
5	40201008	I.C.-SM TLO82CD	2	U14,U15
6	40201009	I.C.-SM MM74HC4052WM	1	U13
7	40201005	I.C.-SM MM74HC86M	2	U17,U24
8	40201003	I.C.-SM MB501LFP	1	U16
9	40201010	I.C.-SM MM74HC14M	1	U35
10	40201011	I.C.-SM MM74HC4316WM	2	U1,U27
11	40200059	I.C. LM306H	3	U8,U10,U29
12	40200066	I.C. SA602AN	2	U9,U12
13	40201012	I.C.-SM ICL7660CSA	1	U20
14	56060003	VOLTAGE REG. LM7805CTH	1	U18
15	56060004	VOLTAGE REG. LM7806CTH	1	U34
16	56060005	VOLTAGE REG. LM2941CT	1	U21
17	40200052	I.C. TLC548IP	2	U31,U32
18	40200028	I.C. TFM-2 OR CLP-A19	2	U2,U28
19	40001011	TRANSISTOR-SM MMBT2222A	3	Q3,Q13,Q19
20	40001014	TRANSISTOR-SM MMBT2907A	4	Q1,Q9,Q10,Q12
21	40001005	TRANSISTOR J-309	5	Q4,Q5,Q8,Q11,Q17
22	40001013	TRANSISTOR NEO2133	3	Q2,Q6,Q18
23	40001012	TRANSISTOR VN10LM	2	Q14,Q15
24	41160001	RES.CHIP 5% 270 OHM	4	R41,R45,R76,R80
25	40201006	I.C.-SM SL1613C/MP	4	U4,U5,U6,U7
26	41160003	RES.CHIP 5% 1K	21	R3-R6,R14,R19, R20,R29,R33,R56, R58,R88,R98,R99, R102,R110,R113, R116,R117,R123, R125
27	41160004	RES.CHIP 5% 2.7K	3	R37,R71,R137
28	41160006	RES.CHIP 5% 180 OHM	2	R83,R84
29	41160020	RES.CHIP 5% 220 OHM	1	R48
30	41160008	RES.CHIP 5% 2.2K	4	R38,R72,R119,R124
31	41160009	RES.CHIP 5% 150 OHM	6	R16,R18,R86,R87, R91,R93
32	41160010	RES.CHIP 5% 39 OHM	1	R85
33	41160011	RES.CHIP 5% 100 OHM	7	R9,R36,R67,R70, R107,R122,R127
34	41101336	RES.CHIP 1% 30.9K NRC12TR 1/8W 1%	2	R25,R26
35	41160013	RES.CHIP 5% 4.7K	2	R32,R134
36	41160043	RES.CHIP 5% 51 OHM	2	R65,R126
37	41160015	RES.CHIP 5% 10K	15	R8,R21,R22,R34, R39,R40,R43,R44, R59,R68,R73,R74, R106,R135,R136
38	41160016	RES.CHIP 5% 68 OHM	1	R15
39	41160017	RES.CHIP 5% 560 OHM	2	R82,R89
40	41160021	RES.CHIP 5% 470 OHM	8	R7,R13,R49,R94, R97,R105,R108, R128
41	41160030	RES.CHIP 5% 2K	2	R28,R55
42	41160023	RES.CHIP 5% 330 OHM	3	R10,R31,R53
43	41160024	RES.CHIP 5% 27K	7	R11,R17,R24,R77, R78,R120,R121

