RC4500 ANTENNA CONTROLLER

INTEGRATION MANUAL

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Serial No_____

Revision History

DATE	MODIFICATION	SW VERSION	INITIALS
18 AUG 2016	Initial release.	2.03	JDK
05 OCT 2016	Corrections made to many screenshots and descriptions. Reorganized chapters. The installation procedure is now separated from the trouble-shooting section.	2.03	JDK
10 NOV 2016	Updated warranty section.	N/A	BK
03 JAN 2017	Added detailed descriptions of signals for J6 – Auxiliary I/O and J7 – Antenna I/O connectors.	2.03	JDK
02 AUG 2017	Massive review of content. Added embedded ACU hardware section.	2.03	ECG
03 AUG 2017	Fixed section numbering and references.	2.03	ECG
09 JAN 2019	Updated to clarify how raw resolver angles are calculated.	3.01	ECG
10 JAN 2019	Updated alarm descriptions.	3.01	ECG
26 MAR 2019	Updated limit determination procedures including azimuth change from resolver to true.	3.01	ECG
02 MAR 2021	Update for software v3.10 release	3.10	TJB
22 DEC 2021	Added motor speed calibration and axis pointing calibration	3.11	RLE

Limited Warranty

New Products

Research Concepts, Inc., RCI, warrants to the original purchaser this product shall be free from defects in material and workmanship for one year, unless expressed otherwise, from the date of the original purchase. During the warranty period, RCI will provide, free of charge, both parts and labor necessary to correct such defects.

To obtain such a warranty service, the ***original purchaser*** must:

1. Notify RCI as soon as possible after discovery of a possible defect, with:
    a. Model and serial number
    b. Purchase date
    c. Detailed description of the problem and circumstances when problem appears, including details on the electrical connection to associated equipment
2. Obtain an RMA number from RCI, then ship the product to RCI in original packaging or its equivalent, fully insured and shipping/customs charges prepaid. RCI is not responsible for damage during shipping.

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RCI warrants *repairs* to be free from defects in material and workmanship for six months from the repair date. If a possible defect is found, use the same process as above to obtain service.

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Repair fees for Dealers and OEMs are an hourly labor charge plus parts cost. ** Dealers and OEMs are responsible for receiving and shipping the products from their customer. **

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RCI will pay for domestic shipping to return the product using the same method that RCI received it. Customers are responsible for all international shipping charges.

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1. Improper maintenance or repair, including the installation of parts or accessories that do not conform to the quality and specifications of the original parts
2. Misuse, abuse, neglect, or improper installation including disregard for installation of backup or safety override equipment
3. Accidental or intentional damage, including lightning
4. Water / Liquid damage

There are no implied warranties.

The foregoing constitutes RCI's entire obligation with respect to this product, and the original purchaser and any user or owner shall have no other remedy and no claim for incidental or consequential damages.

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RC4500 ACU

Table of Contents

1 INTRODUCTION

The RC4500 Antenna Control Unit (ACU) consists of a set of proprietary PCBs and antenna specific drive units.

PLEASE READ AND UNDERSTAND THE MANUAL. Due to the complexity of the functions performed by the RC4500, time invested in understanding its installation and operation will be well spent.

1.1 Manual Organization

The RC4500 PCB set allows for ACU functionality to be packaged in varied configurations. Also, many hardware and software options are available for use with the RC4500 architecture. This manual is organized to:

1) Describe common hardware and software elements that will apply to all instances of the RC4500
2) Provide a structure to allow definition of elements unique to a specific use of the RC4500

Chapter 1 summarizes the contents of the manual and highlights the functionality and features of the RC4500.

Chapter 2 describes the core software features of the RC4500.

Chapter 3 covers RC4500 common installation and calibration procedures, provides help for system troubleshooting and discusses detailed operational topics referred to in the manual.

Appendix A supplies the expert access codes on a single page, which at management's discretion, may be removed to eliminate the possibility of inexperienced users inadvertently corrupting configuration data.

Appendix B, titled "MOUNT SPECIFIC DATA", details unique functions and values unique to a specific antenna mount. This Appendix may not be supplied from RCI if the ACU is not preprogramed for a very specific antenna mount.

Appendix C, titled "ENCLOSURE SPECIFIC DATA", details mechanical and electrical details on how the RC4500 is packaged. This appendix may not be supplied from RCI if the board set is not packaged in an RCI provided enclosure.

Separate appendices describe additional features of the RC4500. Example optional appendices that could accompany the manual include:

APPENDIX A – EXPERT ACCESS CONTROL
APPENDIX REM – REMOTE CONTROL PROTOCOL
APPENDIX SECURITY – SNMP AND SECURITY FEATURES

1.2 Manual Conventions

Throughout the manual, representations of screens the user will see will be shown in the boxed format that follows:

```
AZ:  176.55          BCN:-68.0          MANUAL
EL:   46.44          SAT:
PL:   18.78          SPD:FAST               UTC
<MODE>MENU <0-9>JOG ANTENNA        14:25:47
```

The following table shows typical abbreviations used both on RC4500 screens and in the manual's text.

ITEM	ABREVIATION(S)
True azimuth angle	AZ
Elevation angle to horizon	EL
Polarization Angle	PL
Clockwise	CW
Counter-Clockwise (Anti-Clockwise)	CCW
Down	DN
Latitude	LAT
Longitude	LON
Satellite	SAT
Global Positioning System	GPS
Liquid Crystal Display	LCD
Signal Strength	SS

Satellite longitudes are presented in degree/decimal degree (79.0 W) format since that is the standard representation of satellite positions. Latitude and longitude of the mount are presented in degree/decimal (38.9554N, 94.7543W) format.

When referring to an ACU mode of operation, that mode's name will be capitalized – ex. RECALL.

Throughout the manual and software, the latitude, longitude and true heading of the antenna are collectively referred to as the antenna's "position".

Movements of the antenna (as seen from behind the antenna, looking at the geo stationary arc of satellites) are represented by graphing the azimuth and elevation axes as shown below.
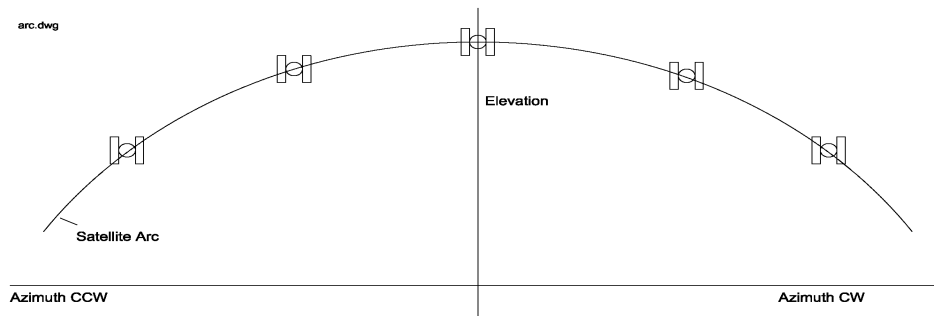
1.3 RC4500 Features

The ACU performs its functions via digital and analog electronic equipment interfaced to the antenna's motor drive and position sensor systems. This equipment is controlled through embedded software algorithms run by the ACU's microcontroller.

The RC4500 ACU is designed to automate the operation of high-performance earth station antennas. Features provided can include:

- Automatic azimuth and elevation pointing solution calculation
- GPS receiver for accurate time-based tracking
- Automatic tracking of inclined orbit satellites via multiple tracking modes
  - Step Tracking
  - Enhanced Predictive Tracking
  - Two-Line Element Tracking (TLE)
- Automatic polarization control of rotating feeds
- Battery backed-up non-volatile memory for storing satellite locations and configuration data
- Automatic repositioning to stored satellites
- Continuous monitoring of antenna drive status
- Support for multiple band satellite operations
- Multiple User Interface Options
  - 4x40 Character Display + 4x4 keypad
  - Ethernet (IP-based) remote control Options
    - Remote 4x40 Character Display + 4x4 keypad
    - Intuitive Graphical User Interface (GUI)
    - SNMP
    - UDP

1.4 Hardware Overview

The following figure is a block diagram showing the four major components of the RC4500 ACU and how they interface with a typical antenna system.
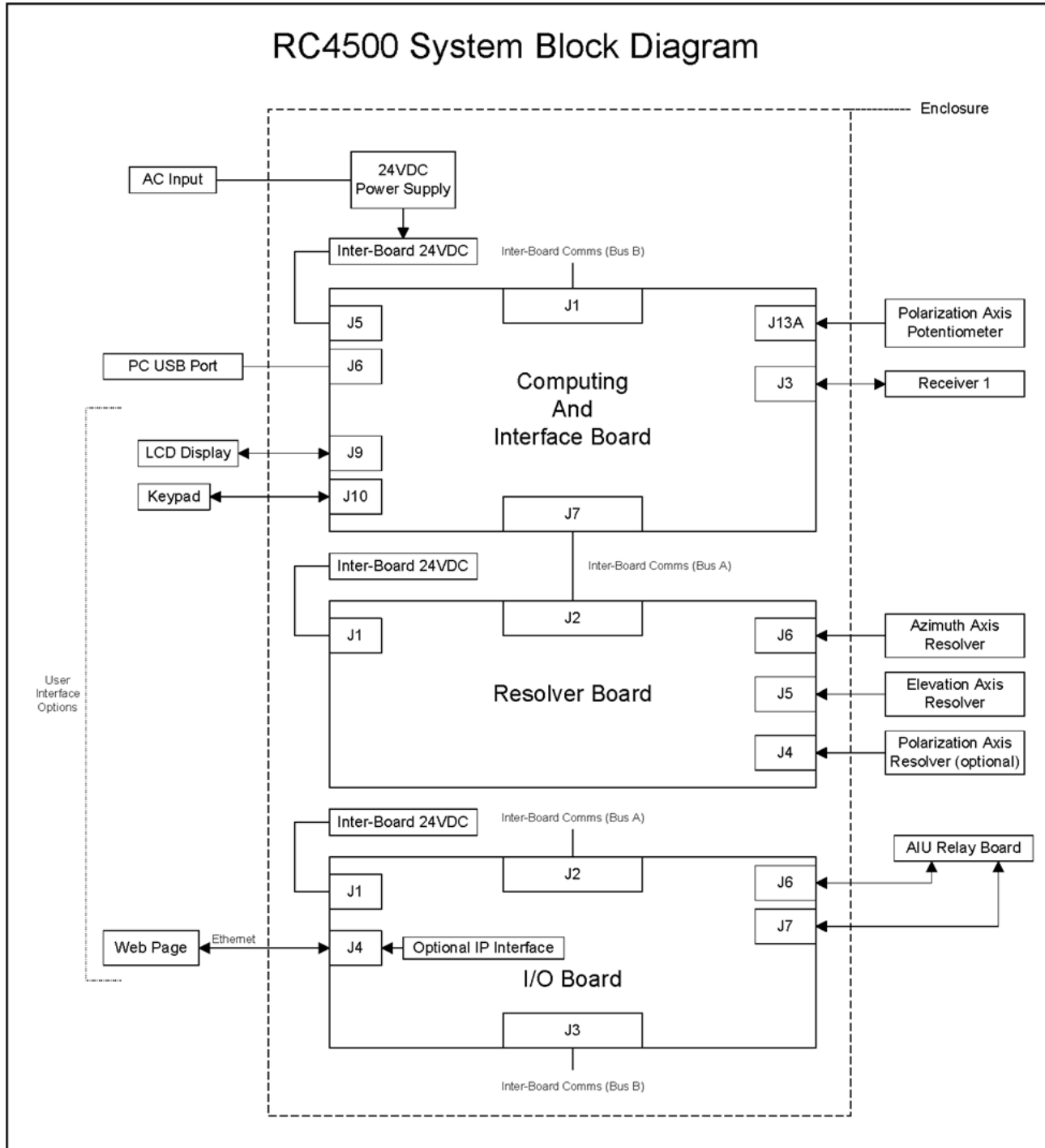
Individual interfaces will be described in detail in section 3.1.2. NOTE: Appendix C "Enclosure Specific Data" will describe how these interfaces are mechanized for a board set in an enclosure.

1.5 Software Overview

The RC4500 allows easy antenna control via its mode-based operation. Multiple user interface (local and remote control) options exist. Section 2.1.1 highlights the software functions by showing data that would be presented if a user interface utilizes the 4x4 keypad and 4x40 character display. Section 2.1.2 highlights the software functions by showing data that would be presented when using the graphical user interface option. The screen displayed to the user is based on the current controller mode. Controller modes are divided into two major groups: operational and programming. The operational modes provide for the normal operation of the antenna. The programming group provides for initial configuration of the controller and will typically not be used on a day-by-day basis. The following example highlights the basic modes of operation provided by the RC4500.

1.5.1 Front Panel Overview

When using the physical font panel, or the remote front panel the screen displayed to the user is based on the current controller mode. Controller modes are divided into two major groups: operational and programming. The operational modes provide for the normal operation of the antenna. The programming group provides for initial configuration of the controller and will typically not be used on a day-by-day basis.

1.5.1.1 Operational Group Functions

1.5.1.1.1 <u>Manual</u>

In MANUAL mode the user may jog the antenna in Azimuth, Elevation and Polarization

```
AZ:  204.93           RF:-50.9        MANUAL
EL:   41.96          SAT:WB-1
PL:   45.00          SPD:FAST            UTC
<MODE>MENU <0-9>JOG ANTENNA     14:25:47
```

1.5.1.1.2 <u>Automatic Recall</u>

In RECALL mode, azimuth, elevation, and polarization pointing angles are generated from data stored in SETUP mode. The user selects which satellite to recall from the stored satellite list.

```
                                        RECALL
#    NAME           LON    INCL BAND TRK   TBL
1    WB-1          111.1W   0    KA   S/E   0%
<SCR>THRU LIST <ENTER>SELECT   <MODE>EXIT
```

1.5.1.1.3 <u>Automatic Move To</u>

From MOVETO mode, the user may ask for the antenna to be automatically moved to user specified or calculated positions via the longitude.

```
AZ:  204.93 ( 204.93) <0>SPD:FAST   MOVETO
EL:   41.39 (  41.39) <5>SENSOR:ANGLE
PL:   45.00 (  45.00) <6>LON:
<1>SET AZ <2>SET EL <3>SET POL  <4>START
```

1.5.1.2 Programming Group Functions

1.5.1.2.1 Configuration Screens

Configuration mode screens allow the user to customize and calibrate the operation of the ACU for use
with a particular antenna. Verifying the correct configuration items will ensure correct operation with a
particular antenna.

```
MODE:2  ANT SIZE: 420      CONFIG-SYSTEM
        ANT LOOK:1

<2-MENU 3-MANUAL>
```

1.5.1.2.2 Maintenance Screens

Maintenance mode screens allow the user to monitor sensor inputs and perform periodic maintenance
actions such as setting time and resetting drive errors.

```
 SYSTEM:12/25/18 13:28:50             TIME
DISPLAY:12/25/18 13:28:50        ZONE:UTC
GPS UTC:12/25/18 13:28:50      OFFSET:   0
1-DATE/TIME 2-ZONE 3-OFFSET 4-GPS SYNC
```

1.5.2 Graphical User Interface Overview

The graphical user interface control option is available via the IP interface of the controller. It is designed to provide all the functions available from the front panel operation in an easy-to-use interface. As well as provide current information of the system.

