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Technical Notes

25T023 Local/Remote Control and Functional Description, Inmarsat EAFC Receiver

LOCAL/REMOTE CONTROL AND FUNCTIONAL DESCRIPTION

INMARSAT EAFC RECEIVER

1.0 INTRODUCTION

This document provides a functional description, theory of operation and operating instructions for the MITEQ INMARSAT EAFC Receiver. For additional discussion on EAFC theory, see MITEQ Technote 25T020. For additional discussion on receiver loop bandwidth, see MITEQ Technote 25T021.

2.0 FUNCTIONAL DESCRIPTION

The MITEQ INMARSAT EAFC Receiver is one part of an overall RF solution for INMARSAT Earth stations. The receiver works optimally with MITEQ INMARSAT converters to provide the low noise and spurious required for INMARSAT Aeronautical applications.

The receiver has complete functionality for INMARSAT Generation 1, 2, and 3 satellites. Algorithms for standard AFC and enhanced AFC are included. The implementation of enhanced AFC for Doppler correction is fully compliant with INMARSAT requirements.

The design of this receiver eliminates any need for loop bandwidth selection as there is no carry over of noise from the input signal to the output signal. Tracking bandwidth is adjusted automatically for optimum tracking performance. Output signal purity and phase continuity is accomplished with a low noise and spurious direct digital synthesizer. The receiver continuously outputs a correction signal, regardless of the tracking status.

A large, informative graphics display simplifies setup and operation. All functions are software controlled and remotely programmable, making this receiver extremely versatile.

The synthesized front end allows reception of a pilot signal anywhere in the 50 to 90 MHz IF frequency band. Receive frequency may be set from the front panel or over the remote bus.

The receiver makes use of digital signal processing techniques to monitor the frequency of the incoming pilot signal. The frequency band containing the pilot signal is filtered, downconverted and digitized. After additional filtering, a Fast Fourier Transform is applied to the data and the resultant frequency spectrum is analyzed to isolate the pilot carrier. Averaging and bandwidth reduction are used to improve signal fidelity so that the receiver can accurately determine the frequency of the pilot carrier. Nearby modulated carriers can also be identified and ignored, preventing "false lock".

Once the frequency of the pilot is reliably known, the microprocessor can add any necessary correction factors. Frequency history from the previous sidereal day is maintained in memory. These data, along

with the transmitting and receiving Earth stations' locations, and the satellite location, are used to calculate the Doppler (inclination) and long term drift factors. These factors are used to calculate the aeronautical correction factors. For C-band downconverters, where the pilot may already have received a correction, the previous correction is easily extracted before the new correction is applied.

The output frequency of the receiver is generated through the use of Direct Digital Synthesis (DDS). The DDS provides a smooth frequency ramp that is phase continuous and precisely controlled. Since the input signal is completely isolated from the output signal, noise components of the input signal are not present on the output signal.

Relays are provided for summary alarm output which may be used for monitoring at a remote console and for redundant switching.

3.0 OPERATING INSTRUCTIONS

3.1 DEFINITIONS

Normal Mode

In "Normal" mode, the receiver has 24 hours of valid tracking data. The current satellite parameters are the results of calculations based on the last 24 hours of valid tracking data. The satellite parameters are updated every 24 hours. The output frequency changes in accordance with the current calculated data.

Fixed Mode

In "Fixed" mode, the satellite parameters have been entered into the receiver's memory and the receiver does not require 24 hours of valid tracking data. The satellite parameters are not automatically updated when the receiver is in fixed mode. The output frequency changes in accordance with the satellite parameters that are in the receiver's memory.

In "Fixed" mode, the receiver will track a pilot signal and log the tracking data into memory. In "Fixed" mode the tracking data is not used for any calculations. When the pilot receiver has been tracking continuously for 24 hours, the tracking data is determined to be valid and the pilot receiver will automatically switch to "Normal" mode. The switch to normal mode will not occur until six hours have passed since the time of ascending node, i.e., it may take up to 30 hours to switch.

Learn Mode

In "Learn" mode, the “Non-Enhanced” correction algorithm is used initially and the receiver does not require 24 hours of valid tracking data. The satellite parameters are not automatically updated when the receiver is in “Learn“ mode. The output frequency changes in a manner that is equal and opposite to the measured pilot error.

In "Learn" mode, the receiver will track a pilot signal and log the tracking data into memory. When the pilot receiver has been tracking continuously for 24 hours, the tracking data is determined to be valid and the pilot receiver will automatically switch to "Normal" mode. The switch to normal mode will not occur until six hours have passed since the time of ascending node, i.e., it may take up to 30 hours to switch.

Non-Enhanced Mode

The "Non-Enhanced" mode provides frequency correction based solely on the measured pilot error. The output frequency changes in a manner that is equal and opposite to the measured pilot error.

In " Non-Enhanced " mode, the receiver will track a pilot signal and log the tracking data into memory. When the pilot receiver has been tracking continuously for 24 hours, the tracking data is determined to be valid and the satellite parameters will be updated. The satellite parameters are provided for information only and are not used in the correction calculations. The pilot receiver will not automatically switch to "Normal" mode.

Tracking Data (History Data)

The pilot receiver measures the frequency of the incoming pilot signal once per second. The once per second data are averaged over a 5 minute interval. The result of each 5 minute interval is entered into a 24 hour table and is displayed graphically on the HISTORY screen. The data in the 24 hour table is used to calculate the satellite parameters.

If the receiver has been unable to track the pilot for more than 50 seconds during a 5 minute interval, the data for that interval is determined to be invalid. An indication of pilot loss will be entered into the 24 hour table for that interval instead of a numeric value and the HISTORY screen will indicate “PILOT LOST”. If the receiver has been operating in “Normal” mode, it will switch to “Fixed” mode (even if “Learn” mode had been used initially).

Satellite Parameters

The user may enter satellite parameters into the receiver when the receiver is not in “Normal” mode. The satellite parameters are automatically updated every 24 hours when the receiver is in “Normal” mode. The satellite parameters are not used when the receiver is in “Non-Enhanced” or “Learn” modes.

The following satellite parameters are required for the EAFC calculations:

Satellite Inclination

Satellite inclination is the peak distance traveled by the satellite over the course of a day, measured geocentrically in degrees from the equator.

Time of Ascending Node

The time of the ascending node is the time of day in UT, at which the satellite crosses the equator in the northbound direction.

Long Term Error (or Satellite Translation Error)

The long term error is the frequency translation error introduced by the satellite transponder. This error is due to aging of the reference crystal for the satellite local oscillator.

Current Calculated (Satellite) Data

Current calculated data are the satellite parameters as calculated from the most recent 24 hours of uninterrupted pilot frequency tracking data.

Hardware Alarms

Hardware alarms are conditions that are indicated by contact closure between pins on a rear panel connector. The two conditions that generate hardware alarms are "Summary Alarm" and "Converter Mute".

Summary Alarm/Redundancy Alarm

The summary alarm and redundancy alarm connectors are used to indicate a failure of a hardware component of the pilot receiver.

Converter Mute

The converter mute connector is incorporated to maintain compliance with INMARSAT requirements to shut down the traffic when a pilot signal is unavailable. While the receiver is in either the Normal or Fixed mode, providing EAFC correction, the converter mute function will become active after 60 minutes have elapsed since the pilot receiver was able to track a pilot signal. While the receiver is in either Non-enhanced or Learn mode, providing non-enhanced frequency correction, the converter mute function will activate after ten seconds have passed since the receiver was able to track a pilot.

Although converter muting is defined in the hardware, this function may also be incorporated in external software by monitoring the pilot status of the receiver.

Pilot Status

Changes in pilot status are indicated on the front panel display and are available remotely by polling through the receiver's remote interface.

Configuration (CONFIG)

The CONFIG parameter on the front panel SETUP screen is used to determine whether the system is operating open loop or closed loop and for determining the valid frequency ranges.

Open loop configurations are used in the correction of C band uplink signals. The CW pilot signal is generated at C band by equipment independent of the C band upconverter. The pilot signal is translated by the satellite to L band (C-L) or S band (C-S). The uncorrected pilot signal is received by the earth station, is downconvertered to a nominal 70 MHz, and fed to the pilot receiver. The pilot receiver provides correction to the C band upconverter.

Closed loop configurations are used in the correction of C band downlink signals. The CW pilot signal is generated at L band (L-C) or at S band (S-C). The pilot signal is translated by the satellite to C band. The pilot signal and the traffic carriers are received by the earth station, downconvertered in the C band downconverter to a nominal 70 MHz, and fed to the pilot receiver. The pilot receiver provides correction to the C band downconverter.

Valid frequency ranges for the various receiver configurations may be found in section 3.7.

AFC Output

While in “Learn” or “Non-Enhanced” mode, the pilot receiver continuously emits a signal at 5 MHz (nominal) that contains the AFC information. This AFC output is never switched off as the presence of the AFC output signal is required to prevent an out of lock alarm at the converter being corrected.

The method of calculation of the frequency of the AFC output signal is to subtract the measured pilot error from the nominal 5MHz AFC output.

The applied compensation is: C = 5 MHz – Pilot Error

EAFC Output

While in “Fixed” or “Normal” mode, the pilot receiver continuously emits a signal at 5 MHz (nominal) that contains the EAFC information. This EAFC output is never switched off as the presence of the EAFC output signal is required to prevent an out of lock alarm at the converter being corrected.

The method of calculation of the frequency of the EAFC output signal is taken from Para. 5; Module 3 of the INMARSAT Aeronautical System Definition Manual.

The Doppler frequency component (Dp) experienced by the pilot carrier at the GES will be multiplied by:

$$M = [Fcom(C) * A(GES)] / [(Fpil(C) * A(GESR) + Fpil(L) * A(GES)]$$

Fcom(C) = C-band uplink communication frequency
Fpil(C) = C-band AFC Pilot frequency
Fpil(L) = L-band AFC Pilot frequency
A(GES) = Doppler shift factor at the GES
A(GESR) = Doppler shift factor at the GES transmitting the pilot

$$R = Dp * M$$

The applied compensation is:

$$C = - (E + T) - R$$

where E and T are long term effects

The factors A(GES) and A(GESR) are functions of earth geometry, GES and satellite locations, and satellite motion.

3.2 THEORY OF OPERATION

3.2.1 SOFTWARE FLOW (See Flowchart)

1. The front end of the pilot receiver is tuned to the nominal frequency of the pilot signal in the 50 to 90 MHz IF frequency band.