44					
45	41160026	RES.CHIP 5%	270K	1	R12
46	41160027	RES.CHIP 5%	680 OHM	2	R81,R95
47	41160028	RES.CHIP 5%	22 OHM	1	R54
48	41160029	RES.CHIP 5%	3.3K	1	R100
49	41160040	RES.CHIP 5%	75 OHM	2	R60,R64
50	41160031	RES.CHIP 5%	47K	5	R42,R46,R75, R79,R129
51	41160032	RES.CHIP 5%	82 OHM	1	R104
52	41160033	RES.CHIP 5%	10M	1	R109
53	41160044	RES.CHIP 5%	110 OHM	4	R2,R35,R47,R61
54	41160038	RES.CHIP 5%	18 OHM	1	R57
55	41160019	RES.CHIP 5%	91 OHM	4	R62,R63,R66,R90
56	41000004	RES. MF 1% RN55C	21.5K	1	R50
57	41000029	RES. MF 1% RN55C	4.99K	1	R111
58	41000033	RES. MF 1% RN55C	10K	2	R114,R115
59	41000032	RES. MF 1% RN55C	12.1K	1	R112
60	41000014	RES. MF 1% RN55C	2.49K	1	R51
61	41700013	RES. VAR. RT24C2W102	1K	1	R52
62	41700014	RES. VAR. RT24C2W103	10K	2	R96,R101
63	41700016	RES. VAR. RJ24CW104	100K	1	R23
64	48000025	CONN. RT. ANGLE 3M 927M21-01-25-30	25 PIN	1	P1
65	80064001	PCB ASSY COUPLER BD.		1	A6
66	46002004	RELAY TELEDYNE	172D-12	1	K1
67	42020001	CAP.CHIP 5% X7R	0.01uF	19	C33,C34,C36,C40, C41,C43,C44,C47, C48,C49,C63,C68, C87,C98,C101,C104, C108,C121,C123
68	42020002	CAP.CHIP 5% X7R	100pF	14	C8,C11,C45,C46, C50,C61,C66,C83, C88,C90,C91,C93, C96,C111
69	42020005	CAP.CHIP 5% X7R	1000pF	33	C6,C10,C14,C17, C18,C20,C21,C23, C24,C26,C29,C30, C35,C39,C42,C55, C56,C57,C58,C60, C79,C81,C92,C95, C113,C122,C126, C127,C132,C133, C134,C136,C137
70	42020003	CAP.CHIP 5% X7R	5pF	3	C59,C110,C128
71	42020004	CAP.CHIP 5% X7R	47pF	10	C15,C19,C22,C53, C71,C110,C107, C116,C117,C118
72	42020006	CAP.CHIP 5% X7R	33pF	2	C64,C69
73	42020007	CAP.CHIP 5% X7R	27pF	3	C13,C27,C38
74	42020008	CAP.CHIP 5% X7R	15pF	1	C16
75	42020009	CAP.CHIP 5% X7R	39pF	1	C31
76	42020010	CAP.CHIP 5% X7R	150pF	1	C32
77	42020011	CAP.CHIP 5% X7R	10pF	2	C37,C82
78	42020012	CAP.CHIP 5% X7R	68pF	5	C62,C67,C102, C103,C105
79	42020020	CAP.CHIP 5% X7R	470pF	1	C141
80	42480001	CAP.ELECT. PAN (DIGIKEY) PCT3226-ND	22uF/16V	15	C28,C51,C72-C78, C80,C85,C86,C97, C119,C125
81	42000019	CAP.CERM C'LAB CN15C101J	100pF	1	C5
82	42025030	CAP.CHIP 5% NPO	270pF	1	C109
83	42260011	CAP. TRIMMER MOUSER 24AA020	1.8-6.0pF	4	C1-C4
84	42260001	CAP. TRIMMER MOUSER 24AA021	2.8-12.5pF	2	C99,C106

85	42260002	CAP. TRIMMER 3.5-20pF MOUSER 24AA022	2	C65,C70
86	40010016	DIODE-SM ZC2800	3	CR1,CR12,CR13
87	40010014	DIODE-SM MMBD914	7	CR2-CR4,CR8-CR11
88	40010011	DIODE KV3201	3	CR5-CR7
89	40040019	CRYSTAL 4.2578125MHZ	1	Y4
90	40040015	CRYSTAL 8.3984375MHZ	1	Y1
91	40040018	CRYSTAL 4.0234225MHZ	1	Y3
92	40040008	CRYSTAL 8.1640625MHZ	1	Y2
93	43011009	INDUCTOR 330nH	6	L1-L6
94	42260008	CAP. TRIMMER 2.5-10pF JOHANNSON 9611	1	C12
95	43011007	INDUCTOR 47uH DELEVAN 1641-473	2	L9,L10
96	43011003	INDUCTOR 5.6uH GOWANDA 10M561J	2	L8,L15
97	43011008	INDUCTOR .47uH DELEVAN 1641-471	1	L14
98	43020001	FILTER	4	TW1-TW4
99	55025002	TERMINAL DOUBLE TURRET CAMBION 160-2043-02-01	5	TP1-TP5
100	31020044	SHIELD	1	N/A
101	89000024	SHIELD ASSY	1	N/A
102	75010033	COAX ASSY	1	W8
103	55080002	CRYSTAL MT. BIVAR 470-025	5	XY1-XY5
104	40001017	TRANSISTOR-SM MMBT918L	2	Q7,Q16
105	43011014	INDUCTOR 4.7uH GOWANDA 10M471J	2	L7,L11
106	42020015	CAP.CHIP 5% X7R 2200pF	1	C94
107	40201042	I.C.-SM MM74HC4046M	1	U36
108	43011016	INDUCTOR 100uH DELEVAN 1641-104	2	L12,L13
109	40201043	I.C.-SM MB505LFP	1	U33
110	42020017	CAP.CHIP 5% X7R 3.3pF	1	C129
111	40040020	CRYSTAL 45MHZ	1	Y5
112	42480003	CAP.ELECT 3.3uF/16V PAN (DIGIKEY) PCT3335-ND	1	C9
113	43025023	COIL FORMED 1T 5/32 DIA. 24AWG	1	L16
114	50110009	SCREW P.H. 4-40 X 5/16LG MS-51957-14	3	N/A
115	52010002	WASHER FLAT NO.4 MS-15795-804	3	N/A
116	52020002	WASHER SPLIT-LOCK NO.4 MS-35338-135	3	N/A
117	53010002	NUT HEX NO.4 MS-35649-244	3	N/A
118	31007502	SOLDER 60/40 SN60BS	A/R	
119	41160045	RES.CHIP 5% 240 OHM	1	R30
120	41160046	RES.CHIP 5% 510 OHM	1	R27
121	42020018	CAP.CHIP 5% X7R 330pF	4	C54,C112,C115,C130
122	52062002	WASHER NYLON SEASTROM 5610-214-20	4	N/A
123	42030003	CAP.CERM CK05BX5R0J 5pF	1	C52
124	41160002	RES.CHIP 5% 56 OHM	2	R131,R133
125	41160072	RES.CHIP 5% 750 OHM	1	R132
126	41160007	RES.CHIP 5% 33 OHM	1	R92
127		CAP.CHIP 5% 620 pF	1	C25
128	42026001	CAP.CHIP 5% CC1210 1uF	1	C140