1.6 Specifications

RC4500 BOARDSET	
Physical	
Size	6 1/16" x 7" x 3 3/4" (PCB Set) / Drive components system dependent
Weight	2.6 lbs. (PCB Set) / Drive components system dependent
Temperature (Operational)	-40 to +60 deg. C.
Temperature (Storage)	-40 to +70 deg C.
Humidity	10% to 95% non-condensing
Position Sense	
Azimuth	16-Bit Resolver, 25-Bit Optical Encoder
Elevation	16-Bit Resolver, 25-Bit Optical Encoder
Polarization	16-Bit Resolver, 23-Bit Optical Encoder, Potentiometer
Limit Switch Inputs	EL Up/Down. AZ CW/CCW, POL CW/CCW, additional options available
Locate Mode	
AZ/EL Pointing Accuracy	±0.01° or better (16-bit), ±0.002° or better (25-bit)
POL Pointing Accuracy	±0.01° or better (16-bit), ±0.002° or better (23-bit), 0.1° or better (pot)
Positive Satellite Identification	Multiple Beacon Tracking Receiver Options, DVB-S2, Modem, and Spectrum Analyzer.
External AGC	Support for external analog signal source and lock input
Track Mode	
Antenna Size	0.4 – 25.0 meters
Tracking Accuracy	0.1 to 3.0 dB selectable; antenna dependent
Maximum Inclination	20°, standard
Tracking Modes	Step-Tracking, Predictive Tracking, NORAD TLE tracking

The RC4500 can be delivered as a printed circuit boardset, a 2RU rackmount enclosure, or as an embedded encpsure within an outdoor Antenna interface Unit (AIU).

2   SOFTWARE

2.1   Operation Overview

The RC4500 allows multiple options for mechanizing the user interface. These can be divided into 2 distinct groups.

The first are versions that utilize a 4x4 keypad and 4x40 character display. Operation using this method will be described in section 2.1.1 and includes the following methods of control:

- Rackmount Front Panel
- Handheld Remote Front Panel
- IP based remote front panel

The second is an IP based graphical user interface (GUI) method of control. Operation using this method will be described in section 2.1.2.

2.1.1 Front Panel Software Operation

2.1.1.1 Front Panel Software Overview

2.1.1.1.1 <u>Modes</u>

The functionality of the RC4500 is achieved by placing the controller in the desired mode of operation. The diagram below shows the hierarchy of the RC4500's modes. Each mode has a unique display screen that presents the information applicable to that mode's operation.

Transition between groups by holding down the MODE key for 5 seconds

OPERATING GROUP	PROGRAMMING GROUP
Transition between modes by pressing the MODE key	Transition between modes by pressing the MODE key

MANUAL Mode 2.1.1.2.1	MENU Mode 2.1.1.2.2	CONFIGURATION 2.1.1.3.1	MAINTENANCE 2.1.1.3.2

Operating group MENU sub-modes:
- SETUP 2.1.1.2.2.1
- RECALL 2.1.1.2.2.2
- DELETE 2.1.1.2.2.3
- MOVETO 2.1.1.2.2.4
- DRIVE 2.1.1.2.2.5
- PEAK UP 2.1.1.2.2.8

CONFIGURATION sub-modes:
- EXPERT ACCESS 2.1.1.3.1.1.1
- to
- RESET DEFAULTS 2.1.1.3.1.3.10

MAINTENANCE sub-modes:
- VOLTS 2.1.1.3.2.1
- DRIVE 2.1.1.3.2.2
- TIME 2.1.1.3.2.3
- LIMITS 2.1.1.3.2.4
- COMMS 2.1.1.3.2.5
- MOVETO 2.1.1.3.2.6
- SHAKE 2.1.1.3.2.7
- BCN 2.1.1.3.2.8
- SNS OFF 2.1.1.3.2.9
- SYS INFO 2.1.1.3.2.10

After initial pairing of an ACU to an antenna, the programming modes will typically not be used. Section 2.1.1.2 will give further details on the operating modes and Section 2.1.1.3 will give further details on the programming modes. The rest of section 2.1.1.1 introduces common elements of all modes.
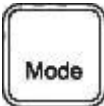
2.1.1.1.2   Keypad Usage
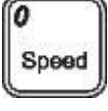
The keypad provides a flexible method of controlling the functionality of the ACU. While each ACU mode has different requirements for user input, the use of the keypad remains consistent throughout all modes.

The keypad provides for both specific actions and general data input. As an example, the <2/UP/N> key initiates an antenna up movement while in MANUAL mode but also allows for the entry of the number 2 when numeric entry is required or the indication of North when entering a latitude value. The required key usage is provided in the detailed description of each mode.

The table on the following page describes both the specific action and general data entry function of each key.

	KEY LABEL	SPECIFIC FUNCTION	GENERAL FUNCTION
Mode	Mode	No specific function	Momentary push switches between modes within group. Button held for 5 seconds switches between operational and programming groups. Momentary push also exits sub-mode screens.
Scroll↑ Angle/CT	Scroll Up Angle/CT	Toggles between multiple az/el position display options in Manual Mode	Scrolls forward through lists. Provides "YES" answer to prompts.
Scroll↓ RF/SS	Scroll Dn RF/SS	Toggles between displayed signal strength sources in Manual Mode	Scrolls backward through lists. Provides "NO" answer to prompts.
Enter	Enter	Heading Fix in Manual Mode	Complete entry of data. Select entry from list. Access sub-mode in CONFIG mode.
1 CCW Pol	1 Pol CCW	Jogs polarization motor counter-clockwise when pol movement is allowed	Supplies "1" for numeric entry. Use to select option 1 from a numbered list.
2 N UP EI	2 N EI UP	Jogs elevation axis up when in MANUAL mode	Supplies "2" for numeric entry. Supplies NORTH for latitude entry (12°34N). Scrolls up during alphanumeric entries.
3 CW Pol	3 Pol CW	Jogs polarization motor clockwise when pol is movement allowed	Supplies "3" for numeric entry.
4 E CCW Az	4 E Az CCW	Move azimuth axis counter-clockwise in MANUAL mode	Supplies "4" for numeric entry. Supplies East for longitude entry (123°45E).
5 H/V	5 H/V	Commands Cross-Polarization movement in MANUAL mode, Store	Supplies "5" for numeric entry.

	KEY LABEL	SPECIFIC FUNCTION	GENERAL FUNCTION
	6 W Az CW	Move azimuth axis clockwise in MANUAL mode	Supplies "6" for numeric entry. Supplies West for longitude entry. (123°45W)
	7 Sat-H	Requests move to predefined Horizontal polarity position	Supplies "7" for numeric entry.
	8 S El DN	Jogs elevation axis down when in MANUAL mode	Supplies "8" for numeric entry. Supplies SOUTH for latitude entry (12°34S). Scrolls down during alphanumeric entries.
	9 Sat-V	Requests move to defined Vertical polarization	Supplies "9" for numeric entry.
	0 Speed	Toggles motor drive speed between FAST and SLOW	Supplies "0" for numeric entry.
	. (decimal point) Stop	Provides way to stop automatic movements	Provides delimiter for various data entries. Decimal point for floating point entry (2.50). Degree sign for lat/lon entry (38°56N). Colon for time entry (12:34:56). Slash for date entry (11/29/18).
	+/- BKSP	Provides way to exit out of certain conditions	Toggles sign of numeric data entry when cursor is at beginning of entry field. Backspaces one field to the left during data entry.

2.1.1.1.3   <u>Data Entry</u>

Many ACU screens request some type of user input. This section provides instructions on the entry of various types of data.

Selection from List (<0-9>SELECT)

When the user is prompted to select an action from a displayed list, pressing the numbered key corresponding to the desired action will initiate the action.

Scrolling Through List (<SCR>THRU LIST)

When the user is prompted to scroll through a list of items, pressing the <Scroll Up/Yes> key will move forward through the list and pressing the <Scroll Dn/No> key will move backward through the list. Pressing the <Enter> key when the desired item from the list is displayed will select the item.

Alphanumeric Entry (NAME:SES 3)

To manually enter the name of a satellite or location, the user scrolls through the list of characters (A-Z, 0-9 and blank) and selects the character by pressing the <6/CW/W> key. To scroll forward through the list of characters use the <2/UP/N> key and use the <8/DN/S> key to scroll backward.

To complete the entry of the alphanumeric string, press <Enter>. The user may delete through the string by using the <BKSP> key or move to the left to adjust once character by pressing the <4/CCW/E> key.

Integer Data Entry (SIZE: 240)

To enter whole numbers, use the 0-9 keys to enter the desired numeric string followed by the <Enter> key. Note that the data field will initially show the current value for the item until numeric entry is started. To terminate the entry without changing the value, the user may use the <Scroll Up/Yes> or <Scroll Dn/No> key. The <BKSP> key may be used to move back in the string to correct the input. Pressing the <Enter> key with the current value displayed will also result in no update.

Floating Point Data Entry (HEADING:180.0)

Entering floating point values is similar to entering integer values except that the decimal point is inserted by using the <Stop> key.

Degree/Decimal Latitude/Longitude Entry (TRUCK LAT:38.9556N)

Entering Latitude or Longitude is the same as floating point data entry. After entering the numeric value of latitude or longitude, the user is prompted to supply W(est) or E(ast) for longitude or N(orth) or S(outh) for latitude.

Degree/Decimal Longitude Entry (SAT LON:179.0E)

This entry is like the degree/minute entry but allows decimal fractions of degrees. This format will be used for satellite longitude entry where the degree/minute format is standard for vehicle position entry.

Time/Date

Time is entered in HH:MM:SS format and date in MM/DD/YY format.

2.1.1.1.4   Display Layout

The following screen shows many elements common to RC4500 mode displays.

```
AZ: 204.93          RF:-50.9        MANUAL
EL:  41.96          SAT:WB-1
PL:  45.00          SPD:FAST            UTC
<MODE>MENU <0-9>JOG ANTENNA      14:25:47
```

MODE TITLE: In the upper right corner, the title of the current ACU mode is displayed – in this example MANUAL designates that the ACU is currently in manual mode.

NOTE: if the mode title is preceded by an exclamation point (!), the mode was initiated by a remote command.

DATA LABELS: Since each mode presents a unique set of data, labels describing the data must be presented. The label will typically be followed by a colon to delimit between the label and the actual data. In the example shown, AZ: is the label for the current azimuth angle.

DATA VALUES: The current value of relevant data for the mode is displayed following the appropriate data label. In the example, the current azimuth angle (AZ:) is 204.93. Likewise, the satellite (SAT:) is WB-1.

USER PROMPTS: Since each mode requires unique (but similar) keypad inputs, prompts for relevant user action are included on the fourth line to the extent possible. In the above example, <MODE> tells the user that pushing the mode key will transition the ACU to MENU mode. There are several types of user data inputs as described in 2.1.1.1.3.

USER INFORMATION: When room allows, information about the current state of the ACU is displayed. In the above example, "SPD:FAST" describes the fact that since the ACU is currently configured for a jog in fast speed.

TIME: In some modes where data (such as azimuth position) may not change for long periods of time, the current time is displayed to reassure the user that the ACU is functioning. In the above example, the current system time (14:25:47) is displayed with the colon flashing once per second.

ALARM STATUS: While not shown in the above example, row 4 is used to display any alarm conditions the ACU has detected. The alarm message will alternate with the text normally on row 4. See section 4.1.2 for more description of the alarm system.

2.1.1.2   Front Panel Operating Group

Within the operating group of modes exists two high level modes – MANUAL and MENU. The MANUAL mode allows the user to manually jog the antenna while the MENU mode allows the user to select the modes that implement the RC4500's automatic movement features. While in either one of these modes, a momentary push of the Mode key will transition the RC4500 to the other mode.

2.1.1.2.1   MANUAL Mode

```
AZ: 204.93          RF:-50.9       MANUAL
EL:  41.96          SAT:WB-1
PL:  45.00          SPD:FAST          UTC
<MODE>MENU <0-9>JOG ANTENNA     14:25:47
```

In MANUAL mode, the user may jog the antenna in all three axes. A momentary push of the <Mode> key will move the controller from the MANUAL mode to the MENU mode.

AZ:

The azimuth field shows a current position value of the azimuth axis. It also shows the status of azimuth limits (STOW, CCW, CW). The limits will be displayed based on the table below. It is possible for different limits to have different sources (Switch Hardware for stow and Pot Based for CCW and CW).

	Switch Hardware + Software Limits	Pot Based Hardware + Software Limits	No Hardware + Software Limits
Limit Reached			
Hardware Limit	STOW, CCW, CW	STOW, CCW, CW	n/a
Software Limit	stow, ccw, cw	stow, ccw, cw	STOW, CCW, CW

The azimuth axis may be moved by pressing the <AZ CCW> or <AZ CW> keys.

EL:

The elevation field shows a current position value of the elevation axis. It also shows the status of elevation limits (STOW, DOWN, UP). The limits will be displayed based on the table below. It is possible for different limits to have different sources (Switch Hardware for Up and Down software for stow).

	Switch Hardware + Software Limits	No Hardware + Software Limits
Limit Reached		
Hardware Limit	STOW, DOWN, UP	n/a
Software Limit	stow, down, up	STOW, DOWN, UP

The elevation axis may be moved by pressing the <El UP> or <El DN> keys.

PL:

The polarization field shows a current angular value of the polarization axis. It also shows the status of polarization limits (STOW, CCW, CW). The limits will be displayed based on the table below. It is possible for different limits to have different sources (Switch Hardware for stow and Pot Based for CCW and CW).

	Switch Hardware + Software Limits	**Pot Based Hardware + Software Limits**	**No Hardware + Software Limits**
Limit Reached			
Hardware Limit	STOW, CCW, CW	STOW, CCW, CW	n/a
Software Limit	stow, ccw, cw	stow, ccw, cw	STOW, CCW, CW

This field will also show if the polarization axis has been placed at a predefined horizontal (H) or vertical (V) position.

The value of the predefined horizontal and vertical positions depends on what mode was active prior to entering the MANUAL mode. If a RECALL operation occurred prior to MANUAL, the H and V values will be those automatically calculated by the RECALL mode. H and V will be defined according to the reference defined in the POL CALIBRATION screen (ie. if REF = H, H = 0 & V = 90 if REF = V, V = 0 & H = 90).

