GENERAL DYNAMICS
SATCOM Technologies

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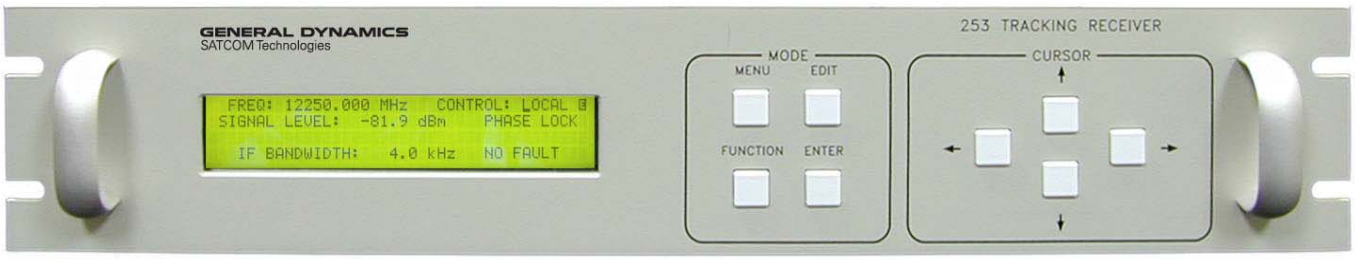
OPERATION AND MAINTENANCE MANUAL FOR THE

SINGLE INPUT 253 TRACKING RECEIVER



3750 W. Loop 281
Longview, Texas 75604

Revision History

Rev. No/change	Revised By	Date	Approved By	Date	ECO#
Rev E – Page 1-6 J5-12 to N/C	L. Shirey	6/7/13	C. Bolton	6/7/13	13356
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1219 Digital Drive, Suite 101
Richardson, Texas 75081
Telephone 972 907 9599
Fax 972 907 0027

MANUFACTURER'S DECLARATION OF CONFORMITY

Manufacturer's Name: COMSAT RSI Precision Controls

Manufacturer's Address: 1219 Digital Dr., Suite 101
Richardson, TX 75081 USA

declare that the product

Model 253 Tracking Receiver Unit

provided that it is installed, maintained and used in applications for which it was made, in accordance with professional practices, relevant installation standards and manufacturer's instructions,

conforms with the following Standards:

Safety: EN 60950:1992

EMC: EN 55011:1991, Grp 1, Class A
EN 50082-1:1992
IEC 801-2:1991, 4kV CD, 8kV AD
IEC 801-3:1988, 3V/m, 27 - 500 MHz
IEC 801-4:1990, 0.5kV Signal Lines,
1kV Pwr Lines

following the provisions of the following Council Directives:

Low Voltage Directive No. 73/23/EEC of 19 February 1973 amended by Council Directive 93/68/EEC of 22 July 1993.

EMC Directive No. 89/336/EEC of 3 May 1989 amended by Council Directives 92/31/EEC of 28 April 1992 and 93/68/EEC of 22 July 1993.

Year of affixing CE marking: 1997

Authorized Signatory

Name: Thomas J. Scanio
Title: Vice President, Product Development

Signature: Thomas J Scanio

Date: 6 March 1998

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SECTION 1

1 INTRODUCTION

1.1 PURPOSE AND FUNCTIONS

The Tracking Receiver performs the tracking signal RF-to-DC conversion. Its input is a beacon or other tracking signal at the down link frequency. It produces outputs which include a DC signal proportional to received signal strength for Steptrack and up to three error signals (cross-elevation, elevation and polarization) for monopulse. Monopulse operation requires additional RF signal processing components in the feed area.

1.2 CAPABILITIES AND PERFORMANCE CHARACTERISTICS

The key features of the Tracking Receiver are a multi-line display, an acquisition range of ± 150 kHz, a dynamic range of 45 dB, three selectable IF bandwidths and a fast acquisition time in a low carrier-to-noise ratio.

The unit provides a great deal of control and status. These are explained more fully in Section 2.4, but are listed below. Controls are divided into operating and configuration classes. The operating controls are those that may be used from day to day in actual operation. The configuration controls are typically set up once at installation and remain unchanged.

Operating controls include:

Local/Remote Control Select
Beacon Frequency Select
2.5/4/280 kHz Bandwidth Select
Auto/Manual VCO Control
Auto Sweep Width Used In Acquisition Select from ±20 KHz to ±150 KHz
Constant/Random/Off Monopulse Scan Select
Monopulse Error Signal Display Scale Factor
Monopulse Phasing
Clearing of Monopulse Track Fault
Signal Strength Display Offset

Configuration controls include:

Serial Port Setup
Band Setup
Beacon Select of CW/PM or 800 Hz BPSK

Status indications include:

Status of All Operating Controls
Status of All Configuration Controls
RF Synthesizer Locked/Unlocked
IF Synthesizer Locked/Unlocked
RCVR Synthesizer Locked/Unlocked
Signal Strength
Monopulse Error Signals
Monopulse Track Fault
Power Supply Voltages
Internal Chassis Temperature
VCO Offset
External Status Inputs
VCO Near End Of Range
Phase-Locked Loop Near End Of Range
DC Power Fault
Temperature Fault
Summary Fault

The unit contains two serial data links that may be used for remote control and status monitoring. Each link can be individually configured for EIA-232C or EIA-422 operation. Status may be requested over the data links at any time. Control functions will be honored only if remote control is manually selected at the front panel. The only functions not offered over the serial links are manual VCO control and configuration controls. The only statuses not available over the data links are the ones for configuration and summary fault.

Key specifications for the Tracking Receiver include the following:

CHASSIS SPECIFICATION	
Size	3.5" (8.9cm) H x 19" (48.3cm) W x 22" (55.9cm) D
Input Power	115/230 VAC, 47-63 Hz, 0.6/0.3A
Power Cord Specifications	18 AWG, 1250 W, 10 A
Temperature Range	0 to 50° C
Max. Operating Altitude	10,000 ft. (3,048 m)
Frequency Range	Various, Standard Bands Include: .95 – 1.75 GHz 2.0 – 2.8 GHz 3.4 – 4.2 GHz 4.0 – 4.8 GHz 7.25 – 7.75 GHz 10.7 – 11.5 GHz 11.45 – 12.25 GHz 12.2 – 13.0 GHz 10.7 – 13.0 GHz
Frequency Resolution	1 kHz

CHASSIS SPECIFICATION	
Input Beacon Level	-55 to –100 dBm
Input Impedance	50 Ohms, Unbalanced
Pre-detection Bandwidths	2.5, 4 or 280 kHz
Output DC Level	-5 to +5 VDC and 0 to +10 VDC
Output Slope	5 dB/V with highest Voltage at highest input level
Modulation Formats	CW, PM (to 1.2 rad), 800 Hz BPSK
Acquisition C/N	40 dB/Hz for CW, 48 dB/Hz for 800 Hz BPSK
Acquisition Sweep	Selectable from ±20 kHz to ±150 kHz

1.3 UNIT OVERVIEW

The unit is shown in the TRACKING RECEIVER drawing, Figure 1-1. It is a 3.5 inch high rack mount chassis which includes the user interface, down converters, if used, and receiver module.

The Tracking Receiver has one RF signal input which contains the sum signal for both steptrack and monopulse. It also contains error signals for monopulse. The error signals are modulated onto the sum signal. The sum signal represents the total received signal power. Signal level indication is derived from the sum signal. The bandwidth of the displayed sum signal may be selected from 2.5, 4, or 280 kHz. The monopulse error signals are processed in a synchronous demodulator.