2. An analysis of the spectrum in the vicinity of the pilot is performed.

3. Noise and modulated carriers are ignored and the pilot signal is selected for tracking.

4. The frequency of the pilot signal is measured and logged into a 24 hour history table.

5. The output frequency is calculated.

6. The output frequency is set.

7. Steps 4 through 6 are repeated once every second.

8. Data is added to the HISTORY table every 5 minutes.

9. Calculated satellite parameters are updated every 24 hours.

3.2.2 OPERATIONAL SCENARIOS

3.2.2.1 OPERATIONAL SCENARIO #1

1. The pilot receiver is setup with all the required data and placed in "Fixed" mode.

2. The output frequency changes in accordance to the data entered.

3. A pilot signal is acquired and the receiver begins to track.

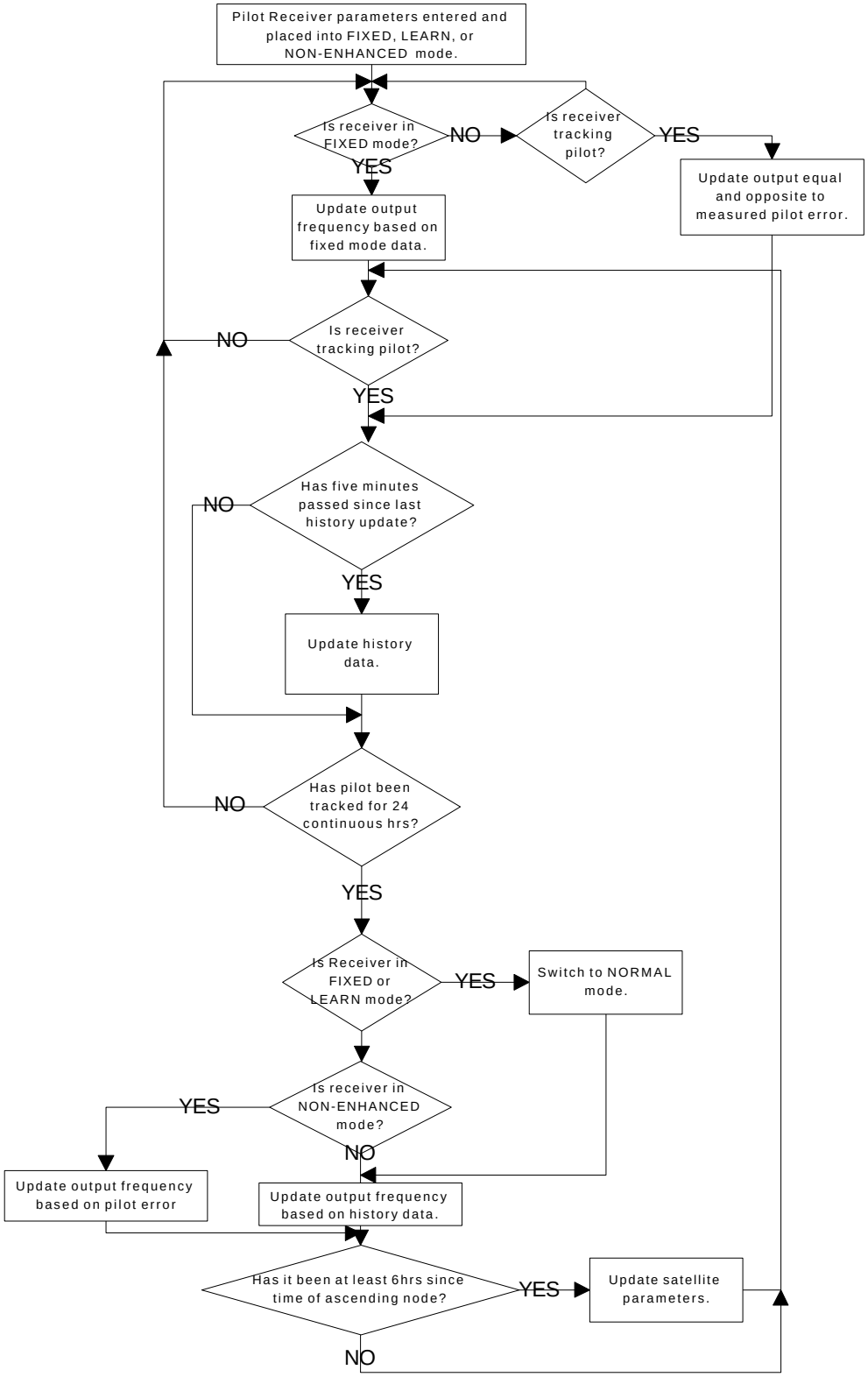
4. After 24 hours of continuous tracking, the receiver automatically switches into "Normal" mode.

5. The pilot receiver calculates new values for the inclination, ascending node, and translation error (long term error) of the satellite.

6. The output frequency changes at a rate no greater than10 Hz/sec. to catch up with the new calculated data.

7. The output frequency changes in accordance with the current calculated data.

8. The current calculated satellite parameters are updated every 24 hours.



Software Flowchart

3.2.2.2 OPERATIONAL SCENARIO #2

1. The pilot receiver is setup as in Scenario #1 and has been tracking for more than 24 hours.

2. The pilot signal is lost due to RF switching, short term fading, etc.

3. The front panel and remote status indicate pilot loss. No hardware alarms are generated.

4. The pilot is reacquired in less than 50 seconds.

5. The pilot receiver resumes tracking and remains in "Normal" mode.

6. Historical data is not interrupted.

7. The output frequency changes in accordance with the current calculated data without interruption.

3.2.2.3 OPERATIONAL SCENARIO #3

1. The pilot receiver is setup as in Scenario #1 and has been tracking for more than 24 hours.

2. The pilot signal is lost due to equipment failure, cable disconnection, etc.

3. The front panel and remote status indicate pilot loss. No hardware alarms are generated.

4. The pilot is not reacquired in less than 50 seconds.

5. The pilot receiver switches to "Fixed" mode.

6. The output frequency continues to change in accordance with the last calculated data, without interruption.

7. Historical data indicates pilot loss.

8. The pilot receiver enters wideband acquisition mode.

9. The pilot is reacquired in less than 60 minutes.

10. The pilot receiver resumes tracking and remains in "Fixed" mode.

11. After 24 hours of continuous tracking, the receiver automatically switches into "Normal" mode.

12. The pilot receiver calculates new values for the inclination, ascending node, and translation error (long term error) of the satellite.

13. The output frequency changes at a rate no greater than 10 Hz/sec. to catch up with the new calculated data.

14. The output frequency changes in accordance with the current calculated data.

3.2.2.4 OPERATIONAL SCENARIO #4

1. The pilot receiver is setup as in Scenario #1 and has been tracking for more than 24 hours.

2. The pilot signal is lost due to equipment failure, cable disconnection, etc.

3. The front panel and remote status indicate pilot loss. No hardware alarms are generated.

4. The pilot is not reacquired in less than 50 seconds.

5. The pilot receiver switches to “Fixed” mode.

6. The output frequency changes in accordance with the last calculated data without interruption.

7. Historical data indicates pilot loss.

8. The pilot receiver enters wideband acquisition mode.

9. The pilot is not reacquired in less than 60 minutes.

10. The pilot receiver status changes to indicate converter mute.

11. The pilot receiver makes a contact closure at the rear panel mute connector.

12. The output frequency changes in accordance with the last calculated data without interruption.

3.2.2.5 OPERATIONAL SCENARIO #5

1. The pilot receiver is setup with all the required data and placed in "Learn" mode.

2. The output frequency remains fixed with no correction.

3. A pilot signal is acquired and the receiver begins to track.

4. The output frequency changes in a manner that is equal and opposite to the received pilot error.

5. After 24 hours of continuous tracking, the receiver automatically switches into "Normal" mode.

6. The pilot receiver calculates new values for the inclination, ascending node, and translation error (long term error) of the satellite.

7. The output frequency changes at a rate no greater than10 Hz/sec. to catch up with the new calculated data.

8. The output frequency changes in accordance with the current calculated data.

9. The current calculated satellite parameters are updated every 24 hours.

3.2.2.6 OPERATIONAL SCENARIO #6

1. The pilot receiver is setup and placed in "Non-enhanced" mode.

2. The output frequency remains fixed with no correction.

3. A pilot signal is acquired and the receiver begins to track.

4. The output frequency changes in a manner that is equal and opposite to the received pilot error.

3.2.2.7 OPERATIONAL SCENARIO #7

1. The pilot receiver is setup as in Scenario #6

2. The pilot signal is lost due to RF switching, short term fading, etc.

3. The front panel and remote status indicate pilot loss. No hardware alarms are generated.

4. The output frequency remains constant at the last known value.

5. The pilot is reacquired in less than 10 seconds.

6. The pilot receiver resumes tracking.

7. Historical data is not interrupted.

8. The output frequency in a manner that is equal and opposite to the received pilot error.

3.2.2.8 OPERATIONAL SCENARIO #8

1. The pilot receiver is setup as in Scenario #6.

2. The pilot signal is lost due to equipment failure, cable disconnection, etc.

3. The front panel and remote status indicate pilot loss. No hardware alarms are generated.

4. The pilot is not reacquired in less than 10 seconds.

5. The pilot receiver status changes to indicate converter mute.

6. The pilot receiver makes a contact closure at the rear panel mute connector.

7. The output returns to the nominal frequency at a rate of 10 Hz per second.

8. The output frequency remains fixed and uncorrected until tracking is reestablished.

3.3 INITIAL SETUP

3.3.1 ENHANCED AFC

In order for the pilot receiver to perform the calculations required for INMARSAT EAFC, certain data must be first entered into the receiver's non-volatile memory.

1. The receiver configuration: "C to L" or "C to S" (uplink) or "L to C" or "S to C" (downlink).

2. Latitude and longitude of the station transmitting the pilot signal.

3. RF uplink frequency of the pilot.

4. Nominal longitude of the satellite.

5. Inclination of the satellite.*

6. Time of the satellite's ascending node.*

7. Translation error of the satellite.*

8. Latitude and longitude of the station containing the pilot receiver.

9. Nominal RF downlink frequency of the pilot.

10. Translation frequency of the C-band or L-band downconverter that is feeding the pilot receiver.

11. Frequency of the RF traffic to be corrected.

*Inclination, ascending node, and translation error (long term error) of the satellite are entered in at the initial setup and are then calculated after 24 hours of continuous pilot tracking.

3.3.2 NON-ENHANCED AFC

In order for the pilot receiver to perform the non-enhanced AFC, certain data must be first entered into the receiver's non-volatile memory.

1. The receiver configuration: "C to L" or "C to S" (uplink) or "L to C" or "S to C" (downlink).

2. Nominal RF downlink frequency of the pilot.

3. Translation frequency of the C-band or L-band downconverter that is feeding the pilot receiver.

3.4 FRONT PANEL OPERATIONS

The front panel display and indicators have been organized so that important information is available at a glance. The keyboard is divided into functional groups which allow an operator to easily change any parameter from the front panel. See Figure 1 for the physical layout of the front panel.

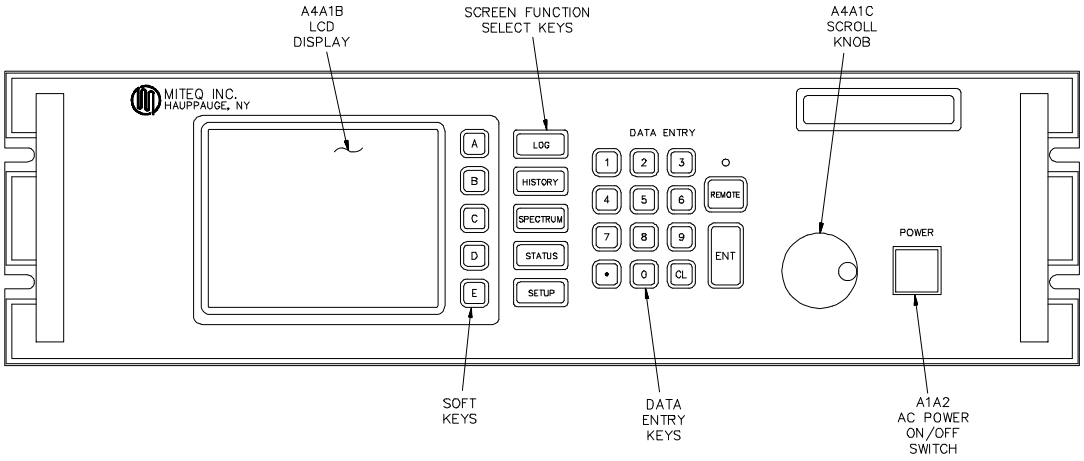


Figure 1. Front Panel, INMARSAT EAFC Receiver

3.4.1 KEYPAD OPERATION

The keypad is divided into five functional groups (Power, Screen Select keys, Soft-keys, Data Entry and Local/Remote Select). The error tone will sound when an illegal key is pressed and in some cases, a warning message will be displayed.