The polarization axis may be moved manually by pressing the <Pol CCW> or <Pol CW> keys. The axis may also be moved automatically to the predefined horizontal or vertical positions by pressing the <H> or <V> keys.

In the MANUAL mode, whenever the <5 H/V> key is pressed the polarization axis will automatically move 90 degrees from its current position. The target position for this automatic "cross polarization" movement considers the user defined polarization axis limits.

RF/EXT/BCN:

This field shows the current signal strength sensed on the selected signal strength channel. By pressing the <Scroll Dn RF/SS> key the source of signal strength will rotate between an external signal strength input (**EXT**) and the RF input (**RF**). If the controller is equipped with an optional internal beacon receiver, **BCN** will also be available as a signal source.

The current signal strength will be displayed as a value between -99.9 and 99.9 for **RF**, **BCN,** and **EXT**.

If a signal lock input has been enabled associated with the observed channel, an "L" will be displayed to the right of the signal strength value whenever the signal lock condition has been satisfied.

SAT:

When the ACU knows the antenna is pointed at a previously stored satellite, the satellite name will be shown in this field.

SPD:

This field shows the selected drive speed. The speed may be toggled between FAST and SLOW by pressing the <Speed> key.

2.1.1.2.2   MENU Mode

MENU mode allows the user to select one of listed modes. Pressing the Mode key will move to MANUAL mode. The modes available to the user will vary depend on the current access level of the ACU (2.1.1.3.1.1.1). When in install or super user mode, the screen below will be presented to the user.

```
1-SETUP      2-RECALL    3-DELETE        MENU
4-MOVETO     5-DRIVE

                                          UTC
<0-9>SELECT  <MODE>MANUAL       00:04:31
```

If the controller is equipped with an optional beacon receiver, an additional "BEACON" mode will also be available.

```
1-SETUP      2-RECALL    3-DELETE        MENU
4-MOVETO     5-DRIVE     6-BEACON

                                          UTC
<0-9>SELECT  <MODE>MANUAL       00:04:31
```

When in normal user access mode, the screen below will be presented to the user.

```
1-RECALL  SATELLITE                       MENU
2-DRIVE  STATUS
3-MOVETO                                   UTC
<0-9>SELECT  <MODE>MANUAL       00:04:31
```

MENU mode displays the time and time zone in the lower right-hand corner.

2.1.1.2.2.1   SETUP

The SETUP mode allows the user to store a satellite into the controller memory for selection via the RECALL mode (2.1.1.2.2.2). When entering the SETUP mode, the user is presented with the following screen.

```
SATELLITE  PARAMETERS                     SETUP
NAME:               INCLIN:     TRACKING:
 LON:                 BAND:       SIGNAL:
NAME  <UP/DN/LF/RT  ALPHANUMERIC>
```

NAME: NAME <UP/DN/LF/RT ALPHANUMERIC>

The user is prompted to enter an up to 10-character name for the satellite that is being setup. Alphanumeric characters can be scrolled through by pressing the <UP> and <DOWN> keys. The cursor can be moved left or right using the <CCW> and <CW> keys respectively. Pressing the <ENTER> key will terminate the current field and move the cursor to the LON: field.

LON: LONGITUDE <DDD.T FORMAT>

The user is prompted to enter the longitude of the satellite. The longitude will be used for tracking, and for determining a search box around the satellite if the signal is lost. To set the longitude, the user will enter the numeric value and press <ENTER>. The user will then select East or West Longitude by pressing the <E/CCW> or <W/CW> key respectively and pressing <ENTER>. The cursor will then be moved to the inclination field.

INCLIN: INCLINATION <1-20 DEG> <0>NON-INCLINED

The user is prompted to enter the inclination for the satellite. This information will be used for tracking and to determine a search box around the satellite if the signal is lost. The user should input the appropriate values using the number keys on the keypad and the press <ENTER>. The cursor will then be moved to the BAND: field.

BAND: BAND <0-C 1-KU 2-L 3-X 4-KA 5-S>

The user is prompted to enter the band for the satellite. This information is used for tracking operations. The user should enter the correct data based on the prompts shown on the bottom line and then press <ENTER>. If equipped with a tracking option, the cursor will then be moved to the TRACKING: field.

TRACKING: <0-NONE 1-MEM 2-STEP>

Or

TRACKING: <0-NONE 1-EPT 2-STEP 3-STP/TLE 4-TLE>

The user is prompted to select a tracking mode for the satellite being setup. Each mode is briefly described below.

    1. MEM   This tracking mode is divided into 2-phases:
        a. The initial phase is a basic step track operation. During this time, the ACU will constantly step track based on input parameters entered previously during the SETUP operation
        b. After 24 hours, the ACU will transition to a memory track operation based on the base points determined during the initial phase.

Or

    1. EPT   The most advanced tracking mode for the RC4500 is Enhanced Predictive tracking (EPT). This tracking is divided into 3-phases:
        a. The initial phase is a basic step track operation. During this time, the ACU will constantly step track based on input parameters entered previously during the SETUP operation
        b. After 3 hours, the ACU will transition to a smart step track operation based on the calculated inclination and the current phase of the orbit.
        c. After 6 hours, the ACU will transition to a fully predictive tracking mode, with peaking operations only occurring at basepoints that occur 48 times per day.

    2. STEP   This mode will cause the ACU to perform the basic step track operations constantly. If the signal is lost in this mode, the ACU will revert to EPT tracking until the signal returns.

    3. STP/TLE   This mode will be the same as STEP, with TLE tracking mode being used when a signal is lost rather than EPT.

    4. TLE   This mode will use TLE tracking at all times.

After selecting the tracking mode, the user will press the <ENTER> key and the cursor will be moved to the SIGNAL: field.

SIGNAL: <SIGNAL SOURCE 0-NONE 1-EXT 2-BEACON>

The user is prompted to select a signal source for the satellite being SETUP. If the tracking mode selected is 1-3, 0-NONE will not be considered a valid signal source. The user should enter the correct data based on the prompts shown on the bottom line and then press <ENTER>. If the signal source is set to 0-NONE or 1-EXT, the ACU will skip the Beacon setup page and proceed immediately to section 0.

SIGNAL: <SIGNAL SOURCE 0-NONE 1-BEACON>

If the ACU is equipped with a driver to control an external beacon tracking receiver, the menu will appear as above.

2.1.1.2.2.1.1 Beacon SETUP

If the unit is configured with an optional beacon receiver interface and the signal source is set to 2-BEACON, the ACU will transition to a screen for entering beacon frequency information for the satellite being SETUP. The first screen shows the prompt for an antenna with a linear feed. The second screen shows the prompt for an antenna with a circular feed.

```
BEACON  PARAMETERS                      SETUP
HFREQ:           HMOD:
VFREQ:           VMOD:
HORZ  BEACON  FREQUENCY  <0-300000.00  MHz>
```

```
BEACON  PARAMETERS                      SETUP
FREQ:              MOD:

BEACON  FREQUENCY  <0-300000.00  MHz>
```

HFREQ:/VFREQ:/FREQ: BEACON FREQUENCY <0-30000.00 MHz>

In the linear case, the user is prompted to enter a frequency for both the horizontal and vertical beacon. If the beacon information for either polarization is unknown, the frequency should be set to 0. In the circular feed case, the user is prompted to enter a single beacon frequency. The user should input the value using the numeric keypad and then press <ENTER>.

HMOD:/VMOD:/MOD: BEACON MODULATION <0-CW,1-BPSK>

In the linear case, the user is prompted to select between CW and BPSK for both the horizontal and vertical beacon. If the beacon information for either polarization is unknown, the MOD should be set to 0. In the circular feed case, the user is prompted to enter a single beacon modulation. The user should input the value from the prompt on the bottom line and then press <ENTER>.

2.1.1.2.2.1.2   AZ/EL Positioning

After entering the beacon frequency, the ACU will transition to the SETUP AZ/EL jog screen. The
message "<ENTER>SAVE AZ/EL POSITION" will be flashing on the bottom line.

```
AZ: 204.81            RF:-50.9        SETUP
EL:  41.84
PL:   5.00         SPD:FAST
<0-9>JOG ANTENNA <BKSP>BEACON <MODE>EXIT
```

From this screen the user can jog the antenna in AZ and EL to properly position the antenna. Pressing
the <BKSP> key will drop into the beacon control screen shown below.

```
BEACON PARAMETERS      BCN:-46.0 L   SETUP
H-FREQ:20199.00  DEMOD:CW    ATTEN: 0


<H,V>TUNE BEACON <ENTER>EDIT   <BKSP>EDIT
```

From this screen, the user can tune to either the horizontal or vertical frequency that was set in the
previous step. When a circular feed is use, the receiver will be tuned to the single frequency
automatically. Pressing the <BKSP> key will return to the SETUP AZ/EL jog screen.

```
AZ: 204.81            BCN:-46.0 L     SETUP
EL:  41.84
PL:   5.00         SPD:FAST
<0-9>JOG ANTENNA <BKSP>BEACON <MODE>EXIT
```

After properly peaking the antenna using the beacon receiver, or an external method pressing <ENTER>
will store the azimuth and elevation angles for the satellite. If a linear feed is being used, the controller
will transition to the SETUP POL jog screen. If a circular feed is being used, the controller will exit the
SETUP mode.

The SETUP POL jog screen allows the user to adjust the polarization to the proper position. The
message "<ENTER>SAVE H-POL POSITION" will be flashing on the bottom line of the display.

```
AZ: 204.81            BCN:-46.0 L     SETUP
EL:  41.84
PL:   5.00         SPD:FAST
<0-9>JOG ANTENNA <BKSP>BEACON <MODE>EXIT
```

The user should manually move the polarization to the horizontal position, and then press the <ENTER>
key. The flashing message on the bottom line will then change to "<ENTER>SAVE V-POL POSITION".
The user should manually move the polarization to the vertical position and the press the <ENTER> key.

If the satellite being SETUP has a tracking mode other than 0-NONE, the ACU will immediately transition
into RECALL mode (2.1.1.2.2.2). If the satellite tracking mode is setup as 0-NONE, the ACU will
immediately transition into MANUAL mode (2.1.1.2.1).

2.1.1.2.2.2   RECALL

The RECALL mode allows the user to position the antenna to satellites that were previously stored using the SETUP mode (2.1.1.2.2.1). When entering the RECALL mode, a scrollable list of satellites will be shown.

```
                                     RECALL
#    NAME          LON    INCL BAND TRK   TBL
1    WB-1         111.1W    0    KA   S/E    0%
<SCR>THRU LIST <ENTER>SELECT  <MODE>EXIT
```

Using the <SCROLL UP> and <SCROLL DN> keys the user can scroll through the list of satellites stored in memory. Pressing the <ENTER> key will select the current satellite displayed.

If there are no satellites in memory, the following screen will be displayed.

```
                                     RECALL
   *       NO SATELLITES IN MEMORY       *
   *    USE SETUP MODE TO STORE NEW      *
                                 <MODE>EXIT
```

After a satellite has been selected, the controller will prompt the user to specify the desired polarization. For antennas with circular feeds, this step will be skipped.

```
H-HORIZONTAL:    5.00              RECALL
V-  VERTICAL: -85.00   SAT:WB-1

<H/V>SELECT RX POLARIZATION   <MODE>MENU
```

After selecting the polarization, the antenna will begin moving to the selected satellite. When the automatic movement is completed, the controller will transition to the MANUAL mode (2.1.1.2.1) for satellites with the tracking set to 0-NONE or TRACK mode (2.1.1.2.2.6) for all other tracking modes.

2.1.1.2.2.3   DELETE

The DELETE mode allows a satellite that was stored via the SETUP mode (2.1.1.2.2.1) to be deleted from the ACU memory.

```
                                      DELETE
#   NAME            LON    INCL BAND TRK  TBL
1   WB-1            111.1W  0    KA  S/E   0%
<SCR>THRU LIST <ENTER>SELECT  <MODE>EXIT
```

Using the <SCROLL UP> and <SCROLL DN> keys the user can scroll through the list of satellites stored in memory. Pressing the <ENTER> key will select the current satellite displayed to delete. All satellite can be deleted by using the "DELETE ALL STORED SATELLITES" at the end of the list.

If there are no satellites in memory, the following screen will be displayed.

```
                                      DELETE
  *      NO SATELLITES IN MEMORY       *
  *    USE SETUP MODE TO STORE NEW     *
                            <MODE>EXIT
```

2.1.1.2.2.4   MOVETO

The MOVETO mode is intended to provide an easy way to move the antenna to a certain position for doing testing such as cutting antenna patterns. This mode is also useful for tuning up automatic movements.

```
AZ: 204.93 ( 204.93) <0>SPD:FAST  MOVETO
EL:  41.39 (  41.39) <5>SENSOR:ANGLE
PL:  45.00 (  45.00) <6>LON:
<1>SET AZ <2>SET EL <3>SET POL  <4>START
```

The current azimuth, elevation, and polarization angles are displayed. When the mode is first entered, the current positions shown are the target positions. New target positions can be selected for azimuth, elevation, and polarization by pressing the <1>, <2>, or <3> key respectively. After setting target positions and setting the desired speed, the automatic movement may be initiated by pressing the <4> key.

<0> SPEED:FAST

The state of this field when this mode is entered will be "FAST". This means that any move will be using the standard speed control of the ACU. When the <0/Speed> key is pressed, this field will change to "SLOW". This means that the move will never go faster than the slow speed set in the "DRIVE PARAMETERS" configuration screen corresponding to the axis being moved.

<5>SENSOR:ANGLE

The state of this field when this mode is entered will be "ANGLE". This means that all the movements requested will occur in angles. When the <5> key is pressed this field will change to "COUNT". This means that all movements requested will occur in counts.

<6>LON:

This field allows the ACU to auto calculate AZ/EL/PL targets based on a satellite orbital slot and the location of the antenna.

2.1.1.2.2.5   DRIVE

```
1-AZIM:JAMMED               DRIVE  RESET
2-ELEV:RUNAWAY
3- POL:OK
<1-3> RESET AXIS            <MODE>EXIT
```

The DRIVE mode provides the way to reset drive system errors (FOLLOW/DRIFT/DRIVE) for each axis. See section 4.1.2 for descriptions of these conditions. An axis' drive status may be reset by pressing the corresponding key.