1.4 INTERFACE INFORMATION

UNIT NAME: TRACKING RECEIVER UNIT

PART NUMBER: 201615

MECHANICAL DIMENSIONS: REFER TO THE FIGURE 1-1

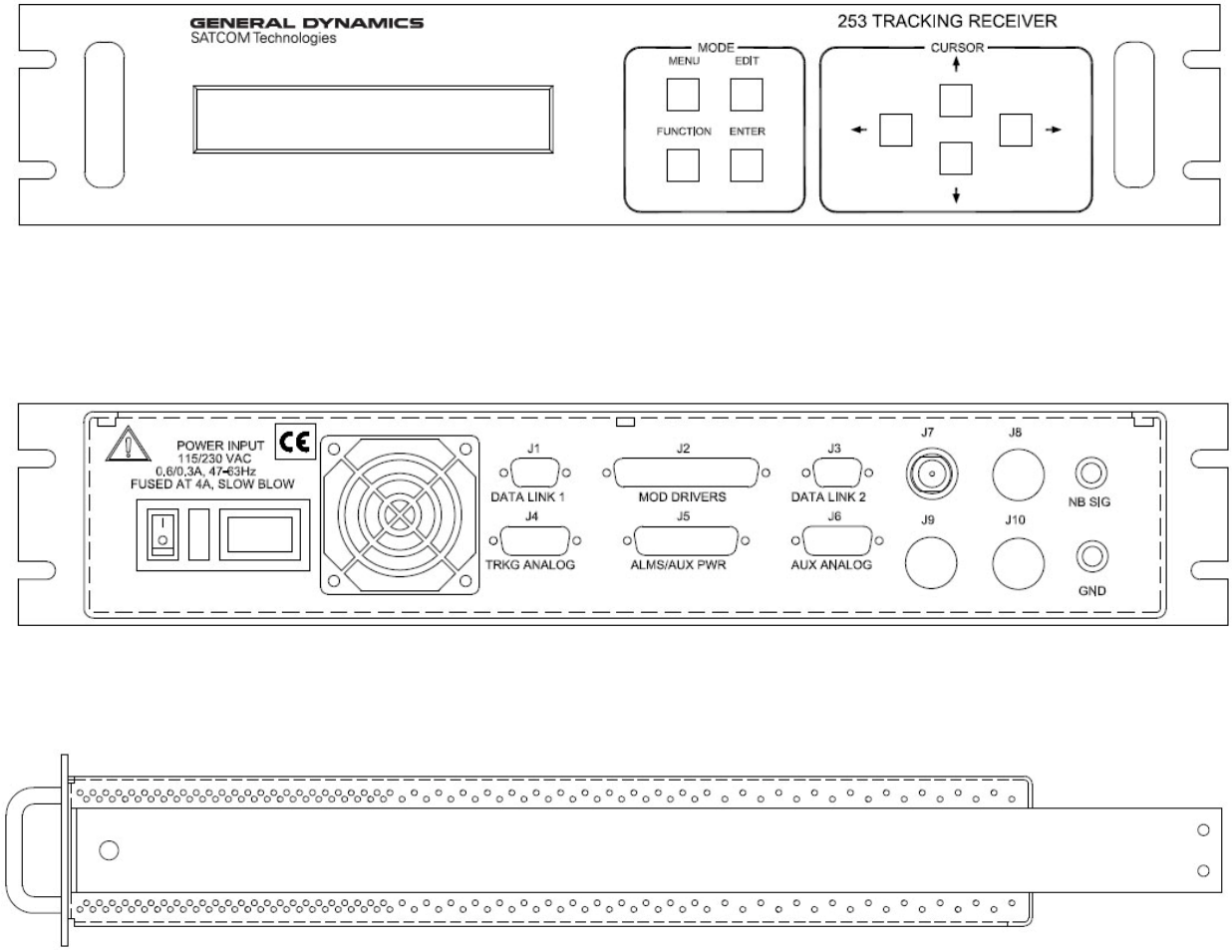
- CHASSIS DEPTH: 24 INCHES (PLUS CLEARANCE FOR MATING CONNECTORS AND CABLE BEND RADIUS)
- WEIGHT: 23.5 lbs (11.4 kg)

POWER REQUIREMENTS:

- VOLTAGE: 90 TO 132 OR 175 TO 264 VAC, 47 TO 63 Hz
- POWER: 60VA
- POWER LOSS 50W

ENVIRONMENT: INDOOR

FIGURE 1-1: TRACKING RECEIVER



TEMPERATURE RANGE:

OPERATIONAL: 0° TO 50° C (32° TO 122° F)

STORAGE: -40° TO 70° C (-40° TO 158° F)

HUMIDITY RANGE:

OPERATIONAL: 95% NON-CONDENSING

STORAGE: 95% NON-CONDENSING

J1 - DATA LINK #1			J3 - DATA LINK #2	
TYPE: 9-PIN D-SUB RECEPTACLE			TYPE: 9-PIN D-SUB RECEPTACLE	
PIN #	**422**	**232**	**422**	**232**
1	RX+	N/C	RX+	N/C
2	RX-	RX+	RX-	RX+
3	TX+	TX+	TX+	TX+
4	TX-	N/C	TX-	N/C
5	GND	GND	GND	GND
6	N/C	N/C	N/C	N/C
7	N/C	N/C	N/C	N/C
8	N/C	N/C	N/C	N/C
9	N/C	N/C	N/C	N/C

J2 - MOD DRIVERS FOR MONOPULSE					
TYPE: 37-PIN D-SUB RECEPTACLE					
PIN	**DESCRIPTION**	**PIN**	**DESCRIPTION**	**PIN**	**DESCRIPTION**
1	DIGITAL PHASE SHIFT 0+	14	GND	27	DIGITAL PHASE SHIFT 7-
2	DIGITAL PHASE SHIFT 1+	15	+5V	28	AXIS SHIFT OUTPUT 0-
3	DIGITAL PHASE SHIFT 2+	16	-12V	29	AXIS SHIFT OUTPUT 1-
4	DIGITAL PHASE SHIFT 3+	17	+12V	30	AXIS SHIFT OUTPUT 2-
5	DIGITAL PHASE SHIFT 4+	18	N/C	31	AXIS SHIFT OUTPUT 3-
6	DIGITAL PHASE SHIFT 5+	19	N/C	32	GND
7	DIGITAL PHASE SHIFT 6+	20	DIGITAL PHASE SHIFT 0-	33	+5V
8	DIGITAL PHASE SHIFT 7+	21	DIGITAL PHASE SHIFT 1-	34	N/C
9	AXIS SHIFT OUTPUT 0+	22	DIGITAL PHASE SHIFT 2-	35	-12V
10	AXIS SHIFT OUTPUT 1+	23	DIGITAL PHASE SHIFT 3-	36	+12V
11	AXIS SHIFT OUTPUT 2+	24	DIGITAL PHASE SHIFT 4-	37	N/C
12	AXIS SHIFT OUTPUT 3+	25	DIGITAL PHASE SHIFT 5-		
13	GND	26	DIGITAL PHASE SHIFT 6-		

J4 – TRACKING SIGNALS - ANALOG	
TYPE: 15-PIN D-SUB RECEPTACLE	
PIN #	**DESCRIPTION**
1	N/A
2	N/A
3	Σ SIGNAL/+5V TO –5V / 10 HZ FILTER
4	Σ SIGNAL RETURN
5	XEL Δ 10 HZ FILTER
6	XEL Δ RETURN
7	EL Δ 10 HZ FILTER
8	EL Δ RETURN
9	POL Δ 10 HZ FILTER
10	POL Δ RETURN
11	GND
12	GND
13	N/C
14	N/C
15	N/C

J5 – ALARMS/AUXILIARY POWER	
TYPE: 25-PIN D-SUB RECEPTACLE	
PIN #	**DESCRIPTION**
1	SUMMARY FAULT COMMON
14	SUMMARY FAULT NORMALLY OPEN (CLOSED W/FAULT)
2	SUMMARY FAULT NORMALLY CLOSED (OPEN W/FAULT)
15	TRACK FAULT COMMON
3	TRACK FAULT NORMALLY OPEN (CLOSED W/FAULT)
16	TRACK FAULT NORMALLY CLOSED (OPEN W/FAULT)
4	N/A
17	N/A
5	N/A
18	N/A
6	STATUS BIT 0
19	STATUS BIT 1
7	STATUS BIT 2
20	STATUS BIT 3
8	STATUS BIT 5
21	STATUS BIT 5
9	STATUS BIT 6
22	STATUS BIT 7
10	+12V OUT (LNA POWER, 200 mA MAX)
23	+12V OUT (LNA POWER, 200 mA MAX)
11	+12V OUT (LNA POWER, 200 mA MAX)
24	GND (LNA POWER, 200 mA MAX)
12	N/C
25	GND (LNA POWER, 200 mA MAX)
13	N/C

J6 - AUXILIARY TRACKING - ANALOG	
TYPE: 15-PIN D-SUB RECEPTACLE	
PIN #	**DESCRIPTION**
1	N/A
2	N/A
3	Σ SIGNAL / 0-10V/1 HZ FILTER
4	Σ SIGNAL RETURN
5	XEL Δ 1 HZ FILTER
6	XEL Δ RETURN
7	EL Δ 1 HZ FILTER
8	EL Δ RETURN
9	POL Δ 1 HZ FILTER
10	POL Δ RETURN
11	GND
12	GND
13	N/C
14	N/C
15	N/C

J7 - RF INPUT	
ALL UNITS	TYPE N FEMALE 50 OHM

TEST POINTS	
TP1	RETURN
TP2	SIGNAL STRENGTH MONITOR 0-10V
TP3	N/A

1.5 Equipment Installation

The 253 Tracking Receiver is intended to be installed in a rack, using (4) bolts or pan head screws to secure the Tracking Receiver's front panel to the rack.