3.4.1.1 POWER

The AC power switch is located on the lower right of the front panel. To cycle power simply push this button. The push-button LED is lit when power is on.

3.4.1.2 SCREEN SELECT KEYS

The screen select keys are located to the right of the display area. They allow the operator to switch between the five screens with ease. By pressing one of the five screen select keys instant access to pertinent data is granted. These keys are operative in both Local and Remote modes.

3.4.1.3 SOFT-KEYS

The five soft-keys, adjacent to the display, are labeled “A” through “E.” The context of these keys is screen dependent. A brief definition is presented, on the active screen, adjacent to the soft-keys. Pressing undefined soft-keys will cause an error tone to sound.

3.4.1.4 DATA ENTRY

The Data Entry keys, along with the Scroll knob, allow the operator to enter specific data into an active field. Data is entered using the numbered keys or Scroll knob then pressing the “ENT” key. Invalid entries will be ignored and cause an error tone to sound. An entry can be re-initiated with the “CL” key. While in Remote mode, local data entry is prohibited, however, all system parameters can be examined.

3.4.1.5 LOCAL/REMOTE SELECT

The front panel “REMOTE” key selects either Local (LED off) or Remote mode (LED on). The mode alternates with each key press. On units equipped with the IEEE-488 remote option this key puts the unit into Local mode only as dictated by that standard.

While in Local mode, receiver settings can be changed using the front panel. All of the status information can be monitored over the remote bus. Remote attempts to alter the receiver settings will be ignored.

With receiver settings under remote control, the system parameters can be observed locally. Efforts to alter the receiver settings from the front panel, while in Remote mode, will be ignored and cause an error tone to sound.

3.4.2 LOCAL OPERATION

In Local mode, the receiver is controlled from the front panel. System parameters can still be monitored over the remote bus, however, attempts to change settings remotely, while in Local mode, will be ignored.

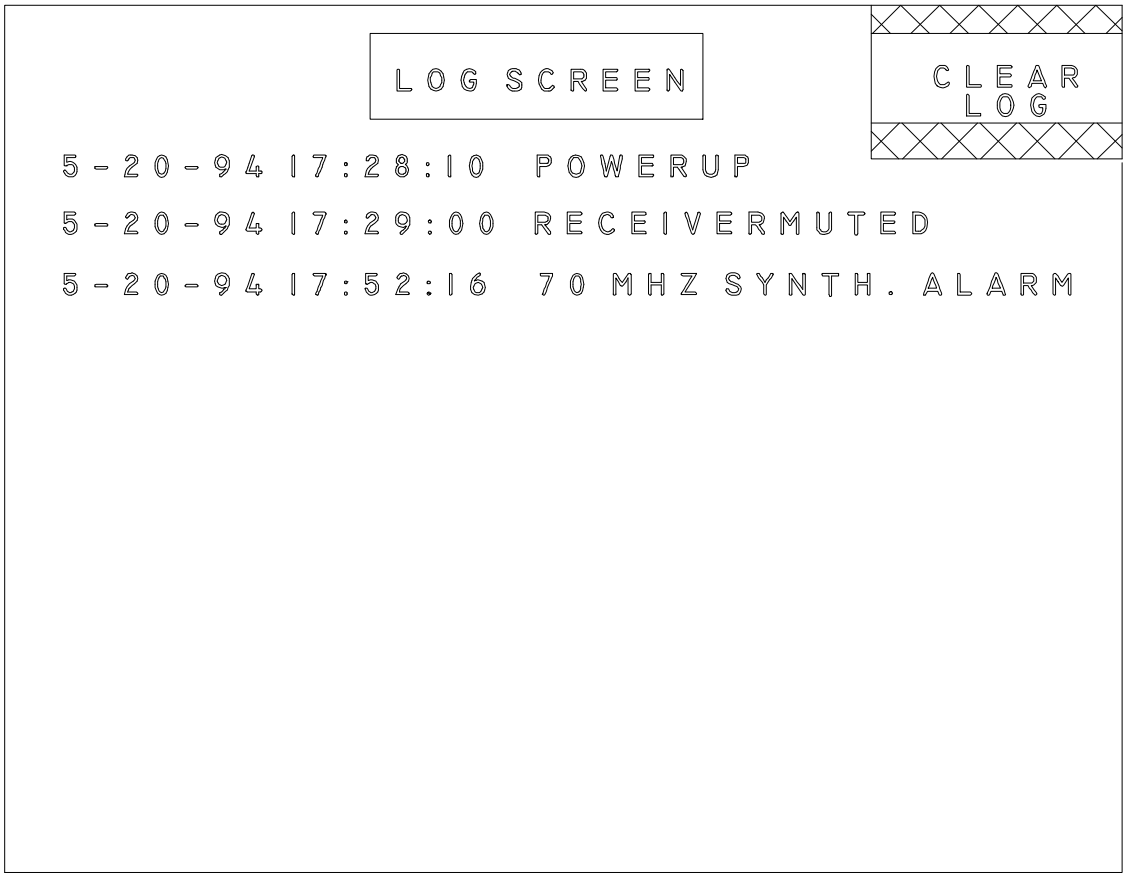
The five front panel screen select keys are located to the right of the LCD display. These keys control the display and allow data entry into the various functional areas of the receiver. The five soft-keys, labeled “A” through “E,” are context sensitive with respect to the current screen and defined on the LCD. The five screens available are:

- Log Screen
- History Screen
- Spectrum Screen
- Status Screen
- Setup Screen

3.4.2.1 LOG SCREEN

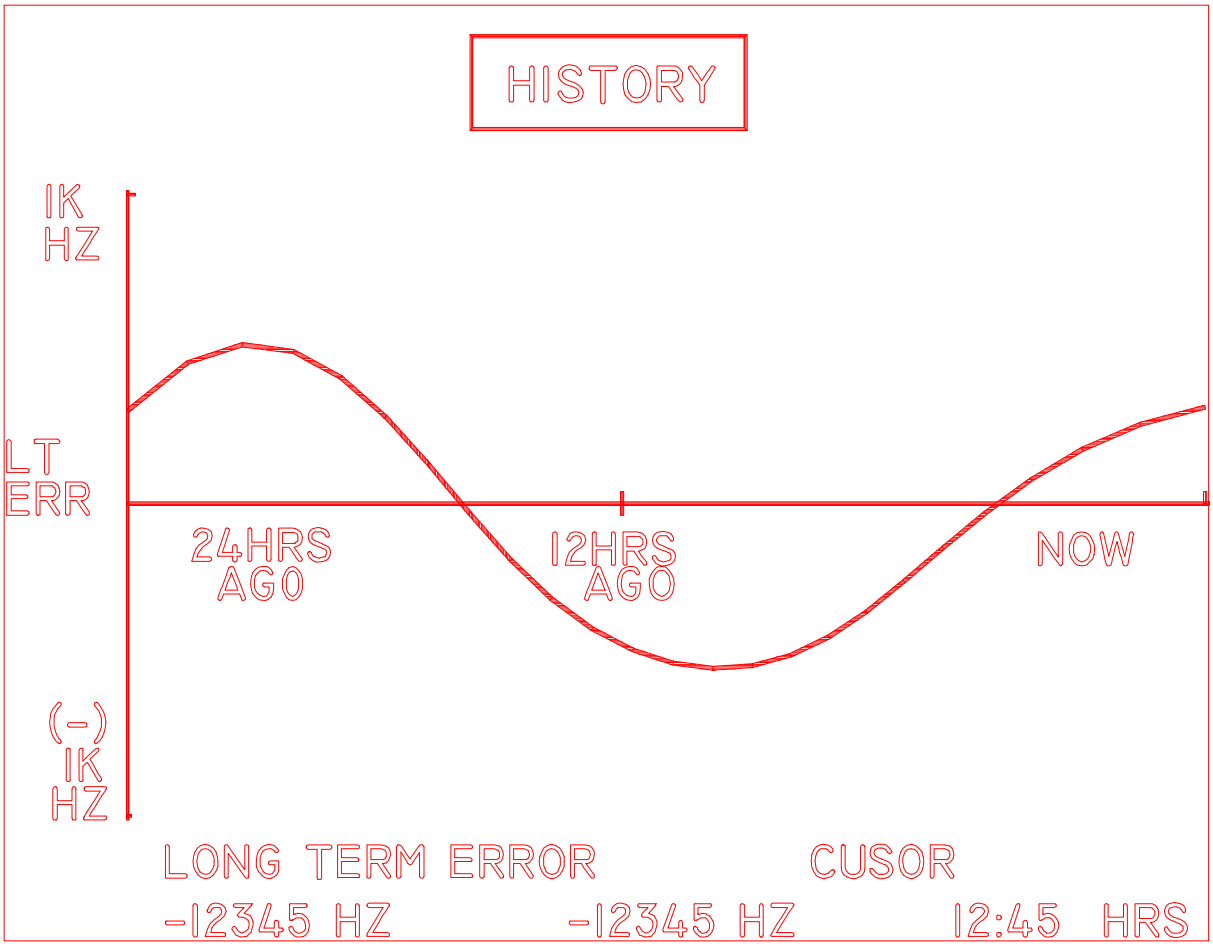
The Log Screen displays the current log of events as recorded by the receiver. The log includes the date, time, and a brief description of the event.

The "A" Soft-key allows the user to clear the current log.