2.1.1.2.2.6   BEACON

The BEACON mode is provided to manually control the optional beacon receiver, during diagnostic procedures. When entering the screen, the user is presented with the screen below. The antenna cannot be moved manually while in this mode.

```
RF:-50.7            BCN SS:-51.6 L      BEACON
^-ATTENUATION:0    .-AUTO      7-FR:20199.80
v-MODULATION:CW                LO:18250.00
<5,9,.,<>>TUNE BEACON          9-IF: 1949.80
```

7-FR   RF <xxxxx.yy> MHz

This field allows the user to enter the actual frequency of the satellite's beacon. When the frequency is entered, the IF frequency will be derived from the LO frequency. The resulting IF frequency is displayed in the IF field. The beacon receiver will then be tuned to that IF frequency.

9- IF: IF <940.00-2150.00> MHz

This field allows the user to enter the intermediate frequency of the satellite's beacon. When the frequency is entered, the RF frequency will be derived from the LO frequency. The resulting RF frequency is displayed in the FR field. The beacon receiver will then be tune to the IF frequency.

.-ATT: ATTENUATION <0-40> dB

This field allows the user to change the input attenuation of the beacon receiver. Press the <STOP> key to enter this field. Pressing the <SCROLL UP> key from the beacon maintenance screen will cause the controller to auto attenuate the beacon receiver.

v-MOD: CW or BP

The <ENTER> key may be pressed to toggle the beacon receiver's demodulation mode between continuous wave (CW) or BPSK (BP) settings.

This setting is ignored if the beacon receiver being used does not support BPSK beacons.

LO: xxxxx.yy MHz

This field indicates the current LO frequency as defined in the feed definition configuration screen (2.1.1.3.1.2.4).

BCN SS: -51.6 L

This field indicates the current signal strength and lock status from the beacon receiver.

RF: -50.7

This field indicates the current signal strength from the L-Band power detector.

2.1.1.2.2.7   TRACK

The TRACK mode is automatically entered via the SETUP (2.1.1.2.2.1) or RECALL (2.1.1.2.2.2) modes if the tracking field for a selected satellite is set to any value other than 0-NONE.

The following screen will be displayed for all track modes, with a brief description of each mode described below.

```
AZ: 204.58 PEAK:  78 BCN:-46.0 L   TRACK
EL:  41.88 BASE:1087 SAT:WB-1      (Ka)
PL:  18.78           STEP:IDLE      19:18
WAITING FOR NEXT PEAKUP...        <0>MENU
```

Fields that are unique to the tracking mode are described below:

PEAK: 78

This field shows the time in seconds to the next scheduled AZ/EL peakup.

BASE:1087

This field shows the time in seconds to the next schedule track table base point.

STEP:IDLE

This field shows the current sub-mode (STEP/EPT/TLE) and state (IDLE/PEAKING/REPOSITION).

The bottom line gives a description of the status of the TRACK mode. Additionally, the bottom line indicates the press <0> will enter the TRACK MENU sub-mode (2.1.1.2.2.7.1). This option will not be displayed in normal access level.

Tracking on the RC4500 can be divided into four separate sub-modes. The sub-mode chosen by the ACU will be a function of the tracking mode selected when storing the satellite, and the current information stored in the track table for the satellite.

- Step Track
    - o In Step Track, the controller periodically peaks on the selected signal source by jogging the antenna in azimuth and elevation. The time and position are recorded in a track table base points maintained in the controller's memory. The interval between Step Track operation is determine from antenna size, frequency band, satellite inclination and a user specified maximum allowable error (2.1.1.3.1.3.8).
- Enhanced Predictive Track (EPT) Track
    - o EPT Track is divided into 2 unique phases.
        - – Phase 1: The ACU will transition to the first EPT phase after 6 base points in a row have been stored via the Step Track sub-mode. In this phase, the ACU will use the algorithm to determine the amplitude and phase of the inclined orbit. Using this data, the ACU will smartly calculate the peaking interval and only peak as need.
        - – Phase 2: The ACU will transition to the second EPT phase after 6 base points have been stored via EPT phase 1. During this phase, the ACU uses the EPT model and current time to accurately calculate the satellite position every 5 seconds. During this phase, the ACU will peak at each basepoint to constantly refine the model. When tracking via EPT, the ACU will be able to track an inclined satellite forever without update.
- Two-Line Element (TLE) Track
    - o In TLE track, the controller smoothly moves the antenna to azimuth and elevation positions derived from the two-line element data set. The ACU will be constantly calculating pointing angles from the TLE data set. Anytime the current position is different from the calculated position, the ACU will move the antenna to close this error.
- Track Search
    - o Track Search is entered when the satellite signal has been lost during Step Tracking when there is no EPT or TLE model to fall back on. The ACU utilizes Intelli-Search, an efficient search algorithm that calculates the nominal trajectory for the satellite, and then searches in an area that coincides with the satellite's expected path. When the satellite is located, the controller re-enters the Step Track sub-mode.

2.1.1.2.2.7.1   TRACK MENU

Pressing the <0> key from the TRACK mode (2.1.1.2.2.6) will drop into the TRACK MENU sub-mode.
This sub-mode is not available in the normal user access level.

```
AZ: 204.58 PEAK:  78 BCN:-46.0 L   TRACK
EL:  41.88 BASE:1087 SAT:WB-1       (Ka)
TRACK MENU <1>PEAKUP NOW <2>VIEW TABLE
<3>MODIFY FACTORS <BKSP>EXIT       83845
```

Pressing the <1> key from the TRACK MENU sub-mode will begin a step tracking peaking operation
immediately. Once completed, the ACU will return to the TRACK mode.

Pressing the <2> key from the TRACK MENU sub-mode will allow the user to view the track table
basepoints that are stored in memory.

```
AZ: 204.58 PEAK:   78 BCN:-46.0 L   TRACK
EL:  41.88 BASE:1087 SAT:WB-1       (Ka)
TRACK TABLE <SCROLL>UP/DOWN <BKSP>EXIT
44 78980  204.66    41.95  <1>DEL  84150
```

Using the <SCROLL UP> and <SCROLL DN> keys the user can scroll through the list of track table base
points. Each entry provides the following information:

- Base Point Number – 44
- Base Point Sidereal Time – 78980
- Base Point AZ Angle – 204.66
- Base Point EL Angle – 41.95

Additionally, any track table basepoint in memory can be deleted by pressing the <1> key. Pressing the
<BKSP> key will return the ACU to the TRACK MENU sub-mode.

Pressing the <3> key from the TRACK MENU sub-mode allows the user to modify various parameters
related to the tracking operation.

```
AZ: 204.58 PEAK:   78 BCN:-46.0 L   TRACK
EL:  41.88 BASE:1087 SAT:WB-1       (Ka)
FACTORS MENU <SCROLL>UP/DOWN <ENTER>EXIT
MAX ERROR (1/10 dB) <1-30>: 3
```

From the TRACK FACTORS sub-mode, the following configuration items related to the tracking can be
modified directly.

- Max Error – Max Error in Track Factors Configuration Screen (2.1.1.3.1.3.8).
- Search Width – Search in Track Factor Configuration Screen (2.1.1.3.1.3.8).
- Track Table Clear – Clears all track table base points.
- Update Flags – When in Step track mode, flags all base points for updating.
- Update time – When in Step track mode, sets how often base point is checked for accuracy.
- Search Retry – When the signal is lost, determines how frequently the ACU will search.
- Signal Threshold – Receiver specific Low Signal Threshold (2.1.1.3.1.2.6)

2.1.1.2.2.8   PEAKUP

The PEAKUP mode performs a quick peak on the signal source currently displayed on the top line of the display in MANUAL mode. This is the same routine that is used during the TRACK operation (2.1.1.2.2.6).

2.1.1.3   Front Panel Programming Group

The programming group has two high-level modes (CONFIG-MENU and MAINTENANCE). Both modes serve as a menu system for sub-modes below them. Momentarily pressing the <Mode> key will switch between these modes in a similar fashion as the MANUAL and MENU modes switched in the operating group.

2.1.1.3.1   Configuration Mode

The CONFIG mode allows users to view and/or modify various controller parameters and to enable or disable certain features. The CONFIG mode groups configuration items into screens containing between 1 to 11 individual items. The top-level CONFIG-MENU allows the user to scroll through the list of configuration item groups. As the user scrolls through the CONFIG-MENU screens, a group title (line 1) and brief description (line 2) of group items is presented to identify the set of configuration items to view or modify.

The example CONFIG-MENU screen identifies the AZIMUTH CALIBRATION group. The description "AZ REFERENCE VOLTAGE/LIMITS/SCALE FACTOR" provides an overview of the type of configuration items that will be available for viewing and/or modification.

```
AZIMUTH CALIBRATION              CONFIG-MENU
AZ  REFERENCE VOLTAGE/LIMITS/SCALE FACTOR


<SCR>THRU LIST <ENTER>SELECT <MODE>MAINT
```

To move through the CONFIG-MENU list, press the <Scroll Up/Yes> key to advance to the next screen or press the <Scroll Dn/No> key to move to the previous screen. To select the currently identified group for viewing/modification, press the <Enter> key and the screen showing the individual items in the group will appear. Momentarily pressing the <Mode> key will move from the CONFIG-MENU mode to the MAINTENANCE mode.

If the AZIMUTH CALIBRATION group were selected, the following screen would appear:

```
VREF:2.50                        CONFIG-AZIM
 CCW:-192.0    CW:192.0    SF: 87.95
PSF:10430           ROFF:   0.00     DIR:0
ZERO DEG VOLTAGE <1.00-4.00 VOLTS>
```

In this example there are seven individual configuration items related to the azimuth axis. To move between the items, use the <Scroll Up> and <Scroll Dn> keys. The cursor will flash at the beginning of the data field for the item currently selected. On line 4, a prompt briefly describing the item and showing the valid range of data will appear. Data may be entered for the item as described in section 2.1.1.1.3. Momentarily pressing the <Mode> key will return to the CONFIG-MENU mode.

The following table lists all the configuration item group titles and descriptions as they appear in the CONFIG-MENU mode. Details for each group are provided in the following subparagraphs. The table also shows which configuration item groups are available according to how the expert access permission (2.1.1.3.1.1.1) is set.

Additional configuration item screens may appear if they are unique to an optional feature (DVB, Beacon, etc.).

GROUP TITLE	GROUP DESCRIPTION	PARA.
NORMAL ACCESS ITEMS		
EXPERT ACCESS PERMISSION	SETS EXPERT ACCESS PERMISSION	2.1.1.3.1.1.1
BEACON DETECTION POINTS	LIST OF PRESET BEACON FREQUENCIES	2.1.1.3.1.1.2
TLE 1 DATA	LINE 1 – TWO LINE ELEMENT SET	2.1.1.3.1.1.3
TLE 2 DATA	LINE 2 – TWO LINE ELEMENT SET	2.1.1.3.1.1.4
INSTALL ITEMS		
AZIMUTH CALIBRATION	AZ REFERENCE VOLTAGE/LIMITS/SCALE FACTOR	2.1.1.3.1.2.1
ELEVATION CALIBRATION	EL REFERENCE VOLTAGE/LIMITS/SCALE FACTOR	2.1.1.3.1.2.2
POLARIZATION CALIBRATION	POL REFERENCE VOLTAGE/LIMITS/SCALE FACTOR	2.1.1.3.1.2.3
FEED DEFINITION	SPECIFY FEED TYPE/BAND/ID	2.1.1.3.1.2.4
EXTERNAL SIG FACTORS	EXTERNAL SIGNAL/SEARCH PARAMETERS	2.1.1.3.1.2.5
BEACON SIG FACTORS	BEACON SCAN/SEARCH PARAMETERS	2.1.1.3.1.2.6
SUPER ITEMS		
SYSTEM DEFINITION	INDICATE PRESENCE OF SYSTEM OPTIONS	2.1.1.3.1.3.1
AZIMUTH ANGLE MOVEMENT	AZIMUTH ANGLE-BASED MOVE PARAMETERS	2.1.1.3.1.3.2
AZIMUTH DRIVE PARAMETERS	AZIM VOLTAGE/CURRENT/IR/JAM/DEADBANDS	2.1.1.3.1.3.3
ELEVATION ANGLE MOVEMENT	ELEVATION ANGLE-BASED MOVE PARAMETERS	2.1.1.3.1.3.4
ELEVATION DRIVE PARAMETERS	ELEV VOLTAGE/CURRENT/IR/JAM/DEADBANDS	2.1.1.3.1.3.5
POL ANGLE MOVEMENT	POL ANGLE-BASED MOVE PARAMETERS	2.1.1.3.1.3.6
POL DRIVE PARAMETERS	POL VOLTAGE/CURRENT/IR/JAM/DEADBANDS	2.1.1.3.1.3.7
TRACK FACTORS	INCLINED ORBIT TRACKING PARAMETERS	2.1.1.3.1.3.8
SHAKE	SETUP SHAKE MOVES/CYCLES/DELAY	2.1.1.3.1.3.9
LOCATION RESET	RESET ANTENNA LOCATION	2.1.1.3.1.3.10
RESET DEFAULTS	RESTORES PROGRAMMING TO FACTORY DEFAULTS	2.1.1.3.1.3.11

2.1.1.3.1.1   Normal Access Items

The seven configuration groups contained in the "Normal" access allows the user to change items that would typically be required to be changed following system configuration. Also available is the "Expert Access Permission" configuration screen to allow the user to change from "Normal" access to "Install" or "Super" access.

2.1.1.3.1.1.1   Expert Access Permission

```
EXPERT ACCESS:     0           CONFIG-EXPERT


0-NORMAL/1-INSTALL/2-SUPER<5 DIGIT CODE>
```

The Expert Access level is used to control access to controller modes and configuration items.

The available expert access levels are: "Normal" (0), "Install" (1), and "Super" (2). The user is restricted to basic operational modes and preset item lists when Expert Access is set to "Normal" (0). The user has access to all controller modes and general configuration items when Expert Access is set to "Install" (1). The user has access to all controller modes and all configuration items when Expert Access is set to "Super" (2).

When the Expert Access screen is displayed, the current expert access level is displayed after EXPERT ACCESS. To change state of the flag, the user must key in a 5 digit code followed by the <ENTER> key. This code is found in Appendix A "Expert Access Codes" at the end of this manual. If the information is lost, call the factory for assistance.

2.1.1.3.1.1.2   Beacon Detection Points

This group allows the user to view beacon information for each satellite stored in memory (2.1.1.2.2.1.1).

```
SAT#:1     NAME:WB-1              CONFIG-BCN
           HFREQ:20199.00   HMOD:0
           VFREQ:     0.00   VMOD:0
<SCR>THRU LIST <ENTER>MODIFY DATA
```

SAT#:   **<SCR> THRU LIST, <ENTER> TO MODIFY DATA**

This field identifies the stored satellite number that is currently being displayed. When in this field, using the <SCROLL UP> or <SCROLL DN> keys will move through the list.

To modify the data, press the <ENTER> key. The cursor will move to the HFREQ field.

NAME:

Name stored in memory for the current satellite.