There is a stud on the rear panel of the 253 Tracking Receiver that is marked with the protective earth (ground) symbol. A proper grounding wire from the rack that this piece of equipment is installed into should be attached to this stud, making sure that the end of the grounding wire has good metal-to-metal contact with the rear panel of this unit. Use the hex nut provided with the Tracking Receiver (or similar nut) to secure this grounding wire to the rear panel stud.

The 253 Tracking Receiver should be connected to a grounded AC power outlet using a detachable power cord.

Make sure the area directly behind the fan on the rear panel of the 253 Tracking Receiver is kept clear once the equipment is installed to allow for proper ventilation of the unit.

1.6 General Equipment Operation Notes

The main power source supplying power to the rack that the 253 Tracking Receiver is installed in should be easily accessible for disconnect should an equipment fault occur.

Symbols used on the unit and in this manual include:

Protective earth terminal 

Caution, risk of electric shock 

Caution, risk of danger. Consult accompanying documents. 

SECTION 2

2 OPERATING INSTRUCTIONS

The Tracking Receiver provides two general operating modes categorized as REMOTE and LOCAL. REMOTE operation is accomplished through the two serial links. Each is separately configurable for EIA-232C or EIA-422 communication standards. The maximum baud rate available is 19200 baud. The maximum command rate over the data link is 5 per second. The Tracking Receiver Interface Specification, drawing number 95-062-5124 (Section 6), provides the data format for all available commands. Either link can be used for external monitoring regardless of current control mode. Control commands received over either link, in REMOTE control mode, are honored. This requires external logic to ensure only one link is in control.

LOCAL operation is accomplished at the front panel through the use of eight keys, four mode keys and four cursor keys, and a 4 line by 40 character backlit liquid crystal display. The front panel keys do not support an auto-repeat function. This interface is screen oriented with user editable fields and status.

2.1 CONTROLS AND INDICATORS

2.1.1 Unit Level

The Power Switch Assembly is located on the rear panel towards the right if viewed from the front of the unit. It contains a replaceable fuse. The supply is rated at 55 Watts, with autoswitching to accept inputs at 115 or 230 VAC.

The Front Panel Keys used for local operator control consist of four mode keys and four cursor keys. The front panel keys do not support an auto-repeat function.

The Contrast Potentiometer, located on the switch PCB towards the front of the unit, controls the LCD contrast. Access to the potentiometer is gained by inserting a flat head screwdriver through the hole in the top of the unit.

The Dot Matrix Liquid Crystal Display is 4 lines by 40 characters in size and backlit. The display uses multiple screens to provide the local operator with all current Control and Status information for the TRU.

The Signal Strength Test Points are banana jacks located on the rear panel individually labeled for the signal strength present at the test point.

2.1.2 Tracking Receiver Board

Switches S1 and S2 are used to select either EIA-232C or EIA-422 operation of the serial ports. Switch position 1 selects EIA-232C operation and position 2 selects EIA-

422 operation. There are no indicators on the Tracking receiver board. The configuration settings for the serial ports and the serial port modems are covered in Section 2.2.2.1.

The board also contains Positive Temperature Coefficient Thermistors (PTCs) for DC power going to external connections.

2.1.3 RF Board

The RF board has no switch or jumper settings. No periodic maintenance or alignment is required.

2.2 CONFIGURATION SETTINGS

2.2.1 Unit Level

Configuration settings for the Tracking Receiver Unit are set locally on the display configuration screens (Section 2.4.3.1).

2.2.2 Tracking Receiver Board

Refer to the TRACKING RECEIVER BOARD ASSEMBLY, drawing number 98-119-5050, of Section 6 for the location of configuration settings.

2.2.2.1 Serial Ports

The following table gives the serial port configuration associated with the switch settings:

SWITCH	POSITION	CONFIGURATION
S1	1	EIA-232C, Port 1
S1	2	EIA-422, Port 1
S2	1	EIA-232C, Port 2
S2	2	EIA-422, Port 2

If 12-Volt modems are required, resistors must be installed in the following locations:

PORT	RESISTOR	VALUE	CONFIGURATION
Port 1 RX	R116	NC	NO 12V MODEM
Port 1 TX	R109	NC	NO 12V MODEM
Port 1 RX	R116	10K	12V MODEM
Port 1 TX	R109	10K	12V MODEM
Port 2 RX	R114	NC	NO 12V MODEM
Port 2 TX	R115	NC	NO 12V MODEM
Port 2 RX	R114	10K	12V MODEM
Port 2 TX	R115	10K	12V MODEM

Note: NC is no-connect, designating the component is omitted.

2.2.2.2 Auxiliary Outputs

There is one sum signal auxiliary output, NB SUM (SUM 2), that may be configured as either -5 to +5 Volt output or 0 to +10 Volt output. The resistors that set the output range and their configuration settings are given in the following table:

OUTPUT	RESISTOR	VALUE	CONFIGURATION
AUX NB SUM (SUM 2)	R41	NC	-5 TO +5 VOLTS
AUX NB SUM (SUM 2)	R41	150K	0 TO +10 VOLTS

Note: NC is no-connect, designating the component is omitted.

2.2.2.3 Digital Inputs

There is one set of eight digital status lines that may be configured in a pull-up or pull-down state. The jumper blocks controlling these lines and their configuration settings are given in the following table:

J16 JUMPER BLOCK	
PIN CONNECTION	**CONFIGURATION**
1-2	PULL-UP
2-3	PULL-DOWN

2.2.2.4 Battery Configuration

Jumper blocks J6 and J17 are used to configure the board when an external battery is used to provide backup to the static RAM on the board. The battery configurations are given in the following table.

JUMPER BLOCK	PIN CONNECTION	CONFIGURATION
J6	1-2	BATTERY
J6	2-3	NO BATTERY
J17	1-2	NO BATTERY
J17	NC	BATTERY

Note: NC is no-connect, designating the jumper is omitted.

2.3 START UP PROCEDURE

To start up the Tracking Receiver Unit, plug it into a source of compatible AC power and turn on the rear panel mounted power switch.

The Tracking Receiver Unit performs a series of tests upon start up, displaying the name of the test being performed sequentially on the screen from left to right. If the TRU halts operation, the test associated with the last displayed message has failed. Section 4.3.1 should be consulted for more detail on the possible causes of failure for that test.

The Tracking Receiver Unit software initializes all parameters from non-volatile memory (RAM) upon successful completion of the start up tests. It loads default parameters from EPROM if a fault was determined in the RAM parameters. It then begins normal operation.

If this is the first time the unit has been started then the Configuration and Operating screens should be reviewed for correct parameter settings.

2.4 NORMAL OPERATION

The selection of control between REMOTE, utilizing serial links, and LOCAL, utilizing front panel keys, is accomplished only at the front panel. When in LOCAL control, the serial link commands are not acknowledged unless requesting status. When in REMOTE control, the operator is allowed to monitor any screen, but may only modify the control selection field of the summary screen.