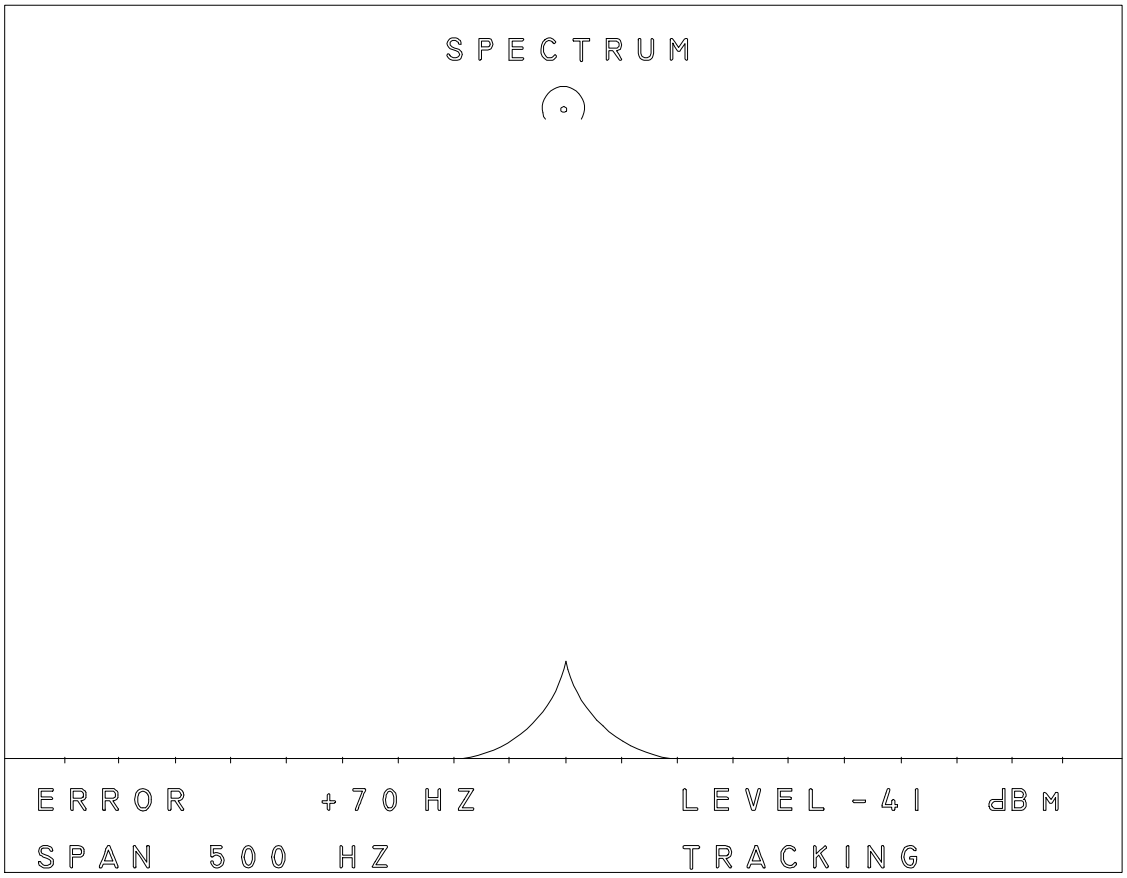
3.4.2.2 HISTORY SCREEN

The History Screen provides a record of the pilot error frequency for the last 24 hours. The history is presented in five minute increments. The user may scroll forwards or backwards through this history by using the Scroll knob on the front panel.



3.4.2.3 SPECTRUM SCREEN

The Spectrum Screen provides a graphic representation of the digitized IF spectrum. This display provides information on the pilot, the aggregate level of the tuned frequency plus or minus 55 kHz, and the mode of the receiver (either "Acquisition", "Tracking", or "Pilot Loss"). The frequency span of the spectral display is provided, as is the current frequency error of the pilot signal.

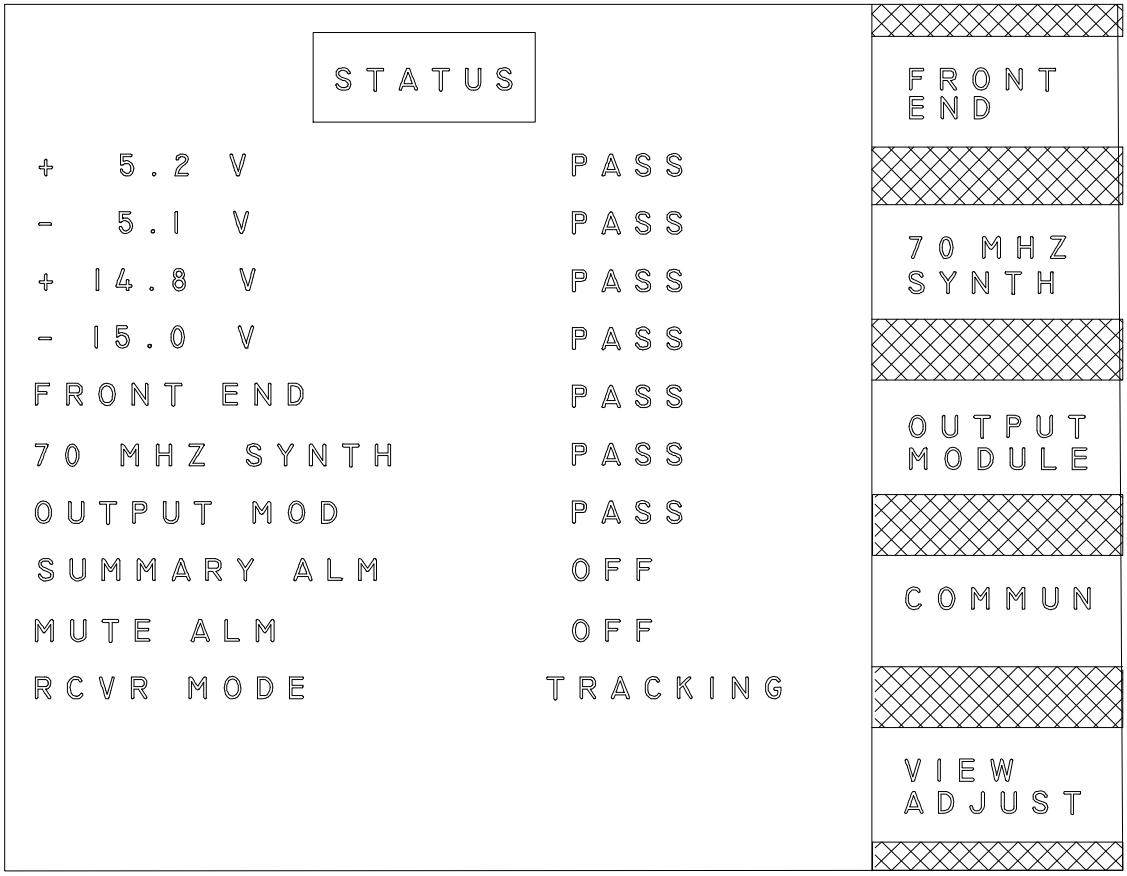


3.4.2.4 STATUS SCREEN

The Status Screen provides current status on the main receiver, as well as each individual sub-system functions. This functional control area provides contrast adjustment for the LCD display and also allows the remote interface communication parameters to be viewed and selected.

3.4.2.4.1 MAIN STATUS SCREEN

This screen displays information on the power supply, the status on each of the sub-system modules, the summary alarm, the mute alarm, and the receiver mode. From this screen the five soft-keys, marked "A" through "E" can select any of the individual status sub-screens.



3.4.2.4.2 FRONT END STATUS SCREEN

This screen provides information on the status of the Front End module. The information consists of the AGC level and the LO input level. Both levels are presented in volts, and a pass/fail indication of both of these parameters is also displayed. The soft-keys to the right of the display can be used to select any of the remaining status sub-screens. To return to the Main Status screen, the "STATUS" Screen select key is depressed.

3.4.2.4.3 70 MHZ SYNTHESIZER STATUS SCREEN

This display provides information on the 70 MHz Synthesizer module and the Reference module. The information provided on the Reference module consists of the Reference Phase voltage, the 5 MHz Reference level, and the Phase Lock voltage. The information from the 70 MHz Synthesizer module consists of the LO Output level and Lock Detection status. The LO Output level is shown in volts and the Lock Detection status as pass/fail. The soft-keys to the right of the display can be used to select any of the remaining status sub-screens. To return to the Main Status screen, press the "STATUS" Screen select key.

3.4.2.4.4 OUTPUT MODULE STATUS SCREEN

This screen provides information on the status of the Output Module. The information provided includes the status of the internal 5 volt regulation circuitry, the Output level, and the 96 MHz Input Reference level. All of the information is presented in volts. The soft-keys to the right of the display can be used to select any of the remaining status sub-screen. To return to the Main Status screen, depress the "STATUS" Screen select key.

3.4.2.4.5 COMMUNICATIONS PARAMETER STATUS SCREEN

This screen provides information and data input for the remote communication parameters. The information displayed includes the type of interface: RS485, RS422, RS232, or IEEE-488, and the address of the receiver. Rotating the front panel Scroll knob allows the user to move the cursor to the "ADDRESS" area of the display. A new address can be entered via the front panel Data Entry keypad using the number keys followed by the "ENT" key. Entries outside the available range will be followed by an error tone.

Rotating the front panel Scroll knob will move the cursor to the "BAUD RATE" area of the display. A new baud rate can be entered via the front panel Data Entry keypad using the number keys followed by the "ENT" key. Entries outside the available range will be followed by an error tone.

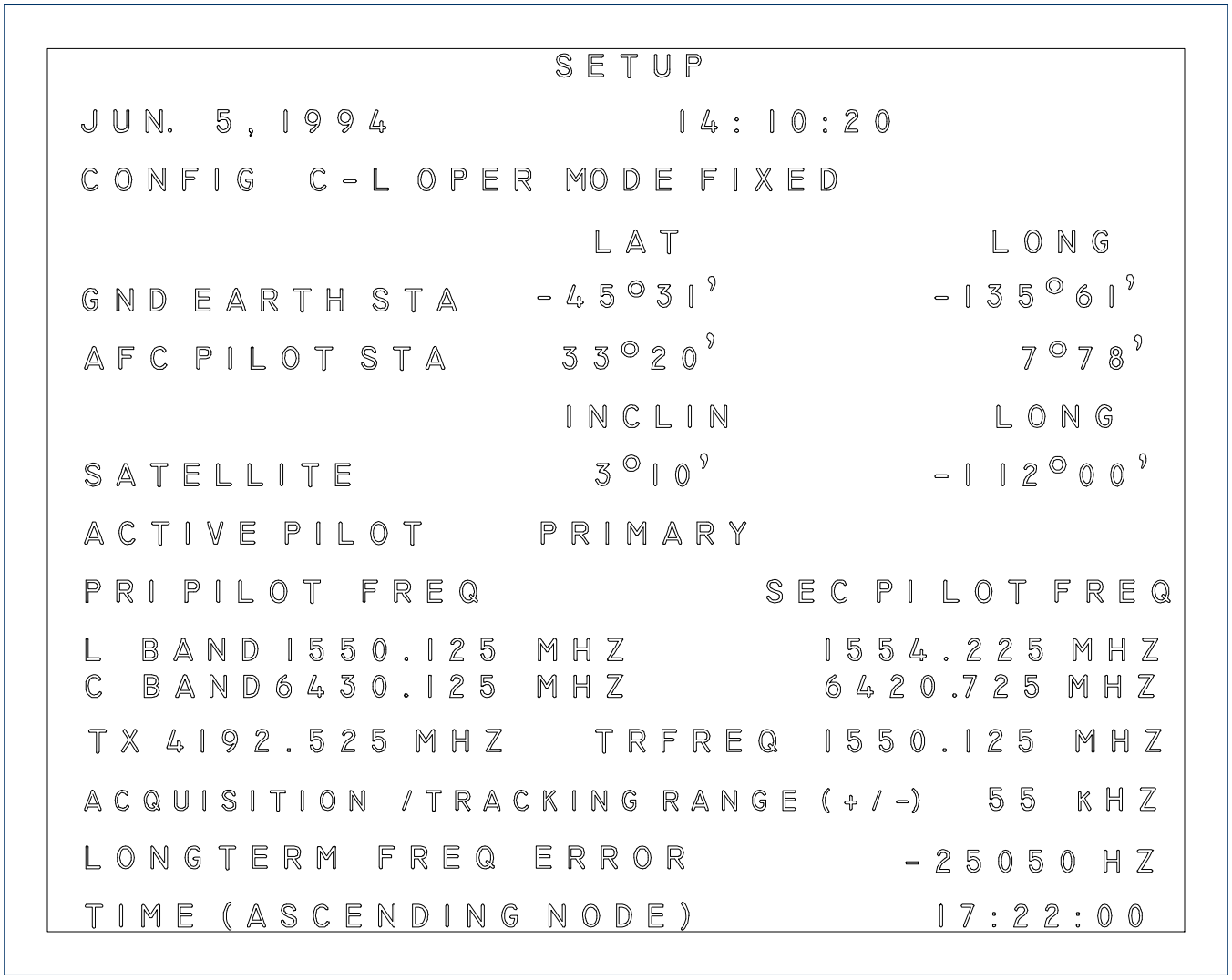
Rotating the front panel Scroll knob will move the cursor to the "PARITY" area of the display. A new parity can be entered via the front panel Data Entry keypad. Entering "2" will set the parity to "NONE"; entering "1" will set the parity to "ODD"; entering "0" will set the parity to "EVEN".