HFREQ: **HORZ BEACON FREQUENCY <0-30000.00 MHz>**

This field identifies the horizontal beacon frequency associated with corresponding stored satellite. This field should be the value of the LO configuration item (2.1.1.3.1.2.4) plus the beacon frequency in L-Band.

For circular satellites, this will be the beacon frequency used during tracking operations.

HMOD: **HORZ BEACON MODULATION <0-CW 1-BPSK>**

This field describes the type of demodulation required for the horizontal beacon signal. CW = Continuous Wave, BPSK = Binary Phase-Shift Keying.

This setting is ignored if the beacon receiver being used does not support BPSK beacons.

VFREQ: **VERT BEACON FREQUENCY <0-30000.00 MHz>**

This field identifies the vertical beacon frequency associated with corresponding stored satellite. This field should be the value of the LO configuration item (2.1.1.3.1.2.4) plus the beacon frequency in L-Band.

For circular satellites, this frequency will not be used and will be 0.00 by default.

VMOD: **VERT BEACON MODULATION <0-CW 1-BPSK>**

This field describes the type of demodulation required for the vertical beacon signal. CW = Continuous Wave, BPSK = Binary Phase-Shift Keying.

This setting is ignored if the beacon receiver being used does not support BPSK beacons.

For circular satellites, this modulation will not be used and will be 0 by default.

2.1.1.3.1.1.3   TLE 1 Data

Note: It is suggested to enter TLE data via the GUI as described in 2.1.2.2.1.1.

The RC4500 uses one screen to show each line of TLE data. The top line of each screen identifies which line is being displayed (TLE1 or TLE2). The top line will also show the stored satellite number and satellite name. The user may scroll through stored satellites via the <Scroll Up> or <Scroll Dn> keys.

When a TLE data screen is initialized it shows the existing TLE data stored.

```
SAT#:1     NAME:WB-1            CONFIG-TLE1
1 29643   06054     21032.29527314
-.00000048   00000-0   00000+0  0   9992
<SCR>THRU LIST <ENTER>MODIFY DATA
```

When scrolling through stored satellites, if the stored satellite does not have TLE data, the following screen will be shown.

```
SAT#:1    WB-1                  CONFIG-TLE1
      ** TLE DATA NOT SELECTED **
       ** IN SATELLITE PRESET LIST **
<SCR>THRU LIST <ENTER>MODIFY DATA
```

After scrolling to the desired stored satellite number, the user may begin to enter data by pressing the <ENTER> key. The cursor will then be placed on the first data character of the first field. The data can then be entered one field at a time.

To enter data, the 0 through 9 numbers, the "." are available directly from the RC4500 keypad. To enter a "+" use the <Scroll Up> key and to enter a "-" use the <Scroll Dn> key. After a number is keyed, the cursor will advance to the next position in the field. When the last number of a field has been entered, pressing the <Enter> key will move to the next field. Numbers can be deleted by pressing the <BKSP> key.

Field 3 (classification) and Field 6 (Piece of Launch Designator) from Line 1 will not be entered, as they contain alphabetic characters. Instead, the user should just skip these field when entering via the TLE Data configuration screens.

After entering the 69th character the RC4500 will calculate the data's checksum and compare it to the last character. If the calculated and entered checksums do not match, an error will be flagged as shown below.

```
SAT#:1     NAME:WB-1            CONFIG-TLE1
1 29643   06054     21032.29527314
-.00000048   00000-0   00000+0  0   9993
<0-9 UP(+) DN(-) BKSP ENTER>    CHK:ERR
```

If the calculated and entered checksums match, an indication of CHK:OK will appear as shown below.

```
SAT#:1     NAME:WB-1            CONFIG-TLE1
1 29643   06054     21032.29527314
-.00000048   00000-0   00000+0  0   9992
<0-9 UP(+) DN(-) BKSP ENTER>    CHK:OK
```

2.1.1.3.1.1.4   TLE 2 Data

Note: It is suggested to enter TLE data via the GUI as described in 2.1.2.2.1.1.

The RC4500 uses one screen to show each line of TLE data. The top line of each screen identifies which line is being displayed (TLE1 or TLE2). The top line will also show the stored satellite number and satellite name. The user may scroll through stored satellites via the <Scroll Up> or <Scroll Dn> keys.

When a TLE data screen is initialized it shows the existing TLE data stored.

```
SAT#:1     NAME:WB-1           CONFIG-TLE2
2 29643    0.0167   84.6392 0001775
 229.6479 172.5173  1.00271423 51878
<SCR>THRU LIST <ENTER>MODIFY DATA
```

When scrolling through stored satellites, if the stored satellite does not have TLE data, the following screen will be shown.

```
SAT#:1    WB-1                 CONFIG-TLE1
      ** TLE DATA NOT SELECTED **
       ** IN SATELLITE PRESET LIST **
<SCR>THRU LIST <ENTER>MODIFY DATA
```

After scrolling to the desired stored satellite number, the user may begin to enter data by pressing the <ENTER> key. The cursor will then be placed on the first data character of the first field. The data can then be entered one field at a time.

To enter data, the 0 through 9 numbers, the "." are available directly from the RC4500 keypad. To enter a "+" use the <Scroll Up> key and to enter a "-" use the <Scroll Dn> key. After a number is keyed, the cursor will advance to the next position in the field. When the last number of a field has been entered, pressing the <Enter> key will move to the next field. Numbers can be deleted by pressing the <BKSP> key.

After entering the 69th character the RC4500 will calculate the data's checksum and compare it to the last character. If the calculated and entered checksums do not match, an error will be flagged as shown below.

```
SAT#:1     NAME:WB-1            CONFIG-TLE2
2 29643    0.0167   84.6392 0001775
 229.6479 172.5173  1.00271423 51877
<0-9 UP(+) DN(-) BKSP ENTER>    CHK:ERR
```

If the calculated and entered checksums match, an indication of CHK:OK will appear as shown below.

```
SAT#:1     NAME:WB-1            CONFIG-TLE2
2 29643    0.0167   84.6392 0001775
 229.6479 172.5173  1.00271423 51878
<0-9 UP(+) DN(-) BKSP ENTER>    CHK:OK
```

2.1.1.3.1.2   Install Access Items

This installation group of configuration groups are items that are most typically changed for pairing a controller with an antenna.

2.1.1.3.1.2.1   Azimuth Calibration

```
                                       CONFIG-AZIM
 CCW:   90.000 CW: 270.000
                            SOFF:    0.000 DIR:0
TRUE CCW LIMIT <0.000-360.000 DEGREES>
```

CCW: **TRUE CCW LIMIT <0.000-360.000 DEGREES>**

CW: **TRUE CW LIMIT <0.000-360.000 DEGREES>**

These items specify the software limits for the antenna's azimuth range of travel.

How these limits are displayed in MANUAL mode is described in section 2.1.1.2.1.

SOFF: **SENSOR OFFSET <+/-90.000 DEGREES>**

This value specifies the offset between the on-axis position sensor and true pointing angles. The value should be set using the Sensor Offset maintenance screen (2.1.1.3.2.9).

DIR: **SENSOR DIRECTION <0-NORMAL, 1-REVERSED>**

The sensor direction defines whether the polarity of the azimuth on-axis position sensor matches that of the ACU software. If the sensor angle decreases as the antenna moves CW, the DIR item must be described as reversed.

2.1.1.3.1.2.2   Elevation Calibration

```
                                   CONFIG-ELEV
DOWN:     5.000 UP:   80.000
                          SOFF:    0.000 DIR:0
DOWN LIMIT <-20.000-120.000 DEGREES>
```

DOWN: **DOWN LIMIT <-20.000-120.000 DEGREES>**

UP: **UP LIMIT <-20.000-120.000 DEGREES>**

These items specify the software limits for the antenna's elevation range of travel.

How these limits are displayed in MANUAL mode is described in section 2.1.1.2.1.

SOFF: **SENSOR OFFSET <+/- 90.0 DEGREES>**

This value specifies the offset between the on-axis position sensor and true pointing angles. The value should be set using the Sensor Offset maintenance screen (2.1.1.3.2.9).

DIR: **SENSOR DIRECTION <0-NORMAL, 1-REVERSED>**

The sensor direction defines whether the polarity of the elevation on-axis position sensor matches that of the ACU software. If the sensor angle decreases as the antenna moves UP, the DIR item must be described as reversed.

2.1.1.3.1.2.3   Polarization Calibration

```
             VREF:2.50   OFF:   0.000 CONFIG-POL
   CCW:  -90.000 CW:   90.000 SF:  45.00
                          SOFF:   0.000 DIR:0
   ZERO DEG VOLTAGE <1.00-4.00 VOLTS>
```

VREF: **ZERO DEG VOLTAGE <1.00-4.00 VOLTS>**

The zero-degree voltage from the potentiometer is the voltage present when the polarization axis is in its center of motion.

See Polarization Calibration in 3.2.4.2.2.

OFF: **ANGLE OFFSET <+/-90.000 DEGREES>**

The angle offset is used to correct for discrepancies between the potentiometer electrical angle and mechanical alignment of the feed.

See Polarization Calibration in 3.2.4.2.2.

CCW: **CCW LIMIT <+/-180.000 DEGREES>**

CW: **CW LIMIT <+/-180.000 DEGREES>**

These items specify the software limits for the antenna's polarization range of travel relative to the antenna's center polarization (0.0) position.

How these limits are displayed in MANUAL mode is described in section 2.1.1.2.1.

SF: **POT SCALE FACTOR <1.00–180.00 DEG/V>**

This value specifies the polarization scale factor applicable to the potentiometer-based polarization feedback.

See Polarization Calibration in 3.2.4.2.2.

SOFF: **SENSOR OFFSET <+/- 90.0 DEGREES>**

This value specifies the offset between the on-axis position sensor and true pointing angles.

See Polarization Calibration in 3.2.4.2.1.

DIR: **SENSOR DIRECTION <0-NORMAL, 1-REVERSED>**

The sensor direction defines whether the polarity of the polarization on-axis position sensor matches that of the ACU software. If the sensor angle decreases as the feed moves CW, the DIR item must be described as reversed.

2.1.1.3.1.2.3.1   Multi-Feed Sensing Operation

When multiple, swappable feeds exist in a system, the optional feed sensing capability allows the RC4500 to detect and configure itself according to the currently attached feed. The multi-feed system allows for unique configuration screens for 8 different feeds.

When the multi-feed option is purchased, an additional feed number item will appear on the top line of the display as shown below. The user can use the <Scroll Up> and <Scroll Dn> buttons to scroll through the polarization calibration screen for each feed.

```
POL#:0 VREF:2.50  OFF:  0.000 CONFIG-POL
 CCW: -90.000 CW:  90.000 SF: 45.00
                         SOFF:   0.000 DIR:0
ZERO DEG VOLTAGE <1.00-4.00 VOLTS>
```

POL#:   FEED INDEX NUMBER

This is the index number for the current Polarization Calibration screen displayed.

Each unique feed is sensed via inputs A, B, and C respectively. The current state of these inputs can be viewed in the LIMITS maintenance screen (2.1.1.3.2.4). The inputs are combined to create a feed number. The table below shows the standard for how each feed number is defined. Due to the high configurability of the RC4500, these values can all be modified in the baseline code. See the mount specific appendix for POL ID bit schemes for each specific antenna.

FEED #	Bit C	Bit B	Bit A	Default Sensed Feed	Default Feed Identifier
0	0	0	0	C-Band Linear	"C-LP"
1	0	0	1	X-Band Linear	"X-LP"
2	0	1	0	Ku-Band Linear	"KULP"
3	0	1	1	Ka-Band Linear	"KALP"
4	1	0	0	C-Band Circular	"C-CP"
5	1	0	1	X-Band Circular	X-CP"
6	1	1	0	Ku-Band Circular	"KUCP"
7	1	1	1	Ka-Band Circular	KACP"

The feed number will carry over no matter what configuration screen the user is in. So that feed "0" in the polarization calibration screen refers to feed "0" in the feed definition configuration screen. Configuration groups that will show unique values based on the feed sensed are listed below.

- Polarization Calibration
- Feed Definition (2.1.1.3.1.2.4)
- POL Angle Movement (2.1.1.3.1.3.6)
- POL Drive Parameters (2.1.1.3.1.3.7)

Refer to the mount specific appendix to determine if the RC4500 being used is equipped with the Multi-Feed Sensing option.

2.1.1.3.1.2.4   Feed Definition

```
                                        CONFIG-FEED
TYPE:0    LO:18250
BAND:4   REF:0
<0>CIRCULAR <1>SINGLE <2>DUAL
```

TYPE: **<0>CIRCULAR <1>SINGLE <2>DUAL**

The polarization type configuration item specifies the configuration of the feed. This item will be used by the controller to determine the appropriate automatic movement of the polarization axis.

Circular type specifies that no movement will be needed to align the polarization axis. No Angle information will be displayed in MANUAL mode.

Single type specifies that the feed must be moved to separate horizontal and vertical polarization positions. Angle and limit information will be displayed in MANUAL mode.

Dual type specifies that the feed can receive both horizontal and vertical polarization from a single position. Angle and limit information will be displayed in MANUAL mode.

BAND: **FEED BAND <0-C 1-KU 2-L 3-X 4-KA 5-S>**

Defines the frequency band of the associated feed. This information will be used to determine the apparent beamwidth of the system.

LO: **FEED LNB FREQ <0-30000 MHZ>**

This value defines the frequency of the associated LNB's local oscillator. This information may be used for tuning of integrated receivers.

REF: **POLARITY AT ZERO DEG <0>HORZ <1>VERT**

The polarity received by the RC4500 when the feed is positioned at 0.0 and a satellite with the same longitude of the antenna is being used.

2.1.1.3.1.2.4.1   Multi-Feed Sensing Option

This section is for the Feed Definition configuration group when the feed sensing option is available on the RC4500. See section 2.1.1.3.1.2.3.1 for more information.

```
POL#:7                                  CONFIG-FEED
TYPE:0    LO:18250   ID:KACP
BAND:4   REF:0
<0>CIRCULAR <1>SINGLE <2>DUAL
```

POL#:   **FEED INDEX NUMBER**

This is the index number for the current Feed Definition screen displayed.

ID: **POL AXIS LABEL (4 CHARACTERS MAX)**

This is an alphanumeric string used to identify the feed. When the multi-feed option is present, these will be displayed in front of the polarization angle in MANUAL mode.

2.1.1.3.1.2.5   External Sig Factors

This screen defines parameters for when the external source is used as the locate source.

```
   LOCK:1          TIME:1.0      CONFIG-EXT
  THRES:-99.9    SENSE:1


LOCK TYPE <0>NONE <1>HI <2>LO
```

LOCK: LOCK TYPE <0>NONE <1>HI <2>LO

When the locate source is set to EXT (1), this item defines whether a discrete signal lock input is required to indicate a satellite has been found.