APPENDIX A

T-49 FINAL ASSEMBLY ACCEPTANCE AND ANNUAL

CALIBRATION TEST REPORT

SERIAL NUMBER _____
TECHNICIAN _____
DATE _____

EXTERNAL VERIFICATION

Test Description		**ACTUAL READING**	**INITIAL**	**FINAL**
1)	AC BATTERY CHARGE		_____	_____
2)	DATA DISPLAY WINDOW OPERATION		_____	_____
	BACK LIGHT OPERATION		_____	_____
3)	TRANSMITTER LOW FREQ/POWER OPERATION		_____	_____
	FREQUENCY 1030+/-1MHZ	_____		
	POWER -10 dBm+/-2dB	_____		
	TRANSMITTER HIGH POWER OPERATION		_____	_____
	POWER +12dBm+/-2dB	_____		
4)	RECEIVER LOCAL OSCILLATOR OPERATION		_____	_____
	FREQUENCY 1045+/-1MHz	_____		
5)	TRANSMITTER MODE S FREQUENCY OPERATION		_____	_____
	FREQUENCY 1090+/-1MHz	_____		
6)	OMNI DIRECTIONAL ANTENNA XPDR TEST			_____
	TYPE XPDR	_____		
	4096 CODE	_____		
	ALTITUDE	_____		
	TAIL #	_____		

	Test Description	ACTUAL READING	INITIAL	FINAL
7)	TAP-115, TAP-125 OR TAP-121 ANTENNA XPDR TEST		_____	_____
	TYPE XPDR	_____		
	4096 CODE	_____		
	ALTITUDE	_____		
	TAIL #	_____		
	FREQUENCY	_____		
	POWER	_____		
	SENSITIVITY	_____		

T-49 Sub-Assembly Adjustment Test Report

RF PCB PROCEDURE

1)	VOLTAGE SETTINGS		_____	_____
	U18 pin3	+5V +/-0.5V	_____	
	U34 pin3	+6V +/-0 5V	_____	
	C76	-4V +/-0.5V	_____	
	U21 pin5	+10V +/-0.1V	_____	
2)	RF FREQUENCY SETTINGS		_____	_____
	"ATCRBS Intruder Press Interrogate" display		_____	_____
	TP1	4.023423MHz+/-45Hz	_____	
	U17 pin 1	8 164063MHz+/-45Hz	_____	
	ATCRBS DISPLAY SCENARIO		_____	_____
	TP1	4.257813MHz+/-45Hz	_____	
	U17 pin 1	8 398438MHz+/-45Hz	_____	
3)	1030 MHz RECEIVER SENSITIVITY U13 PIN 10		_____	_____
	TAP-115	-10dBm to -20dBm	_____	
	TAP-125	less than -20dBm		

Test Description		ACTUAL READING	INITIAL	FINAL
4)	1090 MHz RECEIVER SENSITIVITY U13 pin 10		_____	_____
	TAP-115 -10dBm to -20dBm TAP-125 less than -20dBm	_____		
5)	RF OUTPUT LOW POWER LEVEL SETTING		_____	_____
	ANTENNA -10dBM+/-1dB	_____		
	ANTENNA MINIMUM AMPLITUDE		_____	_____
	P2 LEVEL -9dB +/- 1dB	_____		
6)	POWER MEASUREMENT CALIBRATION SETTING		_____	_____
	1.26V 500 w +/-75w	_____		
	800 mV 200 w +/-30w	_____		
	500 mV 100 w +/-15w	_____		
	300 mV 50w +/-8w	_____		

DIGITAL PCB PROCEDURE

1)	FREQUENCY & VOLTAGE SETTING		_____	_____
	"CALIBRATION xxxW x.xMHz" displayed		_____	_____
	TP8 +10V +/-0.2V	_____		
	TP7 -10V +/-0.5V	_____		
	U55 pin3 +5V +/-0.2V	_____		
	TP3 +5Vpp, 0.20 us +/-0.05us	_____		
	TP2 +5Vpp, 0.25 us +/-0.05us	_____		
	P2-3 0V to -8V +/-1V	_____		
2)	ATCRBS/C INTERROGATION TEST (Not required if System Test I-6 and I-7 are performed)		_____	_____
	ATCRBS Reply on P2-8		_____	_____
	ATCRBS/A Interrogation Non-Reply		_____	_____
	Mode S Simulator Interrogation Non-Reply		_____	_____
	ATCRBS/C Interrogation/P2 Pulse Non-Reply		_____	_____