3.4.2.4.6 VIEW ADJUST SCREEN

This screen allows the operator to adjust the contrast of the LCD display by rotating the front panel Scroll knob.

3.4.2.5 SETUP SCREEN

The Setup Screen provides information and allows data entry for the initial setup of the receiver. There are six main areas of functional control in this display. They are the Date/Time area, the receiver Configuration area, the Operating Mode area, the Active Pilot selection area, the Location area and the Frequency area.



3.4.2.5.1 DATE/TIME FUNCTION

The MITEQ Receiver has an internal Real Time Clock (RTC). By rotating the Scroll knob, the cursor can be moved to the month, day, year, hour, minute, or seconds areas of the display. The Soft-key "A" will increment, and the Soft-key "B" will decrement any of these parameters.

3.4.2.5.2 CONFIGURATION FUNCTION

The receiver is configurable for a C-to-L , C-to-S, L-to-C, or S-to-C link operation. The "A" Soft-key selects the L-to-C configuration; the "B" Soft-key selects C-to-L link operation; the "C" Soft-key selects the S-to-C configuration; the "D" Soft-key selects C-to-S link operation.

3.4.2.5.3 OPERATING MODE

The receiver will operate in Fixed, Learn, Non-Enhanced, or Normal mode. In each mode the receiver periodically gathers data in 5 minute intervals while tracking a pilot. The last 24 hours worth of historical data is then analyzed to determine:

- Long Term Frequency Error
- Peak Doppler Frequency Error
- Time of Ascending Node

Three parameters: Satellite Inclination, Long Term Frequency Error, and Time of Ascending Node are periodically updated on the "SETUP" screen and are calculated from measured values. While in Normal mode, they are read-only parameters and cannot be changed either by the operator or from the remote bus.

In Fixed or Learn mode the receiver also gathers data, however, Long Term Frequency Error, Satellite Inclination and Time of Ascending Node are entered by the operator or over the remote bus. The EAFC algorithm uses these fixed parameters for 24 hours after which time the receiver automatically switches over to Normal mode.

In Non-Enhanced mode these parameters are not used, however, they are updated.

3.4.2.5.4 LOCATION FUNCTIONS

The Latitude and Longitude of the Ground Earth Station, Pilot Earth Station, and the Satellite Longitude are entered by the operator or over the remote bus. Data is entered in degrees and minutes within the following ranges:

Latitude: ±90º Longitude: ±180º

3.4.2.5.5 ACTIVE PILOT SELECTION FUNCTION

Either the Primary or the Secondary Pilot frequency may be chosen as the Active Pilot for the receiver. This selection is made by rotating the front panel Scroll knob to position the cursor on the Active Pilot section of the display, and then selecting either the "A" Soft-key for the Primary Pilot Frequency, or the "B" Soft-key for the Secondary Pilot Frequency.

3.4.2.5.6 FREQUENCY FUNCTIONS

By rotating the Scroll knob to position the cursor over the appropriate frequency section, the operator can use the front panel Data Entry keypad to set the L-Band (or S-band) and C-Band Primary and Secondary Pilot Frequencies. In L-C or S-C mode the C-Band carrier downlink frequency is entered next to the heading "RX". In C-L or C-S mode the heading changes to "TX" and represents the C-Band carrier uplink frequency.

"TRFREQ" is the L-, S- or C-Band Downconverter translation frequency. In L-C or S-C mode, the C-Band Pilot and C-Band carrier frequencies are translated to the 70 MHz Receiver IF input. In C-L or C-S mode the L-Band or S-Band Pilot frequency is translated to the 70 MHz IF frequency.

"ACQUISITION RANGE" is the widest band in which the receiver will attempt to acquire a pilot signal. This is programmable from ±1 kHz to ±55 kHz.

3.5 REMOTE OPERATION

The receiver is supplied with an RS485 bus interface or, as an option, can be supplied with RS232, RS422 or IEEE-488. The command structures for the serial buses are identical. The IEEE-488 format is similar with the exception that no header, trailer or checksum bytes are included in the structures.

3.5.1 RS232/422/485 REMOTE PROTOCOL

The command structures for the serial buses; RS232, RS422 and RS485 are identical. All transmissions are multi-byte sequences beginning with a header byte and ending with a trailer byte and checksum byte. The transmitted bytes are all ASCII printable characters in the range of 20H to 7EH.

Serial data format is a 10 bit sequence consisting of one Start, 7 Data, 1 Parity, and 1 Stop bit. All characters, including the checksum character, are checked for parity. If any character in a command message contains an error (parity, framing or overrun) or the checksum is incorrect, the command is ignored and no response is made. The remote parameters; Address, Baud Rate, and Parity are programmable from the front panel. The response time from command to acknowledge is 100 ms. maximum.

All messages addressed to the receiver are acknowledged with a response message. The receiver continually monitors the communication bus and will accept commands, addressed to it, even in Local mode. When in Local mode, receipt of any SET commands (commands beginning with “$”) will be ignored and the receiver will respond with an error code.

3.5.1.1 DEVICE ADDRESS/BAUD RATE/PARITY SELECTION

The remote control parameters can be accessed by entering the communications parameter status screen. The information displayed includes the remote parameters associated with the interface supplied. This section describes the serial interface parameters.

To set any of the remote parameters simply rotate the front panel Scroll knob to move the cursor to the appropriate area of the display. Use the number keys followed by the "ENT" key to edit the setting. Entries outside the allowable range will be ignored and followed by an error tone. The three fields are Address, Baud Rate, and Parity.

To change the receiver address, move the cursor to the “ADDRESS” field and enter the new setting. Addresses 64-95 are valid.

To change the receiver baud rate, move the cursor to the “BAUD RATE” field and enter the new setting. Baud rates of 300-19200 are valid.

To change the parity, move the cursor to the “PARITY” field and enter the new setting. Entering "2" will select no parity, entering "1" will set the parity to "ODD"; entering "0" will set "EVEN" parity.

3.5.1.2 MESSAGE FORMAT

The message format is as follows:

HEADER - RECEIVER ADDRESS - COMMAND/ERROR CODE - PARAMETERS - TRAILER - CHECKSUM

The response time from command to acknowledge is 100 ms. maximum. Since all bytes are ASCII printable characters, a compatible terminal may be used to control the receiver or monitor traffic on the communication bus.

3.5.1.2.0 HEADER BYTE

The Header byte is 7BH, ASCII character "{".

3.5.1.2.1 RECEIVER ADDRESS

The receiver may take on the address values from 64 to 95 (40H to 5FH).

3.5.1.2.2 COMMAND CODE SUMMARY

COMMAND CODES

ASCII Character String	Function
GET	Ground Earth Station Latitude
GEL	Ground Earth Station Longitude
PIT	AFC Pilot Station Latitude
PIL	AFC Pilot Station Longitude
SAI	Satellite Inclination
SAL	Satellite Longitude
PRL	Primary L-Band Frequency
PRC	Primary C-Band Frequency

3.5.1.2.2 COMMAND CODE SUMMARY - Continued

COMMAND CODES

ASCII Character String	Function
SEL	Secondary L-Band Frequency
SEC	Secondary C-Band Frequency
RXC	Receive C-Band Communications Frequency
TXC	Transmit C-Band Communications Frequency
TRL	Converter Translation Frequency
OUT	Nominal Output Frequency
LTE	Long Term Frequency Error
DOP	Peak Doppler Frequency Error
TIM	Time of Ascending Node
CON	Receiver Configuration
CLK	Internal Calendar/Clock
ALR	Alarm Status
MOD	Receiver Mode
ERR	Pilot Error
LVL	Aggregate Level
HIS	History Data
ACQ	Acquisition Range
COR	Applied Frequency Correction

3.5.1.2.3 ERROR CODES

ASCII Character	Function
a	Command not recognized
b	Illegal parameter or parameter out of range
c	Unit in Local mode
d	Busy

3.5.1.2.4 PARAMETERS

Parameters are all ASCII printable characters in the range of 20H to 7EH. Numeric parameters are sent MSD first, LSD last. Values which do not adhere to the command format, or are beyond the allowable range, will be rejected and cause the receiver to respond with an error code.

3.5.1.2.5 TRAILER BYTE

The Trailer byte is 7DH, ASCII character "}".

3.5.1.2.6 CHECKSUM BYTE

The checksum byte is the sum modulo 95 of all message characters beginning with the header byte up to and including the trailer byte. The value 32 is subtracted from each character value before taking the modulo 95 sum. The value 32 is added to the final sum to obtain the checksum value. All values are in decimal.

Checksum = MOD [(character value - 32), 95] + 32

3.5.1.3 COMMAND CODE DESCRIPTION

The following paragraphs describe each of the command codes. For clarity the header, address, trailer and checksum characters are not shown. Upper case letters are the actual command or response characters. Lower case letters represent parameter character strings.

Commands preceded by “?” are QUERY commands and those preceded by “$” are SET commands. QUERY commands are used to examine system parameters remotely while SET commands are intended to modify system parameters.

3.5.1.3.1 GROUND EARTH STATION LATITUDE = GET

The SET command requires a sign character and a five digit parameter which sets the latitude in degrees and minutes. The acceptable range is from -90°00’ to +90°00’.

Remote Command Sequence: $GETsdddmm
Receiver Response: $GET

The QUERY command requires no parameters.

Remote Command Sequence: ?GET
Receiver Response: ?GETsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-090)

mm: Minutes (00-59)

3.5.1.3.2 GROUND EARTH STATION LONGITUDE = GEL

The SET command requires a sign character and a five digit parameter which sets the longitude. The acceptable range is from -180°00' to +180°00'.

Remote Command Sequence: $GELsdddmm
Receiver Response: $GEL

The QUERY command requires no parameters.

Remote Command Sequence: ?GEL
Receiver Response: ?GELsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-180)

mm: Minutes (00-59)

3.5.1.3.3 AFC PILOT STATION LATITUDE = PIT

The SET command requires a sign character and a five digit parameter which sets the latitude. The acceptable range is from -90°00' to +90°00'.

Remote Command Sequence: $PITsdddmm
Receiver Response: $PIT

The QUERY command requires no parameters.

Remote Command Sequence: ?PIT
Receiver Response: ?PITsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-090)

mm: Minutes (00-59)

3.5.1.3.4 AFC PILOT STATION LONGITUDE = PIL

The SET command requires a sign character and a five digit parameter which sets the longitude. The acceptable range is from -180°00’ to +180°00’.

Remote Command Sequence: $PILsdddmm
Receiver Response: $PIL

The QUERY command requires no parameters.