All parameters are stored in non-volatile memory (battery backed up RAM) and are loaded into the unit upon powering up under normal conditions. A standard default set of parameters is loaded into RAM from EPROM when an error is detected in the stored set of parameters upon powering up the TRU. This normally occurs following battery replacement. Refer to Appendix A for a listing of supplied parameter values. This appendix should be updated if any parameters are changed. The default set does not load frequency band parameters (START, STOP, LCL OSC frequencies). The correct band setups must be entered in order for the unit to be operational. Refer to Table 1 of the test procedure for the TRU.

2.4.1 Mode Keys

The function of the mode keys are as follows:

MENU - The menu key sequences uni-directionally through the available display screens of the active screen group upon each actuation, returning to the top level screen after all screens have been displayed. Actuation of the menu key while in edit mode operates as normal. In addition, the unit exits from edit mode and restores the value of the selected field prior to editing.

EDIT - The edit key changes the state of edit mode upon each successive actuation. The current edit mode state can be determined by the cursor appearance, an underline when in edit mode and a blinking block otherwise. Also, the edit character (a reverse video E), appears in the upper right-hand corner of the screen while in edit mode.

The current edit mode state is used to determine cursor key action. When in edit mode, the cursor keys modify the data in the editable field containing the cursor. When not in edit mode, the cursor keys move between editable fields on a screen. Leaving edit mode through the actuation of the edit key restores the value of the field prior to editing.

FUNCTION - The function key changes the active screen group, displaying the top level screen of the group, upon each successive actuation. There are two screen groups, configuration and operating.

ENTER - The enter key is used to store the edited value of the field containing the cursor and exit edit mode. If the edited value is invalid, pressing the enter key restores the value of the field prior to editing. Actuation of the enter key while not in edit mode has no effect.

2.4.2 Cursor Keys

There are four cursor keys - left, right, up and down. Key action is dependent upon the current edit mode state.

When not in edit mode, the left and right keys move the cursor in their respective direction from the present editable field to the next editable field. The key action rolls over both in the left and right directions. For instance, if the cursor is on the last (right) editable field, pressing right arrow moves the cursor to the first (left) field on the same line. No action of the left or right key causes the cursor to change lines.

When not in edit mode, the up and down keys move the cursor in their respective direction from the present editable field line to the next editable field line. The key action rolls over both in the up and down directions. For instance, if the cursor is on the last (bottom) editable line, pressing the down arrow moves the cursor to the first (top) editable line. When changing lines, the cursor always moves to the left most field.

When in edit mode, the left and right keys move the cursor to successive adjacent digits within a field. The key action rolls over in both directions. For instance, if the cursor is on the last (right) digit, pressing the right arrow moves the cursor to the first (left) digit.

When in edit mode, the up and down keys change the value of the digit underlined by the cursor. The up key increments the value and the down key decrements. The key action rolls over in both directions. For instance, if the value of the digit is a "9", pressing the up arrow changes the digit to a "0". Data can be either numeric or alpha.

2.4.3 Display

The screen descriptions are listed below in the sequence displayed upon successive actuation of the menu key. The backlit dot matrix liquid crystal display provides a maximum screen size of 4 lines by 40 characters. The screen examples shown are not in edit mode and therefore do not have the edit mode character, a reverse video E, in

the upper right hand corner. All editable fields for a screen are shown in bold on the screen examples in the following sections.

2.4.3.1 Configuration Screens

The configuration screen group consists of those screens containing unit configuration options.

2.4.3.1.1 Serial Port Setup

The serial port setup screen is used to set up the communication rate and format for the two available serial ports. The standard hardware configuration is EIA-422 for serial port 1 and EIA-232C for serial port 2, as determined by internal serial configuration switches. Command structure format for the serial links is specified in the TRACKING RECEIVER INTERFACE of Section 6.

```
   SERIAL PORT 1     BAUD: 4800
 PARITY: EVEN    DATA: 8    STOP: 1
   SERIAL PORT 2     BAUD: 4800
 PARITY: EVEN    DATA: 8    STOP: 1
```

The editable field options are as follows:

BAUD - 1200, 2400, 4800, 9600 and 19200 baud rates available.

PARITY - ODD, EVEN and NONE data parity selection available.

2.4.3.1.2 Band Setup

The band setup screen is used to set up the frequency range and hardware configuration for up to six frequency bands. The range is set by the START and STOP frequencies. When a block converter is used to down convert a frequency range to L-Band, the input frequency to the L-Band board is determined by the difference between the command frequency and LCL OSC. The RELAYS field sets the value of band select outputs.

BAND	START	STOP	LCL OSC	RELAYS
1	**950**	**1750**	**0**	**00000000**
2	**3400**	**4200**	**5150**	**00000000**
3	**3000**	**2000**	**0**	**00000000**

The editable field options are as follows:

START and STOP – 69 to 30000 MHz with 1 MHz resolution. These fields should be set to the actual ranges allowed by the RF hardware. For example, L-Band is 950 to 1750 MHz. Unused bands should have a start value greater than the stop value.

LCL OSC – 0 to 30000 MHz with 1 MHz resolution. This should be set to frequency of the block down converter's local oscillator. If no block converter is used, this should be set to 0.

RELAYS – 00000000 to 11111111, adjustable one bit at a time. Each bit can control a band switching RF relay. Single band units should have a value of 00000000.

2.4.3.1.3 Frequency Response Correction

At some isolated frequencies, the receiver can exhibit a spurious response without the presence of an input signal. Should this occur at a frequency corresponding to a desired beacon, the frequency response correction screens can be used to correct the situation. The values used for this correction should be in the 950 to 1750 MHz range.

NO	START FREQ	STOP FREQ	OFFSET
1	**0.000**	**0.000**	**+0.0 MHz**
2	**0.000**	**0.000**	**+0.0 MHz**
3	**0.000**	**0.000**	**+0.0 MHz**

The editable fields are as follows:

START FREQ – This is the starting frequency (placed before the desired frequency) where the correction is to start. A value equal to the desired frequency less 300 kHz is the suggested entry. (EXAMPLE: 1199.700 START FREQ for a spurious signal at 3950 MHz.)
STOP FREQ – This is the ending frequency (placed after the desired frequency) were the correction is to stop. A value equal to the desired frequency plus 300 kHz is the suggested entry. (EXAMPLE: 1200.300 STOP FREQ for a spurious signal at 3950 MHz.)

OFFSET – This is the degree of correction to be done. The first value to try is 400 kHz. Values up to ± 2 MHz can be used.

2.4.3.1.4 Configuration Screen

The configuration screen is used to set tracking mode and display copyright information for the unit, including software version and date.

```
CONFIG: STEPTRACK   BEACON: CW
COPYRIGHT RSI PRECISION CONTROLS
      VERSION:
      SOFTWARE DATE
```

The editable field options are as follows:

CONFIG – This is used to select between STEPTRACK and the monopulse tracking modes of AZ/EL/POL, AZ/EL and POL.

BEACON – This field is used to select between CW/PM beacon modulation or 800 Hz BPSK modulation. This selection is available for software versions 1.261.6.17 and later.

2.4.3.2 Operating Screens

The operating screen group consists of those screens which are utilized in the normal operation and monitoring of the Tracking Receiver unit.

2.4.3.2.1 Summary

The summary screen is used to select beacon frequency and control mode. The FREQ selected is range tested against the valid ranges of the frequency control screen to determine the band utilized. CONTROL selects the source of commands for the unit.

This screen also displays the status of the phase lock loop, the selected IF bandwidth and summary fault. The status of the tracking loop is indicated by PHASE LOCK, UNLOCKED or FIXED TUNE. The fixed tune mode is used only for the widest IF bandwidth of 280 kHz. For these bandwidths, the tracking loop is disabled and the VCXO is fixed tuned.

```
 FREQ: 1500.000 MHz  CONTROL:    REMOTE
SIGNAL LEVEL: -123.4 dBm   PHASE LOCK

 IF BANDWIDTH   2.5 kHz          NO FAULT
```

STEPTRACK OPERATING MODE

The editable field options are as follows:

FREQUENCY – Any value can be selected that is allowed by the band setup screen.