If a signal lock input is used, it may be defined as either having a HI (>3.5 VDC) or LO (< 0.8 VDC) level that indicates lock.

TIME: LOCK TIME <0.0-10.0> SECONDS

This item defines how long the RC4500 will wait after each step before sampling signal strength. Increasing this value may be required to allow equipment such as a modem to generate an AGC output.

THRES: LOW SIGNAL THRESHOLD <-99.9-0.0 dBm>

This item specifies the signal level that the tracking function will use to determine that the signal is lost if the tracking source is set to external.

SENSE: INPUT SENSE POLARITY <0>NEG <1>POS

The polarity flag tells the RC4500 what the sense is on the signal strength input voltage. A positive sense is defined as one that increases in voltage as the signal strength increases. If the signal strength voltage decreases as the signal strength increases, its polarity is considered negative.

2.1.1.3.1.2.6   Beacon Sig Factors

This screen defines parameters for when the internal beacon receiver is used as the locate source.

```
   LOCK:1          TIME:1.0        CONFIG-BCN
  THRES:-99.9    SENSE:1


LOCK TYPE <0>NONE <1>HI <2>LO
```

LOCK: **LOCK TYPE <0>NONE <1>HI <2>LO**

When the internal beacon receiver is used as a locate source, this item defines whether a discrete signal lock input is required to indicate a satellite has been found.

For internal beacon receivers, this value is set correctly by default and should not be changed.

TIME: **LOCK TIME <0.0-10.0> SECONDS**

This item defines how long the RC4500 will wait after each step before sampling signal strength. Increasing this value may be required for noisy carriers.

THRES: **LOW SIGNAL THRESHOLD <-99.9-0.0 dBm>**

This item specifies the signal level that the tracking function will use to determine that the signal is lost if the tracking source is set to beacon.

SENSE: **INPUT SENSE POLARITY <0>NEG <1>POS**

The polarity flag tells the RC4500 what the sense is on the signal strength input voltage. A positive sense is defined as one that increases in voltage as the signal strength increases. If the signal strength voltage decreases as the signal strength increases, its polarity is considered negative.

For internal beacon receivers, this value is set correctly by default and should not be changed.

2.1.1.3.1.2.7   RF Sig Factors

This screen defines parameters for when the L-band power detector is used as the locate source.

```
                                        CONFIG-RF
     LOCK:0         THRES:-99.9

LOCK SOURCE <0-NONE 1-EXT>
```

LOCK: LOCK SOURCE <0-NONE 1-EXT>

When the tracking source is set to RF, this item defines whether a discrete signal lock input is required to indicate a satellite has been found. If a signal lock is used, it must be defined in the External Sig Factors configuration group (2.1.1.3.1.2.5).

THRES: LOW SIGNAL THRESHOLD <-99.9-0.0 dBm>

This item specifies the signal level that the tracking function will use to determine that the signal is lost if the tracking source is set to RF.

2.1.1.3.1.2.8   Location Reset

This screen allows an installed to clear all satellite and track table data from the ACU.

```
RESET CODE:              CONFIG-DEFAULTS


ENTER 12345 TO RESET <5 DIGIT CODE>
```

2.1.1.3.1.3   Super-User Access Items

This set of configuration groups allows the user to modify parameters that are not typically changed. Usually these items address parameters that have been previously characterized for the antenna the controller is paired with. The need to access these items would typically only occur if a unique customization of the system was required.

2.1.1.3.1.3.1   System Definition

```
MODE:2  ANT SIZE: 420       CONFIG-SYSTEM
        ANT LOOK:1

<2-MENU 3-MANUAL>
```

The System Definition configuration screen allows the user to indicate information about the antenna system.

MODE: <2-MENU 3-MANUAL>

This item specifies into which mode that the RC4500 will boot into.

Selection 2 will direct the RC4500 to boot in MENU mode.

Selection 3 will direct the RC4500 to boot in MANUAL mode.

ANT SIZE: ANTENNA SIZE <1-9999 CM>

This item specifies the size of the reflector in centimeters. For example, a 4.2 meter diameter reflector would require a value of 420 (cm) be specified.

The antenna size is used by inclined orbit tracking algorithms to characterize the antenna's beam-width thus affecting size and timing of various tracking movements. The value is also used by scanning and peaking algorithms to determine movements.

ANT LOOK: ANT LOOK REFERENCE <1-HIGH 0-LOW>

This item is used for antennas that have multiple feed boom configurations. For mounts that don't have multiple feed boom configuration items, this value should be set to 1.

2.1.1.3.1.3.2 Azimuth Angle Movement

NOTE: These items are critical to the antenna functioning properly and should not be changed without understanding the consequences of the changes.

```
                              CONFIG-AZ ANG
FAST/SLOW:2.500     COAST: 0.100
MAX ERROR: 0.005      TRIES: 3
FAST/SLOW THRES <0.000-10.000 DEGREES>
```

The Azimuth Angle Movement configuration screen allows the user to indicate various information about the Azimuth Axis angular movement.

FAST/SLOW: **FAST/SLOW THRES <0.000 – 10.000 DEGREES>**

This item specifies the distance from the target position where the drive speed switches from fast to slow.

MAX ERROR: **MAX ERROR <0.001-5.000 DEGREES>**

This item specifies how far away from the azimuth target position the azimuth sensor needs to be to consider a movement complete.

COAST: **COAST RANGE <0.000-5.000 DEGREES>**

This item specifies the distance from the target position where the drive will be deactivated. This value is used to let the antenna coast into position. If the distance to the target position is less than this value, the drive will be deactivated when its position is within MAX ERROR.

TRIES: **MAX NUMBER OF TRIES <0-10>**

This item specifies the maximum number of attempts which will be made to be within MAX ERROR from the target position.

2.1.1.3.1.3.3   Azimuth Drive Parameters

NOTE: These items are critical to the antenna functioning properly and should not be changed without understanding the consequences of the changes.

```
                                         CONFIG-AZ  DRV
                           JAM: 0.2            FDB: 750
                           RUN: 2.0            SDB: 500
          JAM SLOP <0.0-10.0 DEG, 0=OFF>
```

The Azimuth Drive Parameters configuration screen allows the user to set parameters for the azimuth motor drive.

JAM: **JAM SLOP <0.00 – 10.00 DEG, 0=OFF>**

This item specifies the amount of movement that must be sensed to avoid declaring a jam alarm. Setting this value too high will trigger false jams since the mount may not be able to move that far in the required interval (usually 3 seconds). Setting this value too low may allow mechanical slop to appear as movement thus never triggering a jam.

RUN: **RUNAWAY SLOP <0.00 – 10.00 DEG, 0=OFF>**

This item specifies the amount of movement that must be sensed before declaring a runaway alarm. Setting this value too low may allow position sensor noise or slight movement due to wind to trigger a runaway. Setting this value too high will take a long time to generate a runaway and risks antenna damage.

FDB: **FAST ANTI-REV DEADBAND <0 – 9999 MSEC>**
SDB: **SLOW ANTI-REV DEADBAND <0 – 9999 MSEC>**

These items specify the amount of time that the drive will wait before moving the antenna in the opposite direction. These values keep the antenna from rapidly changing direction which may cause antenna damage. The FDB is the interval if the antenna had been moving fast. The SDB is the interval if the antenna had been moving slow

2.1.1.3.1.3.4   Elevation Angle Movement

NOTE: These items are critical to the antenna functioning properly and should not be changed without understanding the consequences of the changes.

```
                                CONFIG-EL ANG
FAST/SLOW:2.500      COAST: 0.100
MAX ERROR: 0.005      TRIES: 3
FAST/SLOW THRES <0.000-10.000 DEGREES>
```

The Elevation Angle Movement configuration screen allows the user to indicate various information about the Elevation Axis angular movement.

FAST/SLOW: **FAST/SLOW THRES <0.000 – 10.000 DEGREES>**

This item specifies the distance from the target position where the drive speed switches from fast to slow.

MAX ERROR: **MAX ERROR <0.001-5.000 DEGREES>**

This item specifies how far away from the azimuth target position the azimuth sensor needs to be to consider a movement complete.

COAST: **COAST RANGE <0.000-5.000 DEGREES>**

This item specifies the distance from the target position where the drive will be deactivated. This value is used to let the antenna coast into position. If the distance to the target position is less than this value, the drive will be deactivated when its position is within MAX ERROR.

TRIES: **MAX NUMBER OF TRIES <0-10>**

This item specifies the maximum number of attempts which will be made to be within MAX ERROR from the target position.

2.1.1.3.1.3.5   Elevation Drive Parameters

NOTE: These items are critical to the antenna functioning properly and should not be changed without understanding the consequences of the changes.

```
                                    CONFIG-EL DRV
                    JAM: 0.2          FDB: 750
                    RUN: 2.0          SDB: 500
JAM SLOP <0.0-10.0 DEG, 0=OFF>
```

The Elevation Drive Parameters configuration screen allows the user to set parameters for the elevation motor drive.

JAM: JAM SLOP <0.00 – 10.00 DEG, 0=OFF>

This item specifies the amount of movement that must be sensed to avoid declaring a jam alarm. Setting this value too high will trigger false jams since the mount may not be able to move that far in the required interval (usually 3 seconds). Setting this value too low may allow mechanical slop to appear as movement thus never triggering a jam.

RUN: RUNAWAY SLOP <0.00 – 10.00 DEG, 0=OFF>

This item specifies the amount of movement that must be sensed before declaring a runaway alarm. Setting this value too low may allow position sensor noise or slight movement due to wind to trigger a runaway. Setting this value too high will take a long time to generate a runaway and risks antenna damage.

FDB: FAST ANTI-REV DEADBAND <0 – 9999 MSEC>
SDB: SLOW ANTI-REV DEADBAND <0 – 9999 MSEC>

These items specify the amount of time that the drive will wait before moving the antenna in the opposite direction. These values keep the antenna from rapidly changing direction which may cause antenna damage. The FDB is the interval if the antenna had been moving fast. The SDB is the interval if the antenna had been moving slow

2.1.1.3.1.3.6   POL Angle Movement

NOTE: These items are critical to the antenna functioning properly and should not be changed without understanding the consequences of the changes.

```
                                   CONFIG-PL ANG
FAST/SLOW:2.500      COAST: 0.100
MAX ERROR: 0.005     TRIES: 3
FAST/SLOW THRES <0.000-10.000 DEGREES>
```

The Polarization Angle Movement configuration screen allows the user to indicate various information about the Polarization Axis angular movement.

FAST/SLOW: **FAST/SLOW THRES <0.000 – 10.000 DEGREES>**

This item specifies the distance from the target position where the drive speed switches from fast to slow.

MAX ERROR: **MAX ERROR <0.001-5.000 DEGREES>**

This item specifies how far away from the azimuth target position the azimuth sensor needs to be to consider a movement complete.

COAST: **COAST RANGE <0.000-5.000 DEGREES>**

This item specifies the distance from the target position where the drive will be deactivated. This value is used to let the antenna coast into position. If the distance to the target position is less than this value, the drive will be deactivated when its position is within MAX ERROR.

TRIES: **MAX NUMBER OF TRIES <0-10>**

This item specifies the maximum number of attempts which will be made to be within MAX ERROR from the target position.

2.1.1.3.1.3.6.1   Multi-Feed Sensing Option

This section is for the POL Angle Movement configuration group when the feed sensing option is available on the RC4500. See section 2.1.1.3.1.2.3.1 for more information.

```
POL#:0                             CONFIG-PL ANG
FAST/SLOW:2.500       COAST: 0.100
MAX ERROR: 0.005      TRIES: 3
FAST/SLOW THRES <0.000-10.000 DEGREES>
```

POL#:   **FEED INDEX NUMBER**

This is the index number for the current POL Angle Movement screen displayed.

2.1.1.3.1.3.7 POL Drive Parameters

NOTE: These items are critical to the antenna functioning properly and should not be changed without understanding the consequences of the changes.

```
                                        CONFIG- PL  DRV
                        JAM:  0.2          FDB:  750
                        RUN:  2.0          SDB:  500
JAM  SLOP  <0.0-10.0  DEG,  0=OFF>
```

The Polarization Drive Parameters configuration screen allows the user to set parameters for the polarization motor drive.

JAM: **JAM SLOP <0.00 – 10.00 DEG, 0=OFF>**

This item specifies the amount of movement that must be sensed to avoid declaring a jam alarm. Setting this value too high will trigger false jams since the mount may not be able to move that far in the required interval (usually 3 seconds). Setting this value too low may allow mechanical slop to appear as movement thus never triggering a jam.

RUN: **RUNAWAY SLOP <0.00 – 10.00 DEG, 0=OFF>**

This item specifies the amount of movement that must be sensed before declaring a runaway alarm. Setting this value too low may allow position sensor noise or slight movement due to wind to trigger a runaway. Setting this value too high will take a long time to generate a runaway and risks antenna damage.

FDB: **FAST ANTI-REV DEADBAND <0 – 9999 MSEC>**
SDB: **SLOW ANTI-REV DEADBAND <0 – 9999 MSEC>**

These items specify the amount of time that the drive will wait before moving the antenna in the opposite direction. These values keep the antenna from rapidly changing direction which may cause antenna damage. The FDB is the interval if the antenna had been moving fast. The SDB is the interval if the antenna had been moving slow

2.1.1.3.1.3.7.1 Multi-Feed Sensing Option

This section is for the POL Drive Parameters configuration group when the feed sensing option is available on the RC4500. See section 2.1.1.3.1.2.3.1 for more information.

```
POL#:0                              CONFIG- PL  DRV
                        JAM:  0.2          FDB:  750
                        RUN:  2.0          SDB:  500
JAM  SLOP  <0.0-10.0  DEG,  0=OFF>
```

POL#:   **FEED INDEX NUMBER**

This is the index number for the current POL Drive Parameters screen displayed.

2.1.1.3.1.3.8 Track Factors

```
    SEARCH: 0                      CONFIG-TRACK
MAX ERROR: 3   TIME: 2
  HOLDOFF:120   LOG:0     AZDP:1.0
<0-MANUAL,1-NARROW,3-NOMINAL,10-WIDE>
```

SEARCH: **<0-MANUAL,1-NARROW,3-NOMINAL,10-WIDE>**

This field specifies the sweep width of the Intelli-Search algorithm. Setting this value too large may cause mistaken alignment on an adjacent satellite. Setting this value too small may not sweep over a region which is wide enough to find the satellite.

The search is disabled by setting the value to zero (0). The search should be disabled for transmit applications or for antennas which move very slowly.

MAX ERROR: **ENTER MAX ERROR IN TENTHS OF A dB<1-30>**

This field specifies the maximum antenna tracking error in tenths of a dB. This value determines the step sizes and the frequency of peak-up operations.