Remote Command Sequence: ?PIL
Receiver Response: ?PILsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-180)

mm: Minutes (00-59)

3.5.1.3.5 SATELLITE INCLINATION = SAI

The SET command requires a 'don't care' sign character and a five digit parameter which sets the inclination. The sign is always assumed to be positive. The SET command is only available while the receiver is operating in Normal mode. The acceptable range is from 0°0’ to +90°00’.

Remote Command Sequence: $SAIsdddmm
Receiver Response: $SAI

The QUERY command requires no parameters.

Remote Command Sequence: ?SAI
Receiver Response: ?SAIsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-090)

mm: Minutes (00-59)

3.5.1.3.6 SATELLITE LONGITUDE = SAL

The SET command requires a sign character and a five digit parameter which sets the longitude. The acceptable range is from -180°00' to +180°00'.

Remote Command Sequence: $SALsdddmm
Receiver Response: $SAL

The QUERY command requires no parameters.

Remote Command Sequence: ?SAL
Receiver Response: ?SALsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-180)

mm: Minutes (00-59)

3.5.1.3.7 PRIMARY L-BAND OR S-BAND FREQUENCY = PRL

The SET command requires a seven digit parameter which sets the frequency value in kHz. The acceptable range is from 1500 MHz to 1700 MHz for L-Band and 2500 to 2690 for S-Band.

Remote Command Sequence: $PRLfffffff
Receiver Response: $PRL

The QUERY command requires no parameters.

Remote Command Sequence: ?PRL
Receiver Response: ?PRLfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.8 PRIMARY C-BAND FREQUENCY = PRC

The SET command requires a seven digit parameter which sets the frequency value in kHz. In a C-L or C-S configuration, the acceptable range is from 5925 MHz to 6475 MHz. In a L-C or S-C configuration, the acceptable range is from 3575 MHz to 4225 MHz.

Remote Command Sequence: $PRCfffffff
Receiver Response: $PRC

The QUERY command requires no parameters.

Remote Command Sequence: ?PRC
Receiver Response: ?PRCfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.9 SECONDARY L-BAND OR S-BAND FREQUENCY = SEL

The SET command requires a seven digit parameter which sets the frequency value in kHz. The acceptable range is from 1500 MHz to 1700 MHz for L-Band, 2500 to 2690 for S-Band.

Remote Command Sequence: $SELfffffff
Receiver Response: $SEL

The QUERY command requires no parameters.

Remote Command Sequence: ?SEL
Receiver Response: ?SELfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.10 SECONDARY C-BAND FREQUENCY = SEC

The SET command requires a seven digit parameter which sets the frequency value in kHz. In a C-L or C-S configuration, the acceptable range is from 5925 MHz to 6475 MHz. In a L-C or S-C configuration, the acceptable range is from 3575 MHz to 4225 MHz.

Remote Command Sequence: $SECfffffff
Receiver Response: $SEC

The QUERY command requires no parameters.

Remote Command Sequence: ?SEC
Receiver Response: ?SECfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.11 RECEIVE C-BAND COMMUNICATIONS FREQUENCY = RXC

This command is only available while the receiver is configured for L-C or S-C operation. The acceptable range is from 3575 MHz to 4225 MHz. The SET command requires a seven digit parameter which sets the frequency value in kHz.

Remote Command Sequence: $RXCfffffff
Receiver Response: $RXC

The QUERY command requires no parameters.

Remote Command Sequence: ?RXC
Receiver Response: ?RXCfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.12 TRANSMIT C-BAND COMMUNICATIONS FREQUENCY = TXC

This command is only available while the receiver is configured for C-L or C-S operation. The acceptable range is from 5925 MHz to 6475 MHz. The SET command requires a seven digit parameter which sets the frequency value in kHz.

Remote Command Sequence: $TXCfffffff
Receiver Response: $TXC

The QUERY command requires no parameters.

Remote Command Sequence: ?TXC
Receiver Response: ?TXCfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.13 CONVERTER TRANSLATION FREQUENCY = TRL

The SET command requires a seven digit parameter which sets the frequency value in kHz. The SET command is only available while the receiver is operating in Normal mode. In a C-L configuration, the acceptable range is from 1410 MHz to 1650 MHz. In a L-C configuration, the acceptable range is from 3485 MHz to 4175 MHz. In a C-S configuration, the acceptable range is from 2410 MHz to 2640 MHz. In a S-C configuration, the acceptable range is from 3485 MHz to 4175 MHz.

Remote Command Sequence: $TRLfffffff
Receiver Response: $TRL

The QUERY command requires no parameters.

Remote Command Sequence: ?TRL
Receiver Response: ?TRLfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.14 NOMINAL OUTPUT FREQUENCY = OUT

The SET command requires a seven digit parameter which sets the frequency value in kHz.

Remote Command Sequence: $OUTfffffff
Receiver Response: $OUT

The QUERY command requires no parameters.

Remote Command Sequence: ?OUT
Receiver Response: ?OUTfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.15 LONG TERM FREQUENCY ERROR = LTE

The SET command requires a sign character and a six digit parameter which sets the frequency value in Hz. The SET command is only available while the receiver is operating in Normal mode. The acceptable range is from -999.999 kHz to +999.999 kHz.

Remote Command Sequence: $LTEsffffff
Receiver Response: $LTE

The QUERY command requires no parameters.

Remote Command Sequence: ?LTE
Receiver Response: ?LTEsffffff

s: ASCII '+' or '-'

ffffff: Six digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.16 PEAK DOPPLER FREQUENCY ERROR = DOP

There is no SET command.

The QUERY command requires no parameters.

Remote Command Sequence: ?DOP
Receiver Response: ?DOPsffffff

s: ASCII '+' or '-'

ffffff: Six digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.17 TIME OF ASCENDING NODE = TIM

The SET command requires a four digit parameter which sets the time value in hours and minutes. The SET command is only available while the receiver is operating in Normal mode. The acceptable range is from 0 hours and 0 minutes to 23 hours and 59 minutes.

Remote Command Sequence: $TIMhhmm
Receiver Response: $TIM

The QUERY command requires no parameters.

Remote Command Sequence: ?TIM
Receiver Response: ?TIMhhmm

hh: Hours, 2 digit ASCII numeric characters, MSD transmitted first, LSD last.

mm: Minutes, 2 digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.18 RECEIVER CONFIGURATION = CON

The SET command requires three characters which set the L/C or S/C Configuration, Normal/Fixed/Learn/Non-Enhanced and Active Pilot modes.

Remote Command Sequence: $CONabc
Receiver Response: $CON

The QUERY command requires no parameters.

Remote Command Sequence: ?CON
Receiver Response: ?CONabc

a: ASCII 'L' for L-C, ASCII 'C' for C-L, ASCII 'D' for S-C, ASCII 'E' for C-S Configuration

b: ASCII 'F' for Fixed, ASCII 'N' for Normal, ASCII 'L' for Learn, or ASCII 'O' for Non-Enhanced mode

c: ASCII 'P' for Primary or 'S' for Secondary Active Pilot Frequency

3.5.1.3.19 INTERNAL CALENDAR CLOCK = CLK

The SET command requires a 12 digit parameter which sets the date and time of the Internal Calendar/Clock.

Remote Command Sequence: $CLKyynnddhhmmss
Receiver Response: $CLK

The QUERY command requires no parameters.

Remote Command Sequence: ?CLK
Receiver Response: ?CLKyynnddhhmmss

yy: Year, 2 digit ASCII numeric characters, MSD transmitted first, LSD last.

nn: Month, 2 digit ASCII numeric characters

dd: Day, 2 digit ASCII numeric characters

hh: Hour, 2 digit ASCII numeric characters

mm: Minute, 2 digit ASCII numeric characters

ss: Second, 2 digit ASCII numeric characters

3.5.1.3.20 ALARM STATUS = ALR

There is no SET command. The QUERY command requires no parameters.

Remote Command Sequence: ?ALR
Receiver Response: ?ALRabcdef

'a' through 'f' are ASCII '0' or '1' and represent the Alarm Status of the following

a: Summary Alarm; '0' = normal, '1'= fault

b: Front End Alarm; '0' = normal, '1'= fault

c: 70 MHz Synthesizer Alarm; '0' = normal, '1'= fault

d: Output Module; '0' = normal, '1'= fault

e: Power Supply; '0' = normal, '1'= fault

f: Spare; always '0'

3.5.1.3.21 RECEIVER MODE = MOD

There is no SET command. The QUERY command requires no parameters.

Remote Command Sequence: ?MOD
Receiver Response: ?MODabc

a: ASCII 'M' for mute relay activated;
'U' for relay not activated

b: ASCII 'T' for Tracking
'A' for Acquire
'P' for Pilot Lost

c: ASCII 'L' for Local mode
'R' for Remote mode

3.5.1.3.22 PILOT ERROR = ERR

There is no SET command. The QUERY command requires no parameters.

Remote Command Sequence: ?ERR
Receiver Response: ?ERRsffffff

s: ASCII '+' or '-'

f: Six digit ASCII numeric characters which represent absolute Pilot Error in Hz;
MSD transmitted first, LSD last. If the pilot is lost, '??????' will be returned instead of a six digit frequency.

3.5.1.3.23 AGGREGATE LEVEL = LVL

There is no SET command. The QUERY command requires no parameters.

Remote Command Sequence: ?LVL
Receiver Response: ?ERRsdd

s: ASCII '+' or '-'

dd: Two digit ASCII numeric characters which represent Aggregate Level within the selected acquisition range; MSD transmitted first, LSD last.

3.5.1.3.24 HISTORY DATA = HIS

There is no SET command. The QUERY command returns the five minute averaged pilot error from five minutes to 24 hours ago. It requires a four digit parameter which references time since the present.

Remote Command Sequence: ?HIShhmm
Receiver Response: ?HIShhmmDsffffff

hh: Two digit ASCII numeric characters which represent hours ago; MSD transmitted first, LSD last.

hh = 00 to 24

mm: Two digit ASCII numeric characters which represent minutes ago; MSD transmitted first, LSD last.

mm = 00 to 55 in steps of 05

s: ASCII '+' or '-'

ffffff: Six digit ASCII numeric characters which represent absolute pilot error recorded hh hours and mm minutes ago; MSD transmitted first, LSD last. If the pilot was lost during the five minute time interval, the Long Term Error frequency will be returned.

3.5.1.3.25 ACQUISITION RANGE = ACQ

The SET command requires a two digit parameter which sets the Acquisition Range value in kHz. The acceptable range is from ±1 kHz to ±55 kHz, the "±" is understood and not included in the command sequence.

Remote Command Sequence: $ACQff
Receiver Response: $ACQ

The QUERY command requires no parameters.

Remote Command Sequence: ?ACQ
Receiver Response: ?ACQff

ff: Two digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.1.3.26 FREQUENCY CORRECTION = COR

There is no SET command. The QUERY command requires no parameters.

Remote Command Sequence: ?COR
Receiver Response: ?CORsffffff

s: ASCII '+' or '-'

f: Six digit ASCII numeric characters which represent correction being applied to the reference frequency in Hz. MSD transmitted first, LSD last.

3.5.1.3.27 EXAMPLES

The receiver address is 41H (ASCII code 'A'). The following are typical commands and responses showing the ASCII printable characters.