Test Description	ACTUAL READING	INITIAL	FINAL
3) MODE S INTERROGATION TEST (Not required if System Test I-6 and I-7 are performed)		_____	_____
Mode S Reply on P2-8		_____	_____
ATCRBS/A Interrogation Non-Reply		_____	_____
ATCRBS/C Interrogation Non-Reply		_____	_____

respond to both Mode A and Mode C ATCRBS interrogations, the Mode C only interrogation will not cause a reply from Mode S transponders. ATCRBS (Mode A/C) transponders equipped with Mode C will respond with a Mode C reply. The pass criterion for a ATCRBS (Mode A/C) transponder is 90% or greater reply efficiency. For a Mode S transponder, the pass criterion is less than 1% reply efficiency.

SURVEILLANCE ID. UF=5 ** In this mode, the Mode S address that was received during the previous Mode S all-call test is used to interrogate the transponder. The Mode S transponder will respond with "4096" code. The pass criterion is a reply efficiency of 99% or greater with the correct downlink format and a valid message.

SURVEILLANCE ALT. UF=4 ** In this mode, the Mode S address that was received during the previous Mode S all-call test is used to interrogate the transponder. The Mode S transponder will respond with altitude code. The pass criterion is a reply efficiency of 99% or greater with the correct downlink format and a valid message.

SURVEILLANCE SHORT. UF=0 ** In this mode, the Mode S address that was received during the previous Mode S all-call test is used to interrogate the transponder. The Mode S transponder will respond with maximum true airspeed information. The pass criterion is a reply efficiency of 99% or greater with the correct downlink format and a valid message

UNDESIRED REPLIES * Random address surveillance ID interrogations are made, with the exception of the transponder's address determined from the Mode S all-call. If the transponder replies an error message is displayed.

SQUITTER ** In this mode, the test set transmits no interrogations but is available to receive downlink format 11. The receipt of this format within 1 25 seconds constitutes a pass situation

MAXIMUM TRUE AIRSPEED ** In this mode, the maximum true airspeed is determined by interrogating a Mode S transponder with an UF=0 and with the acquisition bit set to "one." The transponder will reply with its maximum true airspeed capability. This is done only in the test mode

IDENT * The testing of a transponder's IDENT switch is done only for ATCRBS/A in the test mode. If the IDENT switch is pressed during one of the above interrogations, then ATCRBS/A IDENT is displayed along with the "4096" or altitude and the percent reply.

APPENDIX B

TEST MODES OF THE T-49

A single asterisk, *, following a test indicates the test is required by FAR part 43 section 91 for ATCRBS (Mode A/C) and Mode S transponders. A double asterisk, **, indicates the test is required for Mode S transponders only. All of the tests required by the FARs are performed by the test set.

ATCRBS MODE A * This mode interrogates transponders with the ATCRBS Mode A interrogation with nominal pulse width and separation and a P2 amplitude 9dB below P1 and P3 SLS operation is verified by transmitting interrogations with nominal pulse width and separation but a P2 level equal to P1 and P3. Both ATCRBS (Mode A/C) transponders and Mode S transponders should reply with the "4096" code. A typical main display would be. ATCRBS/A 1200 The percent reply will also be displayed. The pass criteria are a 90% or greater reply efficiency for the normal Mode A interrogation and 10% or less for the SLS interrogation

ATCRBS MODE C * This mode interrogates transponders with the ATCRBS Mode C interrogation with nominal pulse width and separation, P2 amplitude 9dB below P1 and P3, and with SLS Both ATCRBS (Mode A/C) transponders and Mode S transponders should reply with an altitude reply. The altitude will be displayed with the percent reply The pass criteria is a 90% or greater reply efficiency.

ATCRBS MODE A/ MODE S ALL-CALL ** In this mode, the transponder is interrogated with nominal pulse amplitudes, widths, and separations, with P2 9dB below P1, P3, and P4, and with SLS. ATCRBS (Mode A/C) transponders will respond with a Mode A reply while Mode S transponders will respond with the Mode S all-call reply. The pass criteria is a 90% or greater reply efficiency for a ATCRBS transponder and 99% or greater reply efficiency for a Mode S transponder.

ATCRBS MODE C/ MODE S ALL-CALL ** In this mode, the transponder is interrogated with the nominal pulse amplitudes, widths, and separations, with P2 9dB below P1, P3, and P4, and with SLS. ATCRBS (Mode A/C) transponders will respond with the Mode S address reply The pass criteria is a 90% or greater reply efficiency for a ATCRBS transponder and 99% or greater reply efficiency for a Mode S transponder.