CONTROL - LOCAL and REMOTE modes available.

2.4.3.2.2 Analog Status

The analog status screen provides current status of the power supply voltages, battery voltage, internal chassis temperature and VCO offset. This screen is useful in determining the source of a fault indicated on the digital status/fault screen.

```
+12:  +11.7V  -12:  -12.1V  +5:  +4.9V
              BATT:  +3.2V
```

```
INTERNAL CHASSIS TEMP:    +28° C
    VCO OFFSET:   123.4 kHz
```

There are no editable fields on this screen.

2.4.3.2.3 Digital Status/Fault

The digital status/fault screens provide current status for all possible sources of a summary fault. The screen displays the status of the RF, IF, and RCVR synthesizers, individual faults and the external status inputs.

```
RF SYNTH LOCKED    IF SYNTH LOCKED
RCVR SYNTH LOCKED  VCO NEAR LIMIT
DC POWER FAULT     PLL NEAR LIMIT
EXT STAT: 10010011 TEMP FAULT
```

There are no editable fields on these screens. The displayed messages and their causes are as follows:

RF SYNTH UNLOCKED/LOCKED – Indicates the lock status of the RF synthesizer in use. The synthesizer reports a locked status when the frequency commanded is maintained. Unlocked status of the synthesizer generates summary and track faults.

IF SYNTH UNLOCKED/LOCKED – Indicates the lock status of the IF synthesizer. The synthesizer reports a locked status when the frequency commanded is maintained. Unlocked status of the synthesizer generates summary and track faults.

RCVR SYNTH UNLOCKED/LOCKED - Indicates the lock status of the DDS multiplier PLL. This synthesizer reports a locked status when the frequency commanded is maintained. Unlocked status of the DDS multiplier PLL generates summary and track faults.

VCO NEAR LIMIT - Indicates that the VCO offset is near the limit of its range and the nominal beacon frequency selected should be reevaluated. This condition generates a summary fault.

PLL NEAR LIMIT - Indicates that the Phase-Locked Loop offset is near the limit of its range and the nominal beacon frequency selected should be reevaluated. This condition generates a summary fault.

DC POWER FAULT - Indicates that one of the power supply voltages or the battery voltage is not within tolerance. This condition generates summary and track faults. The tolerance ranges are as follows:

+12: +11.4 to +12.6 -12: -13.1 to -10.8 +5: +4.75 to +5.5
BATT: +2.50 TO +4.00

TEMP FAULT - Indicates that the internal chassis temperature range is not within the recommended operating range of the unit, 0° C to 65° C. This condition generates summary and track faults.

EXT STAT – Indicates the state of the eight external status bits, STATUS BIT 7 to STATUS BIT 0. Their status is also reported over the serial data link. Status Bits 7 through 0 are used for generation of a track fault condition.

2.4.3.2.4 Parameter

The parameter screen is used to select the IF bandwidth filter utilized and signal level offset. The signal level offset is added to the signal level prior to displaying it on the summary screen.

```
IF BANDWIDTH:   4.0 kHz
SIGNAL LEVEL OFFSET:   +0 dB
```

The editable field options are as follows:

IF BANDWIDTH – 2.5, 4.0 and 280 kHz filters are available.

SIGNAL LEVEL OFFSET - +100 dB to -200 dB with 1 dB resolution.

2.4.3.2.5 Monopulse

The monopulse screen is used to select the monopulse scanning mode for processing error signals and the error signal display scaling. The track fault field is both an indication of a track fault condition and a means to reset the fault. The voltage level of each individual error signal is divided by its respective scale factor prior to being displayed on the summary screen.

```
MONOSCAN:  CONSTANT  TRACK  FAULT:  RESET
XEL    SCALE:  123.4 V/°   PHASING    0.0°
EL     SCALE:  123.4 V/°   PHASING    0.0°
POL    SCALE   123.4 V/°   PHASING    0.0°
```

The editable field options are as follows:

MONOSCAN - CONSTANT, RANDOM and OFF scanning modes available.

TRACK FAULT - When the RESET field is displayed in reverse video, the track fault is active. Editing the field and actuating the enter key will reset the track fault. A track fault inhibits monopulse operation of the antenna control system.

SCALE - 0.1 V/° to 250.0 V/° with 0.1V/° resolution.

PHASING – 0 TO 359.9° with 0.1° resolution.

2.4.3.2.6 Autophase

The autophase screen is used to enable autophasing for the EL and XEL error channels. In order to accomplish autophasing, each channel must be aimed off axis for a 3 dB reduction in signal level. For the EL channel, the antenna is aimed up in elevation and for the XEL channel, the antenna is aimed clockwise in azimuth. In addition, this screen shows signal level, STATUS and the EL and XEL errors.

```
    AUTOPHASE COMMAND:  PHASE EL
MODE:  AUTO     STATUS:  NEEDED
       SIGNAL LEVEL:    -79.6 dBm
XEL ERROR:  -0.000     EL ERROR:  -0.000
```

Status – Indicates the status of autophase as NEEDED, COMPLETE or PHASE EL (XEL).

The editable field options are as follows:

MODE – AUTO to enable and MANL to disable autophase.

AUTOPHASE COMMAND – Select either the EL or XEL channel to autophase.

2.4.3.2.7 VCO Control

The VCO control screen is used to select the VCO control mode and VCO sweep width for automatic control mode. It also allows the operator to manually tune the VCO, displaying all required data, when in manual control mode. The VCO control mode is forced to automatic if the MENU key is actuated to depart the screen. The auto sweep width field allows the operator to alter the auto beacon search sweep width. The manual VCO step field allows the operator to adjust the increment by which the VCO frequency is changed when in manual control mode. Changing the frequency is accomplished by editing the STEP field. Signal level is provided as a monitor to aid manual tuning.

```
VCO CONT: AUTO    AUTO SWP:  +/-120  kHz
   MANL VCO STEP: 10.0 kHz      STEP
   VCO OFFSET:   -30.0 kHz    UNLOCKED
        SIGNAL LEVEL:  -105.0 dBm
```

The editable field options are as follows:

VCO CONT - AUTO and MANL control modes are available. In auto control, the software controls the VCO in acquisition and gives control of the VCO to the hardware

phase-locked loop at the end of the acquisition cycle. In manual control, the phase-locked loop is always commanded off and the operator manually steers the VCO via the STEP field. When going from auto to manual operation, the VCO is commanded to its nominal present position. When going from manual to auto, the phase-locked loop is commanded to lock about the present VCO position without performing an acquisition process.

AUTO SWP - ± 20 kHz to ± 150 kHz with 1 kHz resolution. Note: In order to use narrow acquisition ranges, the frequency tuning error of the tracking receiver must be accounted for. To determine the tuning error, input a known frequency at -80 dBm. Tune the TRU to this frequency with ±150 kHz AUTO SWP. Verify phase lock and note the VCO offset. This offset should be added to the command frequency of the TRU in order to correct for the time base errors of the unit. For example, if the input frequency is 11200 MHz and the TRU indicates a -23.6 kHz VCO OFFSET, the command frequency must be reduced by 24 kHz to 11199.976 MHz. Verify that the VCO OFFSET is less than 0.7 kHz with the corrected tune frequency. These steps are required since the frequency error may be greater than the acquisition range. NOTE: Software versions 1.282 and earlier have ±40 kHz minimum sweep.

MANUAL VCO STEP - 0.1 kHz to 50.0 kHz with 0.1 kHz resolution.

STEP - This field allows the operator to increment the VCO, by the manual VCO step, in the direction of the cursor key actuated while in manual control mode.

2.5 OPERATION UNDER ADVERSE OR ABNORMAL CONDITIONS

Side band lock may occur due to spurious signals, high noise level, excessive modulation or other conditions requiring local manual VCO control to acquire the beacon frequency.

2.6 SHUT DOWN PROCEDURE

The Tracking Receiver Unit on/off switch is located on the rear of the chassis towards the right side as viewed from the front panel. Turning the switch off shuts down the unit.