A. Set the Ground Earth Station Latitude to -45.31 degrees

Controller Command	Receiver Response
{A$GET-04531}k	{A$GET}'

B. Return the current setting of Satellite Inclination (previously set to 4° 50 minutes).

Controller Command	Receiver Response
{A?SAI}x	{A?SAI+00450}}

C. Set the Primary L-Band Frequency to 1550.125 MHz while in Local mode.

Controller Command	Receiver Response
{A$PRL1550125}3	{Ac}~

3.5.2 485 BUS RS422/TERMINATION

A jumper selectable 120 ohm termination may be placed across the Data terminals. Placing a jumper across E1 connects the resistor between the DATA OUT + and - terminals. E2 connects the resistor between the DATA IN + and - terminals. E1 and E2 are on the main control PC board inside the receiver.

3.5.3 RS232 RTS/CTS (Option 17C Only)

When the receiver is equipped with an RS232 remote bus interface, the RTS output and CTS input signals are internally connected together with a jumper plug.

The jumper must be removed if it is necessary to use the RTS/CTS protocol. The jumper is located on the auxiliary PC board which is mounted onto the main control PC board.

3.5.4 IEEE-488 REMOTE CONTROL

The receiver performs the basic Talker and Listener functions as specified in the IEEE-488 standard. It is also capable of sending a Service Request to the active IEEE-488 controller and will respond with a status word when the Serial Poll Enable message is received.

The messages to and from the receiver are ASCII character strings terminated with CR, LF and EOI. The response time from command to acknowledge is 100 ms. maximum.

3.5.4.1 DEVICE ADDRESS/SERVICE REQUEST ENABLE SELECTION

The remote control parameters can be accessed by the Communications Parameter Status Screen.

Rotating the front panel Scroll knob allows the user to move the cursor to the "ADDRESS" area of the display. A new address can be entered via the front panel Data Entry keypad using the number keys followed by the "ENT" key. Entries outside the available range (00-30) will be followed by an error tone.

Rotating the front panel Scroll knob will move the cursor to the "SRQ" area of the display. The service request can be enabled and disabled via the front panel Data Entry keypad. Entering "1" will enable the SRQ, entering "0" will disable the SRQ.

3.5.4.2 MESSAGE PROTOCOL

The following paragraphs describe each of the command codes. Commands preceded by “?” are QUERY commands and those preceded by “$” are SET commands. QUERY commands are used to examine system parameters remotely while SET commands are intended to modify system parameters.

SET commands do not affect the receiver’s response when it is addressed to talk by the IEEE-488 controller.

QUERY commands determine the receiver’s response when it is addressed to talk by the IEEE-488 controller. The context of the receiver’s response remains in effect until another QUERY command is received. The alarm Query command (?ALR) is in effect at power up as the default format.

3.5.4.2.1 GROUND EARTH STATION LATITUDE = GET

The SET command requires a sign character and a 5 digit parameter which sets the latitude in degrees and minutes. The acceptable range is from -90°00’ to +90°00’.

Remote Command Sequence: $GETsdddmm

The QUERY command requires no parameters.

Remote Command Sequence: ?GET
Receiver Data format when addressed as a talker: ?GETsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-090)
mm: Minutes (00-59)

3.5.4.2.2 GROUND EARTH STATION LONGITUDE = GEL

The SET command requires a sign character and a 5 digit parameter which sets the longitude. The acceptable range is from -180°00' to +180°00'.

Remote Command Sequence: $GELsdddmm

The QUERY command requires no parameters.

Remote Command Sequence: ?GEL
Receiver Data format when addressed as a talker: ?GELsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-180)

mm: Minutes (00-59)

3.5.4.2.3 AFC PILOT STATION LATITUDE = PIT

The SET command requires a sign character and a 5 digit parameter which sets the latitude. The acceptable range is from -90°00' to +90°00'.

Remote Command Sequence: $PITsdddmm

The QUERY command requires no parameters.

Remote Command Sequence: ?PIT
Receiver Data format when addressed as a talker: ?PITsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-090)

mm: Minutes (00-59)

3.5.4.2.4 AFC PILOT STATION LONGITUDE = PIL

The SET command requires a sign character and a 5 digit parameter which sets the longitude. The acceptable range is from -180°00’ to +180°00’.

Remote Command Sequence: $PILsdddmm

The QUERY command requires no parameters.

Remote Command Sequence: ?PIL
Receiver Data format when addressed as a talker: ?PILsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-180)

mm: Minutes (00-59)

3.5.4.2.5 SATELLITE INCLINATION = SAI

The SET command requires a 'don't care' sign character and a 5 digit parameter which sets the inclination. The sign is always assumed to be positive. The SET command is only available while the receiver is operating in Normal mode. The acceptable range is from 0°0’ to +90°00’.

Remote Command Sequence: $SAIsdddmm

The QUERY command requires no parameters.

Remote Command Sequence: ?SAI
Receiver Data format when addressed as a talker: ?SAIsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-090)

mm: Minutes (00-59)

3.5.4.2.6 SATELLITE LONGITUDE = SAL

The SET command requires a sign character and a 5 digit parameter which sets the longitude. The acceptable range is from -180°00' to +180°00'.

Remote Command Sequence: $SALsdddmm

The QUERY command requires no parameters.

Remote Command Sequence: ?SAL
Receiver Data format when addressed as a talker: ?SALsdddmm

s: ASCII '+' or '-'

dddmm: Five digit ASCII numeric characters, MSD transmitted first, LSD last.

ddd: Degrees (000-180)

mm: Minutes (00-59)

3.5.4.2.7 PRIMARY L-BAND OR S-BAND FREQUENCY = PRL

The SET command requires a seven digit parameter which sets the frequency value in kHz. The acceptable range is from 1500 MHz to 1700 MHz for L-Band and 2500 to 2690 for S-Band.

Remote Command Sequence: $PRLfffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?PRL
Receiver Data format when addressed as a talker: ?PRLfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.8 PRIMARY C-BAND FREQUENCY = PRC

The SET command requires a seven digit parameter which sets the frequency value in kHz. In a C-L or C-S configuration, the acceptable range is from 5925 MHz to 6475 MHz. In a L-C or S-C configuration, the acceptable range is from 3575 MHz to 4225 MHz.

Remote Command Sequence: $PRCfffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?PRC
Receiver Data format when addressed as a talker: ?PRCfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.9 SECONDARY L-BAND OR S-BAND FREQUENCY = SEL

The SET command requires a seven digit parameter which sets the frequency value in kHz. The acceptable range is from 1500 MHz to 1700 MHz for L-Band, 2500 to 2690 for S-Band.

Remote Command Sequence: $SELfffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?SEL
Receiver Data format when addressed as a talker: ?SELfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.10 SECONDARY C-BAND FREQUENCY = SEC

The SET command requires a seven digit parameter which sets the frequency value in kHz. In a C-L or C-S configuration, the acceptable range is from 5925 MHz to 6475 MHz. In a L-C or S-C configuration, the acceptable range is from 3575 MHz to 4225 MHz.

Remote Command Sequence: $SECfffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?SEC
Receiver Data format when addressed as a talker: ?SECfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.11 RECEIVE C-BAND COMMUNICATIONS FREQUENCY = RXC

This command is only available while the receiver is configured for L-C or S-C operation.

The SET command requires a 7 digit parameter which sets the frequency value in kHz. The acceptable range is from 3575 MHz to 4225 MHz.

Remote Command Sequence: $RXCfffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?RXC
Receiver Data format when addressed as a talker: ?RXCfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.12 TRANSMIT C-BAND COMMUNICATIONS FREQUENCY = TXC

This command is only available while the receiver is configured for C-L or C-S operation.

The SET command requires a 7 digit parameter which sets the frequency value in kHz. The acceptable range is from 5925 MHz to 6475 MHz.

Remote Command Sequence: $TXCfffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?TXC
Receiver Data format when addressed as a talker: ?TXCfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.13 CONVERTER TRANSLATION FREQUENCY = TRL

The SET command requires a 7 digit parameter which sets the frequency value in kHz. The SET command is only available while the receiver is operating in Normal mode. In a C-L configuration, the acceptable range is from 1410 MHz to 1650 MHz. In a L-C configuration, the acceptable range is from 3485 MHz to 4175 MHz. In a C-S configuration, the acceptable range is from 2410 MHz to 2640 MHz. In a S-C configuration, the acceptable range is from 3485 MHz to 4175 MHz.

Remote Command Sequence: $TRLfffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?TRL
Receiver Data format when addressed as a talker: ?TRLfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.14 NOMINAL OUTPUT FREQUENCY = OUT

The SET command requires a 7 digit parameter which sets the frequency value in kHz.

Remote Command Sequence: $OUTfffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?OUT
Receiver Data format when addressed as a talker: ?OUTfffffff

fffffff: Seven digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.15 LONG TERM FREQUENCY ERROR = LTE

The SET command requires a sign character and a 6 digit parameter which sets the frequency value in Hz. The SET command is only available while the receiver is operating in Normal mode. The acceptable range is from -999.999 kHz to + 999.999 kHz.

Remote Command Sequence: $LTEsffffff

The QUERY command requires no parameters.

Remote Command Sequence: ?LTE
Receiver Data format when addressed as a talker: ?LTEsffffff

s: ASCII '+' or '-'

ffffff: Six digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.16 PEAK DOPPLER FREQUENCY ERROR = DOP

There is no SET command.

The QUERY command requires no parameters.

Remote Command Sequence: ?DOP
Receiver Data format when addressed as a talker: ?DOPsffffff

s: ASCII '+' or '-'

ffffff: Six digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.17 TIME OF ASCENDING NODE = TIM

The SET command requires a 4 digit parameter which sets the time value in hours and minutes. The SET command is only available while the receiver is operating in Normal mode. The acceptable range is from 0 hours 0 minutes to 23 hours 59 minutes.

Remote Command Sequence: $TIMhhmm

The QUERY command requires no parameters.

Remote Command Sequence: ?TIM
Receiver Data format when addressed as a talker: ?TIMhhmm

hh: Hours, 2 digit ASCII numeric characters, MSD transmitted first, LSD last.

mm: Minutes, 2 digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.2.18 RECEIVER CONFIGURATION = CON

The SET command requires three characters which set the L/C or S/C Configuration, Normal/Fixed/Learn/Non-Enhanced and Active Pilot modes.

Remote Command Sequence: $CONabc

The QUERY command requires no parameters.

Remote Command Sequence: ?CON
Receiver Data format when addressed as a talker: ?CONabc

a: ASCII 'L' for L-C, ASCII 'C' for C-L, ASCII 'D' for S-C, ASCII 'E' for C-S Configuration

b: ASCII 'F' for Fixed, ASCII 'N' for Normal, ASCII 'L' for Learn, or ASCII 'O' for Non-Enhanced mode

c: ASCII 'P' for Primary or 'S' for Secondary Active Pilot Frequency

3.5.4.2.19 INTERNAL CALENDAR/CLOCK = CLK

The SET command requires a 12 digit parameter which sets the date and time of the internal calendar/clock.

Remote Command Sequence: $CLKyynnddhhmmss

The QUERY command requires no parameters.

Remote Command Sequence: ?CLK
Receiver Data format when addressed as a talker: ?CLKyynnddhhmmss

yy: Year, 2 digit ASCII numeric characters, MSD transmitted first, LSD last.

nn: Month, 2 digit ASCII numeric characters

dd: Day, 2 digit ASCII numeric characters

hh: Hour, 2 digit ASCII numeric characters

mm: Minute, 2 digit ASCII numeric characters

ss: Second, 2 digit ASCII numeric characters

3.5.4.2.20 ALARM STATUS = ALR

There is no SET command.