HOLDOFF: **SET PEAKUP HOLDOFF TIME <1 - 999 SECONDS>**

This field specifies the number of seconds before a track-table entry during which a peaking operation should not occur. The reason for this holdoff is to avoid a situation where a regular peak-up takes too long and the track table entry time is missed.

TIME: **SIGNAL SAMPLE TIME <2-99 SECONDS>**

This field specifies the number of seconds that will be spent sampling signal strength following each peak-up move. Increasing this value will improve the ability to determine the position of higher signal but will also make total peak-up time proportionately longer.

LOG: **<0>DISABLE <1>ENABLE**

This field is used to enable the output of diagnostic data to the ACU log system. A factory technician may request this data while troubleshooting track system performance.

AZDP: **AZ/EL DELTA FACTOR <0.5 – 1.5>**

This field specifies the step size delta factor. This value is used to compensate non-uniform antenna diameters. The default value of 1.0 will calculate steps assuming the antenna's azimuth and elevation diameters are the same. A value of 1.1 will increase elevation steps by 10% and decrease azimuth steps by 10%. A value of 0.9 will decrease elevation steps by 10% and increase azimuth steps by 10%.

2.1.1.3.1.3.9   Shake

```
AZ 1:   90.0 2: 270.0 3:    0.0 CONF-SHAKE
EL 1:   40.0 2:  30.0 3:    0.0 CYCLE:   10
PL 1:    0.0 2:   0.0 3:    0.0 DELAY:    1
MOVE 1 AZIM <0.0-360.0 DEGREES>
```

AZ #:   **MOVE # AZIM <0.0-360.0 DEGREES>**

The AZ field allows the user to specify the azimuth target for moves 1, 2 or 3.

EL #:   **MOVE # ELEV <+/-90.0 DEGREES>**

The EL field allows the user to specify the elevation target for moves 1, 2 or 3.

PL #:   **MOVE # POL <+/-180.0 DEGREES>**

The PL field allows the user to specify the polarization target for moves 1, 2 or 3.

CYCLE: **NUMBER OF SHAKE CYCLES <1-9999>**

The CYCLE field allows the user to specify the total number of movement cycles the SHAKE function will perform.

DELAY: **DELAY <0-999 SECONDS>**

The DELAY field allows the user to specify the amount of time (in seconds) that the SHAKE function will wait between "moves". Specifying a value of 0 will cause no delay between "moves".

2.1.1.3.1.3.10 Location Reset

```
RESET CODE:                    CONFIG-DEFAULTS



ENTER 12345 TO RESET <5 DIGIT CODE>
```

The Location Reset screen is used to clear out all satellites and track tables currently stored in the controller's memory. To reset the location, the user must key in the 5-digit code listed on the 4th line followed by the <ENTER>.

2.1.1.3.1.3.11 Reset Defaults

```
RESET CODE:                    CONFIG-DEFAULTS



<5 DIGIT CODE>RESET TO FACTORY DEFAULTS
```

The Reset Defaults screen is used to reset the controller's memory. To reset the system memory, the user must key in a 5-digit code followed by the <ENTER> key.

There are two levels of resets that are possible.

1. A first level reset clears NVRAM values including the current selected satellite, the saved position, stored satellite data, and track table data.

2. The full reset clears the NVRAM data and resets all FLASH configuration values to default values.

NOTE: The first level access code is "12345". The full reset code is the same as the INSTALL level Expert Access code given in Appendix A. This appendix may have been removed by a system manager to limit use of the codes.

2.1.1.3.2   <u>Maintenance Items</u>

```
1-VOLTS    2-DRIVE   3-TIME          MAINT
4-LIMITS   5-COMMS
8-MOVETO   0-SHAKE              <>-BCN
^-SNS OFF                       .-SYS INFO
```

2.1.1.3.2.1   VOLTS

The VOLTS maintenance screen shows the current voltage levels sense at the microcontroller's analog to digital inputs. As there are too many input channels to show on one screen, the user is prompted to choose either the 10-bit resolution voltages or the 12-bit resolution voltages.

```
<1>10 BIT ADC VOLTAGES       AD VOLTAGES
<2>12 BIT ADC VOLTAGES


```

There are four 12-bit resolution channels that read values from the azimuth, elevation and polarization sensors along with a higher resolution receiver channel. These values will be of more interest during system calibration.

The eight 10-bit resolution channels deal with other sensors such as the L-band power detector, internal temperature sensor, etc.

2.1.1.3.2.1.1   10 Bit ADC Voltages

The 10 BIT ADC maintenance screen shows the current voltage levels sensed at the microcontroller's eight 10-bit resolution analog to digital inputs. The voltage will be displayed in the 0.000 to 5.000 range. If the microcontroller sees less than 0.001, it will display "UNDER".

Next to the scaled voltage will be the current analog to digital "count" (0 to 1023).

```
1- SAC:1.423   441   5-  RF:1.971   611 ADC
2-TEMP:3.277  1016   6-SPAR:1.571   487  10
3-REC3:1.548   480   7-DRIV:1.571   487 BIT
4-REC2:0.000     0   8-BATT:3.187   988
```

1-SAC: Single Axis Compass (Optional)

2-TEMP: Optional off-board temperature sensor

3-REC3: External receiver AGC voltage from options board

4-REC2: Not currently used

5-RF: Voltage from options board L-band power detector

6-SPAR: Not currently used

7-DRIV: Drive current sensing feedback

8-BATT: Microprocessor backup battery voltage

2.1.1.3.2.1.2   12 Bit ADC Voltages

The 12 BIT ADC maintenance screen shows the current voltage levels sensed at the microcontroller's four 12-bit resolution analog to digital inputs. The voltage will be displayed in the 0.0001 to 5.0000 range. If the microcontroller sees less than 0.0001, it will display "UNDER".

Next to the scaled voltage will be the current analog to digital "count" (0 to 4095).

Note that the EL and SIG analog to digital channels have some associated scaling and conditioning circuitry in the RC4500. Therefore, the voltages seen at this screen may not be exactly the same as the input voltages external to the RC4500.

```
AZ:  2.5421   2083   30495        12 BIT ADC
 EL: 1.4567   1193   32409              L1:0
POL: 2.5000   2048                      L2:0
SIG: 3.3358   2732                      L3:1
```

AZ:

Shows the current voltage from the azimuth potentiometer, the current A to D counts for the azimuth potentiometer, and the azimuth resolver count (if equipped). If the potentiometer is not present on the system, UNDER will be displayed.

EL:

Shows the current scaled voltage from the elevation inclinometer, the current A to D counts for the elevation inclinometer, and the elevation resolver count (if equipped).

POL:

Shows the current voltage from the polarization potentiometer, the current A to D counts for the polarization potentiometer, and the polarization resolver count (if equipped). If the potentiometer is not present on the system, UNDER will be displayed.

SIG:

Shows the scaled AGC voltage from the computing and interface board's "Receiver" port.

L1:

Shows the state of the lock input from the computing and interface board's "Receiver" port.

L2:

Shows the state of the lock input from the options board's "Receiver" port.

L3:

Not currently used on the RC4500.

2.1.1.3.2.2   DRIVE

```
1-AZIM:JAMMED                    DRIVE RESET
2-ELEV:RUNAWAY
3- POL:OK
<1-3> RESET AXIS                 <MODE>EXIT
```

The DRIVE maintenance screen provides the way to reset drive system errors (FOLLOW/DRIFT/DRIVE) for each axis. See section 4.1.2 for descriptions of these conditions. An axis' drive status may be reset by pressing the corresponding key.

2.1.1.3.2.3   TIME

The TIME maintenance screen allows the user to set the system and display time.

Note that all dates are displayed and entered in month/day/year (MM/DD/YY) format. All times are displayed and entered in hour/minute/second (HH:MM:SS) format. Refer to section 2.1.1.1.3 for instructions on entering date and time.

```
 SYSTEM:12/25/18 13:28:50             TIME
DISPLAY:12/25/18 13:28:50        ZONE:UTC
GPS UTC:12/25/18 13:28:50     OFFSET:   0
1-DATE/TIME 2-ZONE 3-OFFSET 4-GPS SYNC
```

SYSTEM:DD/MM/YY HH:MM:SS

Current date and UTC time as maintained by the RC4500's real-time clock. This time is used for all time-based tracking and peaking operations, as well as for calculating sidereal time for track table points.

DISPLAY: DD/MM/YY HH:MM:SS

Current time that will be displayed in several screens (MANUAL, MENU). This time is offset from the system time by the OFFSET number of hours described later.

GPS UTC: DD/MM/YY HH:MM:SS

Universal Coordinated Time (UTC) from the optional GPS if valid time data is being received. If valid time data is not being received, a GPS status message is displayed:

GPS OFFLINE - no serial data from GPS is being received.

WAITING FOR GPS - serial data is being received from GPS but data indicates an accurate time solution cannot be guaranteed.

NO GPS PRESENT - The GPS present configuration item has been set to indicate that a GPS receiver is not installed.

ZONE:

A three-character alphanumeric time zone string the user may customize for displaying during the MANUAL and MENU modes. This string may be changed by selecting action 4-ZONE.

OFFSET:

The number of hours the displayed reference time is offset from system time.

The values for the time parameters may be altered by the actions described below.

1-DATE/TIME   ENTER UTC DATE (MM.DD.YY)/ENTER UTC TIME (HH.MM.SS)

This action allows the user to manually set the system date and time. The prompt indicates that the / delimiter for date is entered by using the (decimal point) key.

2-ZONE   ENTER 3 LETTER TIME ZONE

The user may enter three alphanumeric characters (ex. CST) for a time zone designator.

3-OFFSET   ENTER TIMEZONE OFFSET <-11/+12 HOURS>

The user may enter the number of hours of offset from system time for offsetting displayed time.

4-GPS SYNC

If valid GPS UTC data is being received, pressing the <4> key will cause system time to be synchronized with the current GPS UTC time.

2.1.1.3.2.4   LIMITS

The limits maintenance screen shows the current state of each limit switch as sensed by the RC4500's microcontroller. The state of each limit is shown as 0 (not at limit), 1 (at hardware limit), or 2 (at software limit). The limits maintenance screen will show the state of the input, even if the input is not used by the software.

```
AZIM CW:0 CCW:0 STOW:1 R:0 G:0     LIMITS
ELEV UP:0  DN:0 STOW:0             ACTIVE
 POL CW:0 CCW:0 STOW:0 A:0 B:0 C:0 D:1
<BKSP>MAKE LIMITS INACTIVE    <MODE>EXIT
```

The limits maintenance screen also shows the status of:

R: Red Button (Stow)

G: Green Button (Locate)

A, B, C, D   Auxiliary switch inputs, most used as POL ID BITs (2.1.1.3.1.2.3.1)

<BKSP>MAKE LIMITS INACTIVE   <MODE>EXIT

From this screen the user may inactivate software logic that prevents axis movement due to a limit switch by pressing the BKSP switch. **Note that inactivating limits should be done with caution. Whenever limits are "INACTIVE" the alarm system will flash the following:**

** WARNING – LIMITS INACTIVE **

The limit switch logic may be returned to "ACTIVE" by pressing BKSP again.

No automatic movements are possible with the limits in an inactive state.

2.1.1.3.2.5   COMMS

This screen allows the user to ascertain if the GPS sensor is communicating correctly with the RC4500.

```
<1>VIEW GPS DATA                     COMMS


```

2.1.1.3.2.5.1   GPS Data

Pressing the <1> key allows the user to ascertain if the GPS receiver is communicating correctly with the RC4500.

```
<BKSP> TO FREEZE DISPLAY       GPS COMMS
7E  $GPRMC,233723,A,3857.3305,N,09445.26
00,W,000.0,000.0,171218,002.1,E*6B  $GPG
GA,233723,3857.3305,N,09445.2600,W,2,10,
```

The screen shows the raw ASCII data coming from the GPS receiver. If there is correct communication established with the GPS, somewhere in the lines of displayed characters the strings "GPRMC" and/or "GPGGA" should be recognizable. GPRMC and GPGGA are names of data sentences defined by the NMEA-0183 standard. These two sentences are transmitted once a second by the GPS receiver.

$GPRMC,233723,A,3857.3305,N,09445.2600.W.000.0,000.0,171218,002.1,E*6B

NOTE: In the second field beyond the GPRMC string there will be either an "A" or a "V". "A" indicates that the GPS receiver is generating a valid navigation solution. "V" indicates conditions aren't correct yet for calculating a navigation solution. This latter condition may indicate that the GPS receiver does not have a good enough view of the sky or that the receiver has not been powered on long enough to generate a solution. Under normal conditions the receiver should generate a solution within 2 minutes of powering on. If the unit has not been powered on for a long time and/or the receiver has been moved a considerable distance from its last known location, the "time-to-first-fix" may be up to 4 minutes.

If no characters are being received from the GPS, the message "INITIALIZING GPS" will remain on line 4 of the display. Normally this message will go away within 3 seconds of entering this mode.

2.1.1.3.2.6   MOVETO

The MOVETO mode is intended to provide an easy way to move the antenna to a certain position for doing testing such as cutting antenna patterns. This mode is also useful for tuning up automatic movements.

```
AZ: 204.93 ( 204.93) <0>SPD:FAST   MOVETO
EL:  41.39 (  41.39) <5>SENSOR:ANGLE
PL:  45.00 (  45.00) <6>LON:
<1>SET AZ <2>SET EL <3>SET POL  <4>START
```

The current azimuth, elevation, and polarization angles are displayed. When the mode is first entered, the current positions shown are the target positions. New target positions can be selected for azimuth, elevation, and polarization by pressing the <1>, <2>, or <3> key respectively. After setting target positions and setting the desired speed, the automatic movement may be initiated by pressing the <4> key.

<0> SPEED:FAST

The state of this field when this mode is entered will be "FAST". This means that any move will be using the standard speed control of the ACU. When the <0/Speed> key is pressed, this field will change to "SLOW". This means that the move will never go faster than the slow speed set in the "DRIVE PARAMETERS" configuration screen corresponding to the axis being moved.

<5>SENSOR:ANGLE

The state of this field when this mode is entered will be "ANGLE". This means that all the movements requested will occur in angles. When the <5> key is pressed this field will change to "COUNT". This means that all movements requested will occur in counts.

<6>LON:

This field allows the ACU to auto calculate AZ/EL/PL targets based on a satellite orbital slot and the location of the antenna.

2.1.1.3.2.7   SHAKE

The SHAKE mode performs repetitive mount movements. The SHAKE mode is for support of mount testing and for automatic mount demonstrations such as trade shows.