ATCRBS MODE A ONLY ** The transponder is interrogated with the nominal pulse width and separation, with P2 amplitude 9dB below P1 and P3, and with SLS. This interrogation causes only ATCRBS (Mode A/C) transponders to reply. Although a Mode S transponder will respond to both Mode A and Mode C ATCRBS interrogations, the Mode A only interrogation will not cause a reply from Mode S transponders The pass criterion for a ATCRBS (Mode A/C) transponder is 90% or greater reply efficiency For a Mode S transponder, the pass criterion is less than 1% reply efficiency.

ATCRBS MODE C ONLY ** The transponder is interrogated with the nominal pulse width and separation, with P2 amplitude 9dB below P1 and P3, and with SLS. This interrogation causes only ATCRBS (Mode A/C) transponders to reply. Although a Mode S transponder will

APPENDIX C

RS-232 COMMUNICATION PROCEDURE

The program on this diskette is part of an automated data recording process built into the T-49

When the technician is testing a transponder on the ramp, if he presses the STORE button after performing an INTERROGATE, a copy of the pertinent test data is stored in a RAM inside the T-49. The T-49 later can be connected to a computer COM port and the data uplinked to the computer for printing or storage.

The document titled 'PROTOCOL' on this diskette defines the protocol used between the T-49 and the computer. The protocol includes provision for recording the results of INTERROGATE. The source code for this program is included as an aid to developing new receiver programs.

The cable used to connect the T-49 to the computer follows the MICROSOFT MOUSE pinout The T-49 outputs data on pin 2 and determines if a computer is present based on the status of pin 4 (DTE.)

COMPUTER SERIAL PORT	T-49 ACCESSORIES
PIN 1	PIN 1
PIN 2	PIN 2
PIN 3	PIN 3
PIN 4	PIN 4
PIN 5	PIN 5
PIN 6	PIN 6
PIN 7	PIN 7
PIN 8	PIN 8
PIN 9	PIN 9

To uplink data to the computer, connect the T-49 to the serial port with a suitable cable, start the T-49 program, and then turn on the T-49 by pressing either the AC or DC on buttons The T-49 will continually output the data to the computer until the data has been captured and then it will display:

Save data: Press OFF
To erase: Press TEST

Press TEST to erase the data or Press OFF to save data and restart unit If TEST is pressed, then the T-49 displays·

Data erased
Press OFF to restart

The syntax for the command is:

T49 -2 filename._ _ _

'-2' specifies to use COM2. instead of COM1.
Note: Defaults to active serial port if omitted

'filename' stores the output to the disk instead of the screen.
Create a file name up to 6 characters with a three character extension.

Ex· output txt

A \>dir

Volume in drive A has no label Directory of A:\

PROTOCOL		4480	12-05-90	7.45a
T-49	BAK	6016	11-21-90	7·19p
T-49	C	6016	11-21-90	7:20p
T-49	EXE	17030	11-21-90	7:21p
T-49	MAP	6049	11-21-90	7·21p
READ	ME	2432	12-05-90	7 52a
T-49	OBJ	5081	11-21-90	7 21p

7 File (s) 313344 bytes free

A \>type read. me

APPENDIX D

SERVICE AND TRAINING INFORMATION

Service

Repair, calibration and certification of TIC products is available at our facility at 728 Garden Street, Carlstadt, New Jersey 07072. Turn-around time varies but is generally within three weeks Expedited quick turn-around is available on an individual basis, but the customer must contact TIC prior to returning the test equipment.

TIC charges an hourly rate for labor plus any parts necessary to repair the unit. Estimates will be provided prior to completing the repair if requested. TIC will also provide the customer with an estimate of average repair cost upon request.

TIC maintains a stock of repair parts for a minimum of five years after discontinuing a product Generally, the parts that commonly fail are stocked until there is very little demand for them Part numbers and descriptions are in the instruction manual. Price, availability, and placement of orders may be obtained by calling our Parts Department at (201) 933-1600 or by faxing (201) 933-7340 Parts shipments of stocked items are within 24 hours.

Training

TIC does not generally provide operator training. We feel there is more than adequate information in the instruction manual for a qualified technician to perform aircraft testing without special training This is particularly true of the newer "smart" boxes which have automatic test sequences designed into the unit. Telephone assistance is available when necessary

TIC does not generally provide service training. Experienced and trained avionic electronic technicians should be able to test, calibrate, and repair our instruments with the aid of the instruction book and, on occasion, telephone instructions from our technicians. TIC will quote on providing in-plant training for customers with special requirements

APPENDIX E

TCAS TESTING SUGGESTIONS

This letter serves as a checklist that contains pointers for using the TIC T-49 XPDR/TCAS Ramp Test Set with a TCAS System. This letter will allow a T-49 user to better understand the use of the T-49 and the overall TCAS System.

IMPORTANT

The T-49 is a Ramp Test Set that verifies operation of the aircraft TCAS System. Since all TCAS Equipment employs one or more directional antennas, it is best to use the T-49 outside of the hanger to avoid multi-path reflections and the resultant erroneous indications.