The QUERY command requires no parameters.

Remote Command Sequence: ?ALR
Receiver Data format when addressed as a talker: ?ALRabcdef

'a' through 'f' are ASCII '0' or '1' and represent the alarm status of the following:

a: Summary Alarm; '0' = normal, '1'= fault

b: Front End Alarm; '0' = normal, '1'= fault

c: 70 MHz Synthesizer Alarm; '0' = normal, '1'= fault

d: Output Module; '0' = normal, '1'= fault

e: Power Supply; '0' = normal, '1'= fault

f: Spare; always '0'

3.5.4.2.21 RECEIVER MODE = MOD

There is no SET command.

The QUERY command requires no parameters.

Remote Command Sequence: ?MOD

a: ASCII 'M' for mute relay activated;
'U' for relay not activated

b: ASCII 'T' for Tracking
'A' for Acquire
'P' for Pilot Lost

c: ASCII 'L' for Local mode
'R' for Remote mode

3.5.4.2.22 PILOT ERROR = ERR

There is no SET command.

The QUERY command requires no parameters.

Remote Command Sequence: ?ERR
Receiver Data format when addressed as a talker: ?ERRsffffff

s: ASCII '+' or '-'

f: Six digit ASCII numeric characters which represent absolute pilot error in Hz; MSD transmitted first, LSD last.

3.5.4.2.23 AGGREGATE LEVEL = LVL

There is no SET command.

The QUERY command requires no parameters.

Remote Command Sequence: ?LVL
Receiver Data format when addressed as a talker: ?ERRsdd

s: ASCII '+' or '-'

dd: Two digit ASCII numeric characters which represent aggregate level within the selected acquisition range; MSD transmitted first, LSD last.

3.5.4.2.24 HISTORY DATA = HIS

There is no SET command.

The QUERY command requires a 4 digit parameter which references time since the present.

Remote Command Sequence: ?HIShhmm
Receiver Data format when addressed as a talker:?HIShhmmsffffff

hh: Two digit ASCII numeric characters which represent hours ago; MSD transmitted first, LSD last.

mm: Two digit ASCII numeric characters which represent minutes ago; MSD transmitted first, LSD last.

s: ASCII '+' or '-'

ffffff: Six digit ASCII numeric characters which represent absolute pilot error recorded hh hours and mm minutes ago; MSD transmitted first, LSD last.

3.5.4.2.25 ACQUISITION RANGE = ACQ

The SET command requires a 2 digit parameter which sets the acquisition range value in kHz. The acceptable range is from ±1 kHz to ±55 kHz, the "±" is understood and not included in the command sequence.

Remote Command Sequence: $ACQff

The QUERY command requires no parameters.

Remote Command Sequence: ?ACQ
Receiver Data format when addressed as a talker: ?ACQff

ff: Two digit ASCII numeric characters, MSD transmitted first, LSD last.

3.5.4.3 SERVICE REQUEST

The receiver will issue a service request (activate the SRQ line) if the SRQ is enabled and one of the status alarms indicate a failure. The IEEE-488 controller then performs a serial poll addressing the unit to talk. The following bits are reported back to the controller:

Bit Number

7	6	5	4	3	2	1	0
0	1	0	0	0	S2	S1	S0

The S"n" bits indicate in binary code which component fault line caused the service request (a = 0, b = 1, c = 2, etc.). In the case of multiple faults, the lowest fault value will be reported.

The IEEE-488 controller may perform a serial poll without a service request being generated by the receiver (a request may have been generated by another device on the bus). In this case, the message will have the same format with the exception that bit 6 will be a "0."

3.6 INTERFACE CONNECTIONS

3.6.1 REMOTE INTERFACE CONNECTIONS

The remote interface connector(s) is located on the rear panel of the receiver. The approximate location(s) is depicted in Figure 2.

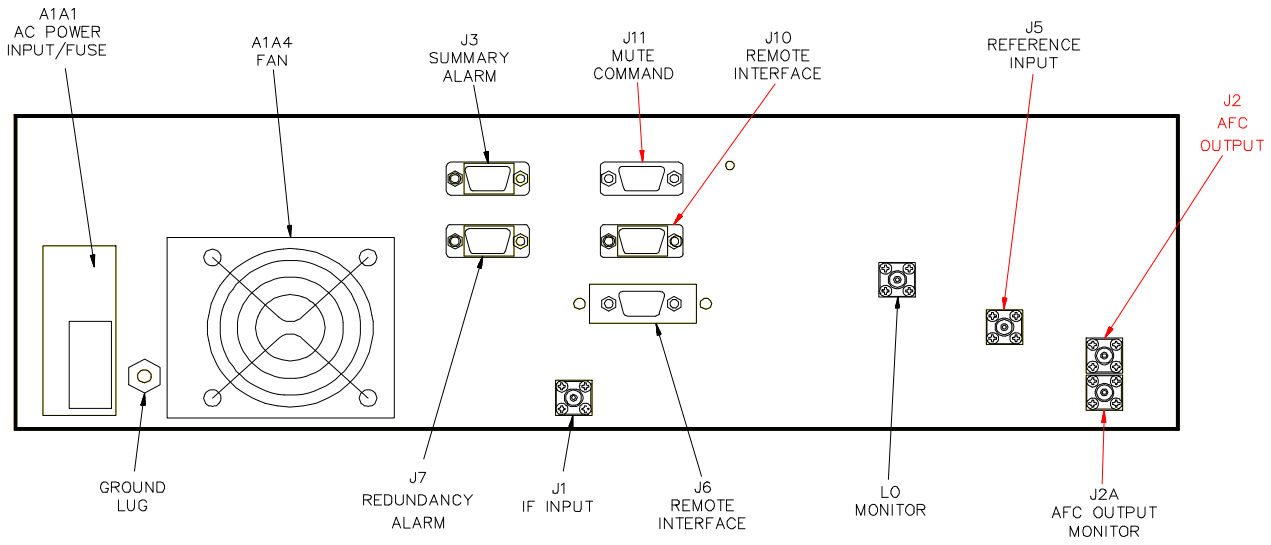


Figure 2. INMARSAT EAFC Receiver Rear Panel Diagram

3.6.1.1 RS422/485 REAR PANEL INTERFACE CONNECTOR

J6 and J10

Pin	Signal
1	Ground
3	Data Out -
5	Data In -
7	Data Out +
9	Data Out -

Note: For RS485 two wire party line operation Data In + must be externally wired to Data Out +, and Data In - must be externally wired to Data Out -.

3.6.1.2 RS232 REAR PANEL INTERFACE CONNECTOR

J6

Pin	Signal
1	Ground
2	TX Data
3	RCV Data
7	Ground

3.6.1.3 IEEE-488 REAR PANEL INTERFACE CONNECTOR

IEEE-488 compatible contact connector (receptacle).

3.6.2 SUMMARY ALARM CONNECTOR

The summary connector, located on the rear panel, provides the status of the receiver's alarm functions via a contact closure interface. The summary alarm connector pin designations are as follows:

1. DC Power Status -
    a. Normal: Pins 1-2 open, 2-3 closed
    b. Fault: Pins 1-2 closed, 2-3 open
2. Summary Alarm Status -
    a. Normal (No Alarms): Pins 4-5 open, 5-6 closed
    b. Fault (Any Alarm): Pins 4-5 closed, 5-6 open

3.6.3 REDUNDANCY SWITCH CONNECTOR

The redundancy switch connector, located on the rear panel, provides a summary alarm output via a contact closure interface. This can be used in conjunction with a Redundancy Switchover Unit. The redundancy switch connector pin designations are as follows:

1. Summary Alarm Status -
    a. Normal (No Alarms): Pins 1-2 open, 2-3 closed
    b. Fault (Any Alarm): Pins 1-2 closed, 2-3 open

3.6.4 MUTE CONNECTOR

The mute connector, located on the rear panel, provides a mute command output via a contact closure interface. This may be used in conjunction with a MITEQ up and down converters. The mute connector pin designations are as follows:

1. Mute Command -
    a. Normal (No Mute): Pins 1-2 open, 2-3 closed
    b. Mute: Pins 1-2 closed, 2-3 open

3.7 DATA ENTRY LIMITS

The following is a list of valid data entries for the INMARSAT EAFC RECEIVER.

PARAMETER	MINIMUM	MAXIMUM
Ground Earth Station Latitude	-90°00’	+90°00’
Ground Earth Station Longitude	-180°00’	+180°00’
AFC Pilot Station Latitude	-90°00’	+90°00’
AFC Pilot Station Longitude	-180°00’	+180°00’
Satellite Inclination	-90°00’	+90°00’
Satellite Longitude	-180°00’	+180°00’
Primary L-Band Frequency (C-L)	1500.000 MHz	1700.000 MHz
Primary L-Band Frequency (L-C)	1500.000 MHz	1700.000 MHz
Primary S-Band Frequency (S-L)	2500.000 MHz	2690.000 MHz
Primary S-Band Frequency (L-S)	2500.000 MHz	2690.000 MHz
Primary C-Band Frequency (C-L)	5925.000 MHz	6475.000 MHz
Primary C-Band Frequency (L-C)	3575.000 MHz	4225.000 MHz
Primary C-Band Frequency (C-S)	5925.000 MHz	6475.000 MHz
Primary C-Band Frequency (S-C)	3575.000 MHz	4225.000 MHz
Secondary L-Band Frequency (C-L)	1500.000 MHz	1700.000 MHz
Secondary L-Band Frequency (L-C)	1500.000 MHz	1700.000 MHz
Secondary S-Band Frequency (C-S)	2500.000 MHz	2690.000 MHz
Secondary S-Band Frequency (S-C)	2500.000 MHz	2690.000 MHz
Secondary C-Band Frequency (C-L)	5925.000 MHz	6475.000 MHz
Secondary C-Band Frequency (L-C)	3575.000 MHz	4225.000 MHz
Secondary C-Band Frequency (C-S)	5925.000 MHz	6475.000 MHz
Secondary C-Band Frequency (S-C)	3575.000 MHz	4225.000 MHz

PARAMETER	MINIMUM	MAXIMUM
Receive C-Band Frequency (L-C)	3575.000 MHz	4225.000 MHz
Transmit C-Band Frequency (C-L)	5925.000 MHz	6475.000 MHz
Receive C-Band Frequency (S-C)	3575.000 MHz	4225.000 MHz
Transmit C-Band Frequency (C-S)	5925.000 MHz	6475.000 MHz
Converter Translation Frequency (C-L)	1410.000 MHz	1650.000 MHz
Converter Translation Frequency (L-C)	3485.000 MHz	4175.000 MHz
Converter Translation Frequency (C-S)	2410.000 MHz	2640.000 MHz
Converter Translation Frequency (S-C)	3485.000 MHz	4175.000 MHz
Acquisition / Tracking Range	1 kHz	55 kHz
Long Term Error	-999.999 kHz	+999.999 kHz
Peak Doppler Error	-999.999 kHz	+999.999 kHz

PARAMETER	RANGE
Time of Ascending Node:	hour = 00-23 minute = 00-59
Internal Calender Clock:	year = 00-99 month = 01-12 day 00-31 hour = 00-23 minute = 00-59 second = 00-59

PARAMETER	STEP SIZE
Acquisition / Tracking Range:	1 kHz
Frequency in C-L mode	25 kHz
Frequency in L-C mode	25 kHz
Frequency in C-S mode	5 kHz
Frequency in S-C mode	5 kHz