SECTION 3

3 PRINCIPLES OF OPERATION

3.1 UNIT LEVEL

The Tracking Receiver Block Diagram is shown in FIGURE 3-1. Also refer to the schematic which is included on the top level assembly drawing. The Tracking Receiver consists of the following major subassemblies: the L-Band Board, Tracking Receiver Board and block down converters as required to cover the desired input frequency range.

The L-Band Board has an input frequency range of 950 to 1750 MHz. Block down converters are used to convert other frequency bands to L-Band. Multiple down converters are required to cover an input frequency range greater than 800 MHz. The L-Band Board uses multiple conversions in order to track and measure the input signal from –55 to –100 dBm. The Tracking Receiver Board provides control to and receives status and signal strength from the L-Band Board.

3.2 RF BOARD (A11)

The block diagram of the L-Band Board is shown in FIGURE 3-2. In addition, a portion of the Tracking Receiver Board is also shown.

The RF input signal passes through a low pass filter before driving the first mixer. The input filter rejects image and other spurious signals. The RF input is down converted to 835 MHz by mixing with the output of the RF synthesizer. A high side LO is used and therefore the RF synthesizer covers a frequency range of 1785 to 2585 MHz. The Tracking Receiver Board provides the frequency control word and monitors the phase lock status of the RF synthesizer.

The 835 MHz IF output of the first mixer is filtered, amplified and filtered again before driving the second mixer. The band pass filters have nominal bandwidths of 25 MHz. A high side LO signal of 905 MHz from the IF synthesizer is used to down convert the first IF to 70 MHz. The IF synthesizer is controlled and monitored by the Tracking Receiver Board.

A low pass filter prevents the LO and RF signals to the second mixer from overdriving the 70 MHz amplifier. This amplifier drives an 11 dB coupler and a 4 MHz wide band pass filter. The nominal gain from the RF input to the 70 MHz coupled output is -16 dB.

The output of the 4 MHz wide band pass filter is down converted to 10.7 MHz by mixing with a LO frequency of 59.3 MHz. This LO is generated by using a phase locked loop to multiply the output of a DDS (direct digital synthesizer) by 10. The DDS is controlled by the Tracking Receiver Board to cover a mixer input frequency range of 70 MHz +/-150 kHz. An amplifier follows the mixer to drive a 400 kHz wide band pass filter that then drives the final mixer.

FIGURE 3-1: TRACKING RECEIVER BLOCK DIAGRAM

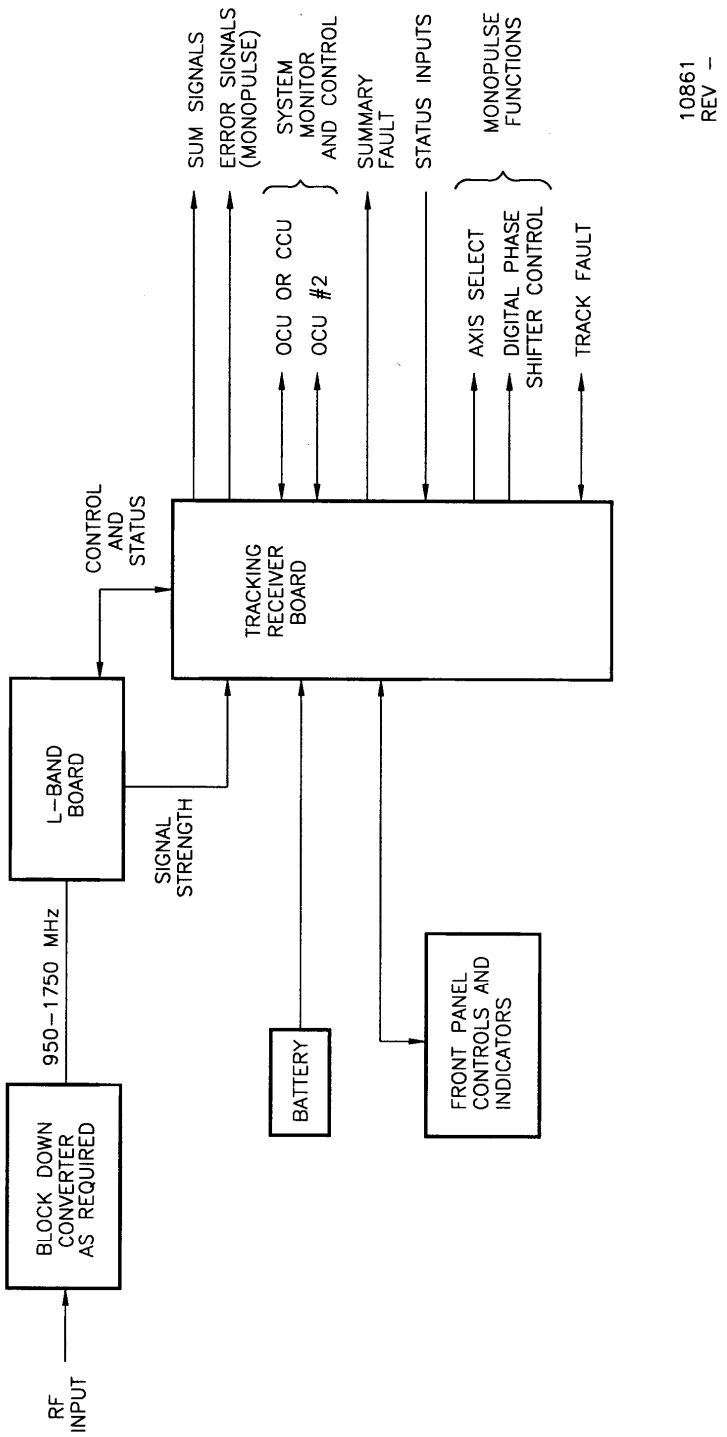
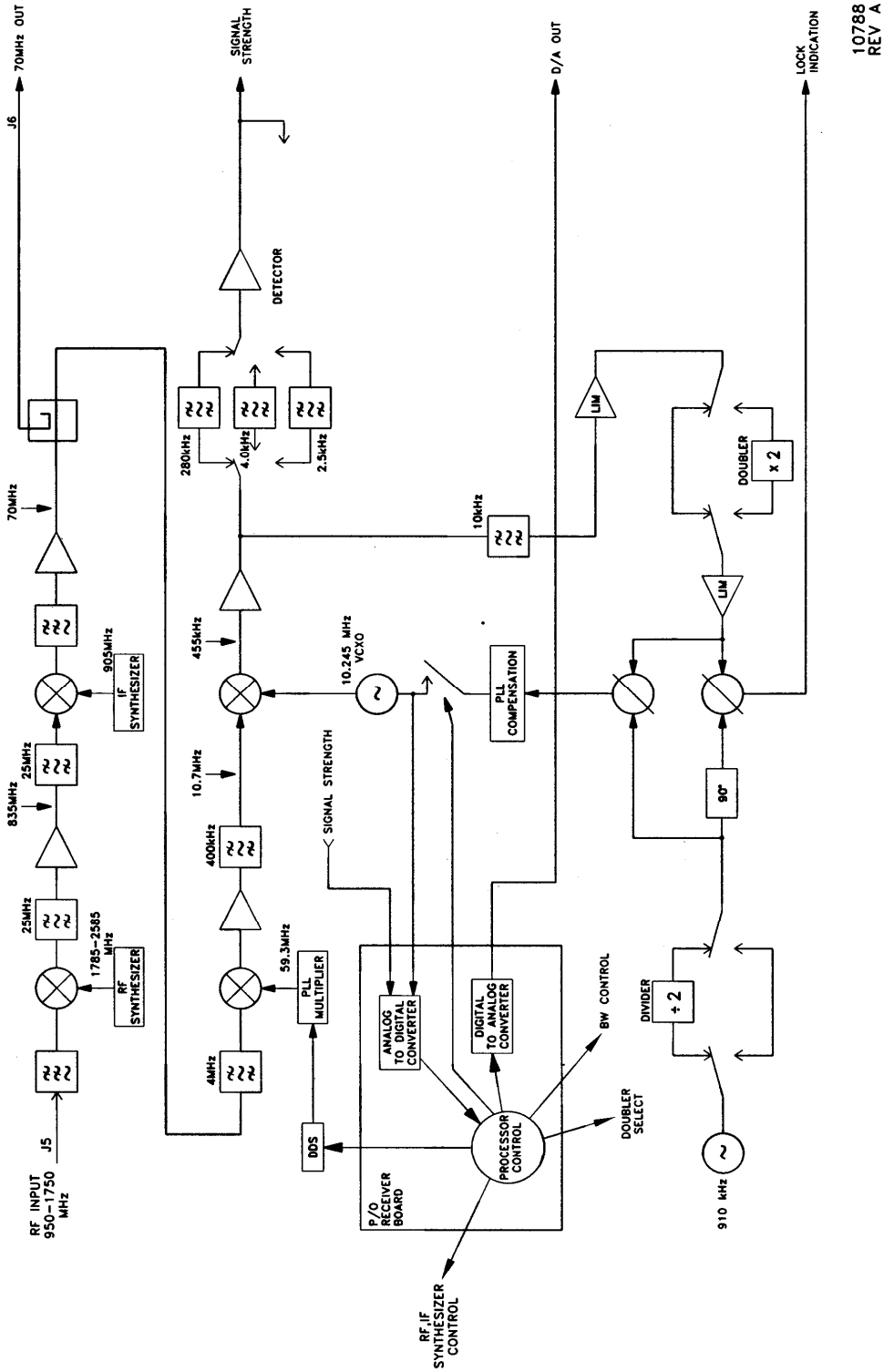