Best results are obtained by performing tests at a ramp location away from other aircraft and reflective obstructions.

TCAS System Setup for T-49 Testing

STEP 1

Set the Radar Altimeter for greater than 500.'

The Radar Altimeter must be set appropriately for the TCAS system to give Traffic Advisories (TA) and Resolution Advisories (RA). If set to below 500 feet, the TCAS system will track and display intruders but will not issue advisories.

STEP 2

Bypass the aircraft "On the Ground Switch."

By bypassing this switch, the aircraft will act as it should being in the air and will engage the TCAS System

STEP 3

Be aware of the particular options of the TCAS System.

The first is the method of range display. There are two common options: the 8" Weather Radar/TCAS display and the IVSI display. The 8" display has the ability to change the range ring size from 20nmi to 4nmi. The IVSI will have a fixed range of 4nmi Also, be aware that with any range selected, the range distance displayed for the rear of the aircraft is always less than the front. Now when running a T-49 scenario, the range of the simulated intruder is displayed on the front panel of the T-49, and the intruder will not be displayed in the cockpit until the ranges correlate. The other TCAS System option to be aware of is the ability to change the vertical range of the display. Some aircraft have the option to select the vertical range from ABOVE to NORMAL to BELOW. Some aircraft cannot change this vertical range and is in the

NORMAL position. When in the NORMAL position, the display window is +2700 feet to -2700 feet. The ABOVE position is +8700 feet to -2700 feet. The BELOW position is +2700 feet to -8700 feet. If the T-49 runs a scenario which simulates an intruder that has an altitude outside the NORMAL vertical range (partially for the +3500 feet scenario, always for T-49's equipped with the +/- 6500 foot scenario) then the TCAS will track but not display this intruder until the display is switched to the appropriate position or the intruder moves into the selected vertical range.

STEP 4

Bypass the landing gear switch.

If the landing gear switch is not bypassed, then this forces the aircraft bottom directional antenna to act as a non-bearing reporting omni-directional antenna. This is because the landing gear will cause interference to the bottom directional antenna when the aircraft is in flight When the landing gear is not bypassed, any intruder being tracked by the bottom directional antenna will cause the TCAS to issue non-bearing TA and RAs. When the landing gear switch is bypassed, TCAS will issue the TA and RAs with bearing.

T-49 Points of Interest

Point 1

Verify the correct Target Altitude being displayed by the T-49.

At the beginning of every scenario, the T-49 reads the barometric altitude (simulated by Pitot-Static Tester or the actual altitude of the aircraft relative to sea level) of the aircraft. If the altitude is not received properly, then the T-49 will default to a Target Altitude equal to 0 feet If the Target Altitude does not match the aircraft under test, then the relative offset altitude simulated will be incorrect and the simulated intruder may not cause the TCAS to issue any TA or RAs

Point 2

Be aware that the T-49 directional antenna is directional.

The directional antenna of the T-49 must be directed at the directional antenna of the TCAS for the duration of the scenario. If it is not, the simulated track may be dropped from the TCAS display The T49 is equipped with an insert in the directional antenna that will fit most standard tripod fittings. Using a tripod will help to make the directional antenna more stable. Also, the signal path between the T-49 directional antenna and at least one of the TCAS directional antenna, must be free of objects that may cause interference (ladders, trucks, or even the body curve of the aircraft.)

Point 3

The T-49 has a cursor on the front panel display that should toggle for the duration of the scenario.

This activity verifies to the user that the T-49 is receiving valid interrogations from the TCAS System and is replying to them accordingly

T-49 TAP-125 Anti-Radiation Coupler

The TAP-125 replaces the TAP-115. It performs all of the functions of the TAP-115 and also provides a diversity test for Mode S Transponders and reduces the radiated power from the covered antennas by more than 20dB. Once the test set has been modified and calibrated for use with a TAP-125, any measurement made with the TAP-115 will be inaccurate. The TAP-125's are provided with each test set to cover both of the transponder blade antennas while testing either transponder or TCAS system. The test set has been modified if the software revision level is 4.0 or higher.

Operation Procedure

1. Place the anti-radiation coupler, TAP-125, over both transponder antennas by pulling the 'ring' to separate the spring loaded jaws. The TAP-125 must be centered over the antenna base and placed such that the EMI gasket material is compressed against the skin of the aircraft. Connect one of the TAP-125 cables to the test set. The TAP-125 cable not connected does not have to be terminated.

2. Conduct all transponder tests as before.

3 Diversity test - Mode S transponders only. After completing step 2 above, press 'test ' Continue to press 'test' until the diversity test shows in the display After a short period of time, the display will show 'Diversity Pass' indicating a successful test or the display will show 'Diversity Fail' indicating the leakage from the active antenna to the tested antenna is greater than -20dB.

Note: If the test shows 'Diversity Fail' repeat the test since this may be the result of an interrogation from a near-by secondary surveillance radar or other interference at the time the gate is open to receive the leakage signal.

4 Remove the TAP-125 cable from the test set and connect the other TAP-125 cable and repeat tests 2 and 3 above

5. Remove the TAP-125 cable and leave the transponder antennas covered. Connect the omni antenna or directional antenna and proceed with TCAS testing.

Note: If during the TCAS testing the altitude of the aircraft is changed, it is necessary to connect one of the TAP-125 cables to the test set and repeat step 2 above.

T-49 TAP-131 Antenna Coupler

The TAP-131 antenna coupler is to be used when measuring the following transponder functions UUT transmitter power, frequency, and receiver sensitivity Readings of these three functions are shown on the data display window, assuming all tests ran positively, as the last three blocks of the automatic interrogate scenario. If a coupler is not used, the last three scenario blocks appear blank Note that the coupler must be positioned properly. See Figure E-1. The antenna coupler is calibrated to an AT-740/A (MIL-A-25707/A) flush mounted antenna.

Operation Procedure

1 Place the antenna coupler, TAP-131 as shown in Figure E-1.

2. Conduct all transponder tests as before.

3 Diversity test - Mode S transponders only After completing step 2 above, press 'test ' Continue to press 'test' until the diversity test shows in the display. After a short period of time, the display will show 'Diversity Pass' indicating a successful test or the display will show 'Diversity Fail' indicating the leakage from the active antenna to the tested antenna is greater than -20dB

Note: If the test shows 'Diversity Fail' repeat the test since this may be the result of an interrogation from a near-by secondary surveillance radar or other interference at the time the gate is open to receive the leakage signal.

4 Repeat tests 1, 2, and 3 for each flush mounted antenna.

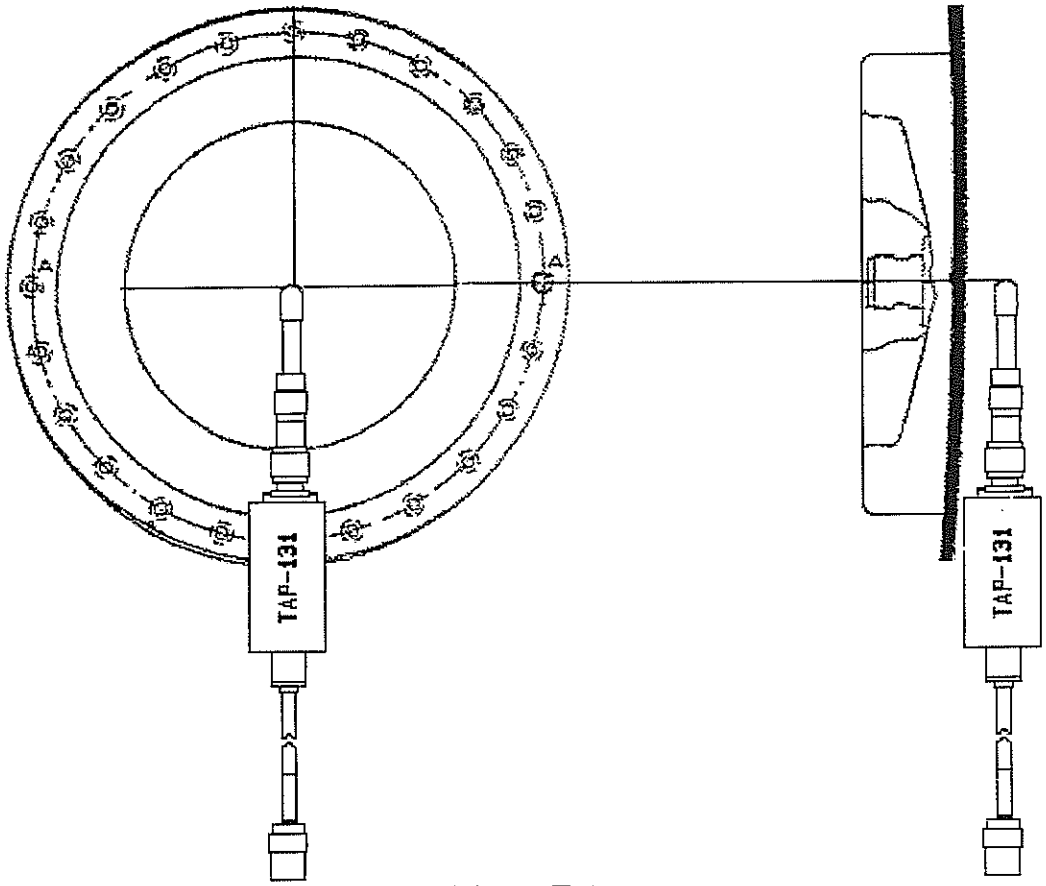


Figure E-1

Operation procedure with blade antenna.