FIGURE 3-2: L-BAND RECEIVER BLOCK DIAGRAM



The final mixer down converts the 10.7 MHz IF to 455 kHz. The LO is generated by a VCXO (voltage controlled crystal oscillator). This oscillator is used open loop to acquire a signal and then controlled by a phase-locked loop which tracks the input signal. The Tracking Receiver Board monitors the frequency of this VCXO and adjusts the first LO using the DDS to keep the VCXO at center frequency.

The 455 kHz IF output of the second mixer is amplified and split into two paths. One path is filtered by a 10 kHz wide bandpass filter and limited to drive the phase locked loop circuitry. The limiter output can be doubled in frequency or connected directly to the input of the second limiter. The output of this limiter drives two phase detectors. A 910 kHz signal is divided either by two or not to drive the other inputs to the phase detectors. Therefore, the phase detectors can operate at either 455 kHz or 910 kHz.

This selection is controlled by the Tracking Receiver Board. The doubler is used when operating with carriers directly modulated by BPSK. In this case, the 910 kHz signal bypasses the divider and the doubler is used to double the 455 kHz output of the first limiter. In the normal mode of operation (not BPSK), the divider is used and the doubler is not, so the phase detectors operate at 455 kHz. This mode is shown on the block diagram. The output of one phase detector provides the error signal to the PLL compensation circuitry. If the Tracking Receiver Board commands the switch to the VCXO to close, the loop will lock and track the input signal. The second phase detector is driven in quadrature from the first in order to provide a phase-locked indication to the Tracking Receiver Board.

The other path generates the signal strength signal. A predetection bandwidth of 2.5, 4.0 or 280 kHz is selected before detection. The detector provides a log voltage proportional to signal level at a scale factor of 5 dB/volt.

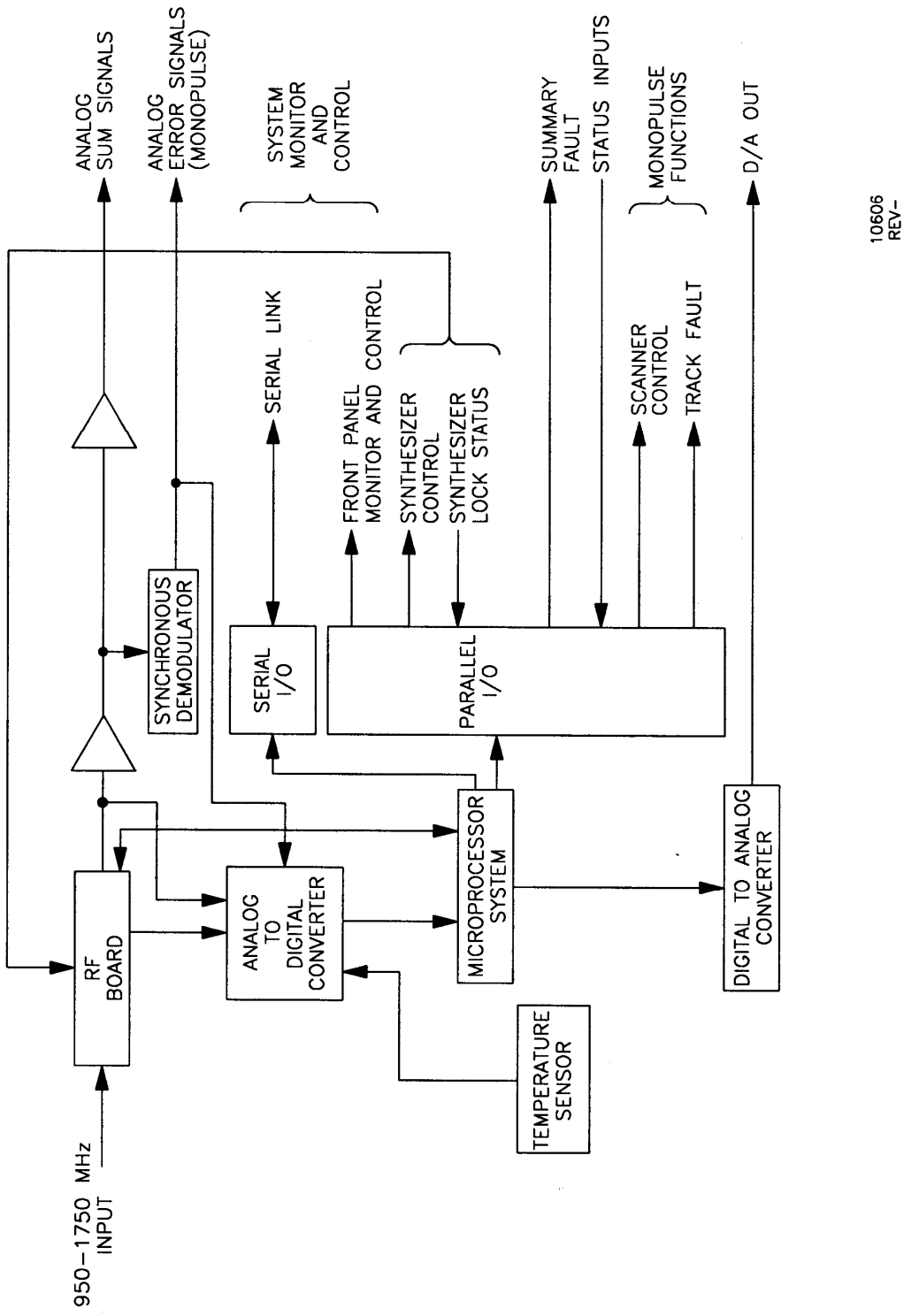
3.3 TRACKING RECEIVER BOARD (A10)

The Tracking Receiver Board Block Diagram, Figure 3-3, is used to describe the board functions.

The Tracking Receiver Board contains a digital-to-analog converter whose output can be used for various functions. The board also contains an analog-to-digital converter which has many inputs. These include feedback from the VCXO, both wide and narrow bandwidth sum signals, all monopulse error signals, a temperature sensor and all power supply voltages, including the battery used in the tracking receiver chassis.

The synchronous demodulator uses one of the two sum signals to derive two monopulse error signals (cross-elevation and elevation). These error signals are amplitude modulated on to the sum signals. The demodulator's timing functions come from the microprocessor system. The same timing functions also control the scanner output lines which produce the error signal amplitude modulation by controlling RF devices in the feed area.

FIGURE 3-3: TRACKING RECEIVER BOARD BLOCK DIAGRAM



The last monopulse function is track fault. The track fault output is a signal which goes directly to the CCU in the drive cabinet and which inhibits active monopulse tracking. The track fault can come from internal receiver status or from external status on up to eight switchable RF components in the feed area. For steptrack systems, the eight points are available for status monitoring.