1 To obtain a relative power, sensitivity and frequency reading, place antenna coupler TAP-131 as shown in Figure E-2.

2 Conduct all transponder tests as before.

3 Diversity test - Mode S transponders only After completing step 2 above, press 'test ' Continue to press 'test' until the diversity test shows in the display After a short period of time, the display will show 'Diversity Pass' indicating a successful test or the display will show 'Diversity Fail' indicating the leakage from the active antenna to the tested antenna is greater than -20dB

Note: If the test shows 'Diversity Fail' repeat the test since this may be the result of an interrogation from a near-by secondary surveillance radar or other interference at the time the gate is open to receive the leakage signal.

4 Repeat tests 1, 2, and 3 for each blade antenna.

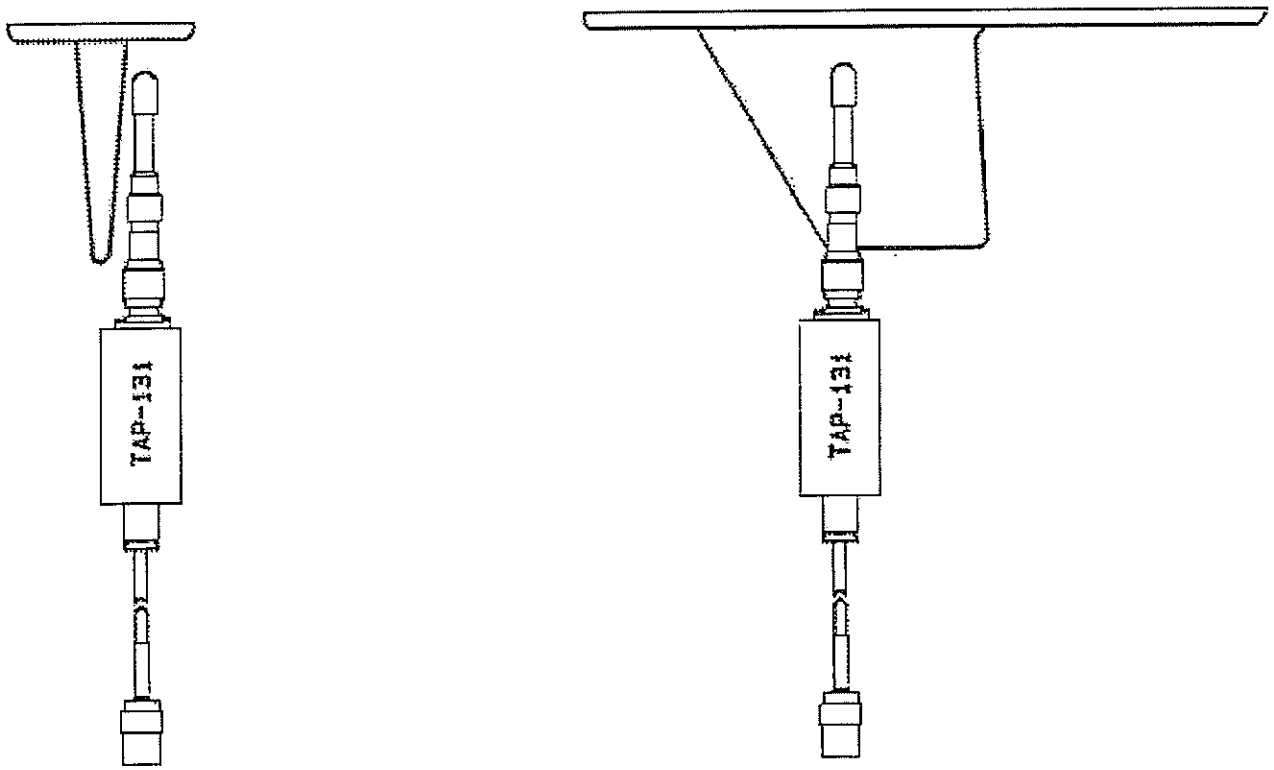


Figure E-2

APPENDIX F

BATTERY REPLACEMENT PROCEDURE

If it is determined that the battery will not retain its charge and must be replaced, the following steps should be followed:

1. Remove the unit from the case and place it with the panel down.

2 Loosen, but do not remove, the two nuts on the battery assembly-retaining bracket

3. Turn the unit over so that the front panel is accessible

4 Back out the center (adjacent to the battery assembly) panel retaining screw so that its tip is flush with the rear surface of the panel.

5 Hold the battery assembly and remove the two black Phillips head screws in the panel that retains the battery assembly.

6 Turn the unit over again and gently slide the battery assembly off the retaining bracket

7 Remove the top bracket from the battery by pulling straight up with the mounting spacers attached.

8 Remove the battery pack from the lower tray

9 Remove the tape protecting the solder contacts.

10. Unsolder the three RED leads and one BLACK lead from the battery

11 Resolder the three RED leads to the terminal with the red + symbol, and the BLACK lead to the other terminal.

12 Replace the tape protecting the terminals.

13 The procedure for reassembly is the reverse order as for disassembly

14 Return the unit to the case and confirm that the unit operates properly by observing that the first display message appears.