The microprocessor system also controls the two serial EIA-232C/422 data links, the front panel display and key switches (when an integrated down converter is provided with the receiver) and a DDS (Direct Digital Synthesizer) for receiver functions. The microprocessor system consists of the processor itself, address latching and decoding, data buffers, a watchdog timer, read only memory (ROM) for program storage and random access memory (RAM) for program execution.

3.4 DC POWER SUPPLY AND BATTERY

The DC power supply is a 55W continuous, 65W peak, high performance quad output, ±12V and + 5V, supply with automatic selection of AC input range of 90-132 VAC or 175-264 VAC for 47-63 Hz single phase input power. The +5V output is adjustable between 4.75V and 5.5V.

The battery is a 3.6V high-energy lithium battery, with a Velcro mounting strip, providing 1900 mA H. The battery has an estimated service life of 10 years. It is used to prevent loss of data in the non-volatile RAM when power is not applied to the Tracking Receiver Unit.

SECTION 4

4 MAINTENANCE AND SERVICING INSTRUCTIONS

ATTENTION

Maintenance should be performed only by qualified personnel.

4.1 TOOLS AND TEST EQUIPMENT REQUIRED

Horsehair Brush
Screwdrivers - Slot and #2 Phillips Head
7/16 Open End Wrench
5/16 Open End Wrench
Vacuum
Multimeter
Oscilloscope

4.2 INSPECTION, CLEANING AND LUBRICATION

4.2.1 General

Once a year, brush and vacuum the interior of the unit to remove dust and lint.  Shut down the unit and disconnect the power cord prior to removing the cover. The exterior of the unit's chassis may be washed with water and a non-abrasive mild soap solution.

4.2.2 Air Filter Cleaning

Frequency of cleaning is dependent upon the operating environment of the unit and should be determined accordingly.

The mesh screen may be cleaned from the back panel using the vacuum and horsehair brush. Optionally, the screen guard may be removed carefully with a slot head screwdriver prior to cleaning. This allows access to a greater surface area of the screen. Replace screen guard when finished.

4.3 TROUBLESHOOTING

4.3.1 Start Up Fault Messages

The start-up fault messages are displayed should a given function fail at start up. A failure will cause both summary and track faults and halt operation of the Tracking Receiver. The fault conditions and the potential sections of the tracking receiver board or unit assemblies causing the fault are as follows:

FAULT CONDITION	POTENTIAL SOURCE
RAM ERROR	RAM
SOFTWARE FAULT	EPROM
TIMERS FAULT	Microprocessor
SERIAL PORTS FAULT	Microprocessor
POWER SUPPLY FAULT	Power Supply A/D Conversion
VCO CONTROL FAULT	D/A Conversion A/D Conversion

4.3.2 Operating Fault Messages

The operating fault messages are those indicated by the digital status/faults screen. The fault conditions and the potential sections of the tracking receiver board or unit assemblies causing the fault are as follows:

FAULT CONDITION	POTENTIAL SOURCE
RF, IF, or RCVR SYNTHESIZER UNLOCKED	Synthesizer Circuitry (RF Board) Digital Inputs To RF Board (from Receiver Board)
VCO NEAR LIMIT	Beacon Drift Phase-Locked Loop
PLL NEAR LIMIT	Beacon Drift Phase-Locked Loop
DC POWER FAULT	Power Supply Battery A/D Conversion
TEMPERATURE FAULT	Cooling Fan Ambient Temp. Drift Temperature Sensor A/D Conversion

4.3.3 Other Faults

Failure to lock may be caused by any or all of the following:

Tuned To Wrong Frequency	Input Beacon Level Too Low
Auto Sweep Width Too Narrow	L-Band Board Problem

4.4 SPECIALIZED ASSEMBLY, REPAIR OR REPLACEMENT INSTRUCTIONS

All ESD precautions must be followed when working inside the TRU chassis.

4.4.1 Software Upgrade Installation

Software for the Model 253 Tracking Receiver Unit (TRU) is located on the Tracking Receiver Board (A3), programmed in two PLCC EPROMs. Changes or upgrades in software code will require these EPROMs to be replaced with a new version chip set. The following discussion details the procedure to perform this change.

Replacing EPROMS

Prior to replacing software, record parameters on charts in Appendix A.
Disconnect power and pull TRU out from rack. Remove top lid of unit.

ATTENTION

Components inside the TRU chassis are static sensitive. Use precautionary handling procedures to prevent damage from electrostatic field forces.

Locate PLCC EPROM at U36 and U39. Remove chip from PLCC socket. Replace chip with new version. Install –01 EPROM in socket U39. Install -02 EPROM in socket U36.

Replace lid on TRU and connect power. Place the power switch in the "ON" position and verify TRU display is active. Re-enter parameters, if necessary.

4.4.2 Input AC Power Fuse Replacement

The input AC power fuse is located in the power entry module at the rear of the chassis.

Prior to replacing the fuse, the power cord should be disconnected from the power entry module.

The fuse housing is removed from the module with a flat head screwdriver. The housing has a compartment to hold a spare fuse to expedite replacement of the blown fuse. If the spare is used a new spare should be placed in the housing at the earliest possible time. The fuse, measuring 5x20 mm, is rated at 250V and 4A.

4.4.3 Battery Replacement

Prior to removing the battery, all parameters must be recorded on chart in Appendix A.

The battery should be replaced at the earliest convenience once a DC power fault has occurred due to battery voltage falling below 2.5 V. Normal non-volatile memory operation will continue until the battery voltage reaches 2.1 V.

 The battery can be replaced once the power switch is off, the power cord disconnected, and the top cover is removed. The screws for the L-Band Board must be removed so that it may be lifted off the Tracking Receiver Board, allowing access to the battery connector.

Replacement Battery: 3.6V, 2.1Ah at 2mA, non-rechargeable (e.g. Tadiran TL-5242/W).

Dispose of batteries in a proper manner according to the requirements of the country in which the equipment is installed.

Re-enter recorded parameter values after replacing the battery.

Note: If you do not enter band select values, you will be unable to select correct frequency.

4.4.4 DC Power Supply Adjustment

 The DC power supply adjustment is a potentiometer which adjusts the +5 V output only. This output should be adjusted to +5.1 V with the power supply loaded normally.

Reference the DC Power Supply Drawing (Section 6.1) for location of the adjustment potentiometer.

4.4.5 LCD Display Contrast Adjustment

The contrast of the LCD may be adjusted by tuning the potentiometer through a hole in the top cover of the chassis on the right side closest to the front. Use a small flat-head screw driver. The adjustment pot is located about 1.5” beneath the lid of the chassis.

SECTION 5

5 SPECIALIZED SHIPPING PRECAUTIONS

The Tracking Receiver and circuit board assemblies are sensitive to ESD and must be packaged in protective metal film bags and padded with electro-static resistant bubble wrap. Provide sufficient padding within the shipping crate to prevent any breakage.

SECTION 6

6 DRAWINGS AND PARTS LIST

The following drawings are grouped by major assembly.

Section 1 - Assemblies

BLOCK DOWN CONVERTER ASSEMBLY	201396
TRACKING RECEIVER ASSEMBLY	201615

Section 2 - Interface Specifications

TRACKING RECEIVER INTERFACE	95-062-5124-00

Section 3 - Test Procedures

TEST PROC, ACCEPT, TRACKING RECEIVER	CG-0293

Section 4 - SPECIFICATIONS

BLOCK DOWN CONVERTERS	9046 D

7 APPENDIX A PARAMETER SETTINGS

CONFIGURATION PARAMETERS

FIELD NAME	DEFAULT SETTING	CURRENT SETTING
PORT 1 - BAUD	4800	
PORT 1 - PARITY	ODD	
PORT 2 – BAUD	4800	
PORT 2 – PARITY	ODD	
FREQ	950.000 MHz	
CONTROL	REMOTE	
IF BANDWIDTH	4.0 Khz	
SIGNAL LEVEL OFFSET	0	
VCO CONT	AUTO	
AUTO SWP	120 kHz	
MANUAL VCO STEP	10.0 kHz	
CONFIGURATION	STEPTRACK	