The SHAKE mode implements a repetitive sequence of three "moves". Each "move" is programmed with azimuth, elevation and polarization targets. Moves # 1 and 2 proceed in the order elevation, polarization and azimuth. Move # 3 proceeds in the order of azimuth, polarization and elevation to accommodate a "stow-like" sequence.

```
AZ 1: -40.0 2:  50.0 3:   0.0       SHAKE
EL 1:  30.0 2:  40.0 3: -75.0 CYCLE: 100
PL 1: -10.0 2:  10.0 3:   0.0 DELAY:    5
<1>START <CONFIG MENU>MODIFY  <MODE>EXIT
```

This opening screen shows the programmed values for the SHAKE mode. The azimuth (AZ), elevation (EL) and polarization (PL) targets for each of the three "moves" is displayed. Also displayed is the programmed number of movement CYCLES to accomplish and the time in seconds to DELAY between each "move". The pattern the above move targets describe is shown in the following figure.
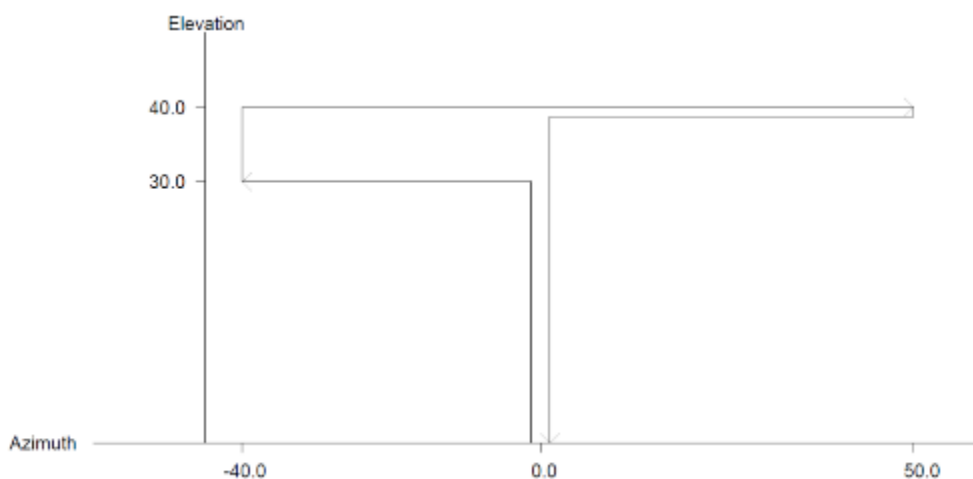
The programming of the targets, cycles and delay is accomplished via the SHAKE configuration screen (2.1.1.3.1.3.9). To initiate the SHAKE sequence, press the <1> key. If you wish to modify the SHAKE parameters go to the CONFIG-SHAKE mode. To exit out of SHAKE press the <MODE> key.

When SHAKE is started the following screen appears:

```
AZIM:   28.1 (   90.0)             SHAKE
ELEV:   40.0 (   30.0)
 POL:  -13.8 ( -10.0)     CYCLE:   1/ 100
SHAKE  RUNNING...    <STOP>HALT <MODE>EXIT
```

As each axis moves its header (AZIM, ELEV, POL) flashes and the current position is updated. The CYCLE field shows the current cycle / total cycles. When the SHAKE function is delaying between moves, "DELAY" is displayed.

Movement may be stopped at any time by pressing the <STOP> or <MODE> keys.

2.1.1.3.2.8   BCN

If the controller is equipped with an optional beacon receiver, pressing the <ENTER> key from the maintenance mode enters the beacon receiver maintenance screen. This screen is provided to manually control the beacon receiver, during diagnostic procedures. When entering the screen, the user is presented with the screen below.

```
az:  204.9 RF:-50.7 SS:-51.6 L         BCN
el:   41.5 ^-ATT: 0 .-AUTO  7-FR:20199.80
pl:   45.0 v-MOD:CW              LO:18250.00
<5,9,.,<>>TUNE BEACON       9-IF: 1949.80
```

Manual Antenna Control

Azimuth, elevation, and polarization angles as well as limit status are shown in the upper left corner of the display. The antenna may be moved as if it is in the MANUAL mode (2.1.1.2.1).

7-FR   RF <xxxxx.yy> MHz

This field allows the user to enter the actual frequency of the satellite's beacon. When the frequency is entered, the IF frequency will be derived from the LO frequency. The resulting IF frequency is displayed in the IF field. The beacon receiver will then be tuned to that IF frequency.

9- IF: IF <940.00-2150.00> MHz

This field allows the user to enter the intermediate frequency of the satellite's beacon. When the frequency is entered, the RF frequency will be derived from the LO frequency. The resulting RF frequency is displayed in the FR field. The beacon receiver will then be tune to the IF frequency.

.-ATT: ATTENUATION <0-40> dB

This field allows the user to change the input attenuation of the beacon receiver. Press the <STOP> key to enter this field. Pressing the <SCROLL UP> key from the beacon maintenance screen will cause the controller to auto attenuate the beacon receiver.

v-MOD: CW or BP

The <ENTER> key may be pressed to toggle the beacon receiver's demodulation mode between continuous wave (CW) or BPSK (BP) settings.

This setting is ignored if the beacon receiver being used does not support BPSK beacons.

LO: xxxxx.yy MHz

This field indicates the current LO frequency as defined in the feed definition configuration screen (2.1.1.3.1.2.4).

SS: -51.6 L

This field indicates the current signal strength and lock status from the beacon receiver.

RF: -50.7

This field indicates the current signal strength from the L-Band power detector.

2.1.1.3.2.9   SNS OFF

Pressing the <Scroll Up> key from the maintenance menu enters the sensor offset maintenance screen. This screen allows sensor offsets to be calculated and set for the on-axis position sensors

```
          TRUE        RAW        REF        SNS  OFF
az:  204.93     32.55     180.00    (  -7.61)
el:   45.00     26.96     180.00    (  18.03)
<1-AZ,3-EL>REF  <5>LON  <7-AZ,9-EL>OFFSET
```

The following list describes each column:

TRUE: The angles in this column are the same angles that will be displayed in all other controller modes. These angles are raw sensor angles plus the sensor offset. The azimuth angle is the true heading. The elevation angle is the RF-look angle above the horizontal.

RAW: The angle displayed is the actual resolver angle plus an automatic offset of -180.00 degrees. This automatic offset keeps the resolver centered within its dynamic range. This angle can be from -180.00 degrees to +180.00 degrees.

REF: The angles in this column are user-defined reference angles. These can be set directly by selecting <1>AZ or <3>EL and entering a value. These angles can also be calculated by selecting <5>LON and entering a satellite longitude.

SNS OFF: The angles in this column are the current sensor offset angles.

The antenna can be jogged while in this mode.

2.1.1.3.2.10 SYS INFO

Pressing the <.> button from the maintenance mode screen enters into the system information maintenance screen. This screen displays various system and software information.

```
Serial Number: 1001          SYSTEM INFO
Firmware: RC4500-YA-NPITN
Version:3.10.47
Lat:38.9555N Lon:94.7543W      <MODE>EXIT
```

Serial Number:

Serial number of the current controller being used. This is programmed at the factory.

Firmware:

Current firmware that is installed on the controller. It includes the controller identifier (RC4500), the type of antenna (YA), and the software options (NPITN).

Version:

The current version of the software. The version number of the software is increased for the implementation of significant software improvement or changes.

Lat:38.9555N Lon:94.7543W

The antenna location stored in the ACU memory.

2.1.2   Graphical User Interface Software Overview

The Graphical User Interface to the ACU can be accessed by navigating to the IP address of the controller using a web browser. The default IP address of the ACU is 192.168.1.1

2.1.2.1   Graphical User Interface Main Page

The main page contains all important information about the status of the RC4500 as well as the antenna. The main page offers easy access to automatic operations needed for daily use (Recall/Peak Up/Move To), and manual jog control of the antenna. Sub-menus will be displayed when there is additional information that needs to be displayed or retrieved from the user.

2.1.2.1.1   ACU Status Window

The ACU status window shows current information about the RC4500 and any satellite information that may be available.

STEP TRACK: WAITING FOR NEXT PEAKUP...
SATELLITE:WB-1   LON:111.1°W   BAND:Ka   BCN   FREQ:20199.00 MHz
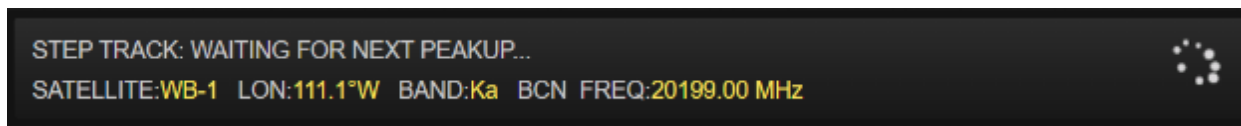
Any alarms that are currently present will also display in the ACU status window box. In the image below, the standby alarm is displayed. Note that the box will also turn red when an alarm is present.

ANTENNA IN STANDBY - DRIVES INACTIVE
SATELLITE:WB-1   LON:111.1°W   BAND:Ka   BCN   FREQ:20199.00 MHz
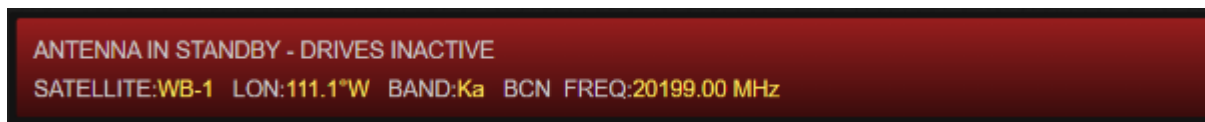
2.1.2.1.2   Antenna Position Display

The antenna position display at the bottom of the page shows the current status of the Azimuth, Elevation and Polarization axis. The information is displayed both numerically and graphically. These positions are updated continuously during all operations.

If the antenna was at a limit, the limit would show inside of the smaller box.

2.1.2.1.3   Local Jog Control

The bottom right side of the main page provides a keypad for manual jog control of the antenna. The keys provide the ability to jog the antenna in azimuth, elevation, and polarization. It also provides the ability to move to the preset H and V positions, as well as providing the ability to move the feed a preset 90° to cross pol.

The keypad also provides the ability to change the speed via a Fast/Slow button. The button will always highlight the speed that the next jog is going use. In the image below, the next jog is set for Fast speed.

The keypad also provides a <STOP> key. This key can be used during any automatic movement to stop the current operation.

2.1.2.1.4   Main Display Window

The center section of the display can be used for multiple functions. These include displaying the satellite arc, spectrum analyzer display, tracking diagnostics, and many additional antenna specific functions.

2.1.2.1.4.1   Satellite Arc Display

The center section of the display is used to display the satellite arc of the current satellites stored in the controller memory.
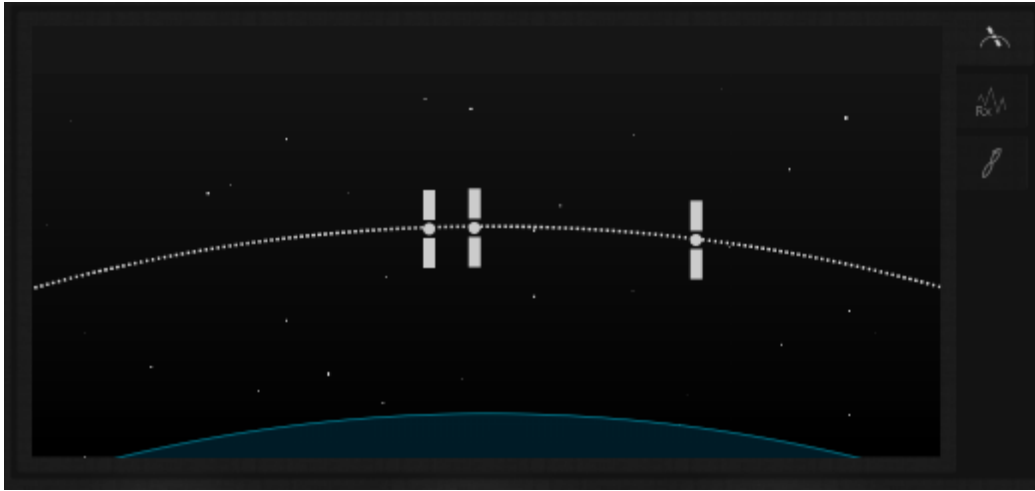
When 'hovering" over a satellite with a mouse, information for that satellite preset will be displayed in the upper portion of the window as shown below. Clicking on a satellite will start a RECALL automatic movement as described in section 2.1.1.2.2.2.
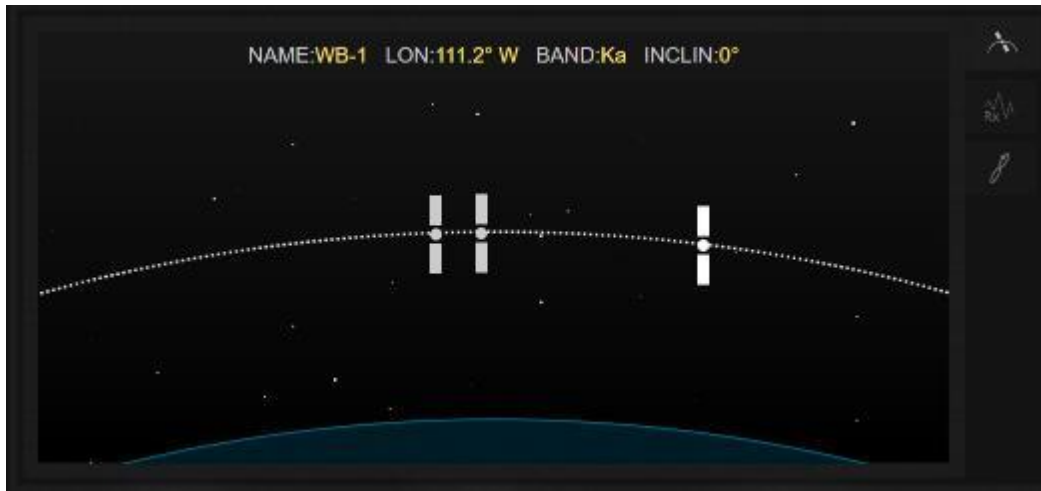
2.1.2.1.4.2   Spectrum Analyzer Display

If the ACU is equipped with the spectrum analyzer option, a button will be available on the left side of the main display that will allow you to switch to the spectrum analyzer display.

The Spectrum Analyzer functional window consists of the spectrum display on the left side and spectrum analyzer controls on the right side.

The spectrum display with 10 by 10 graticule, shows the start frequency center frequency and stop frequency beneath, all in MHz.

The right side of the spectrum display shows the graticular amplitude levels. The controls on the right side of the window are Frequency, Amplitude, Bandwidth, and Marker.

2.1.2.1.4.2.1   Frequency Controls
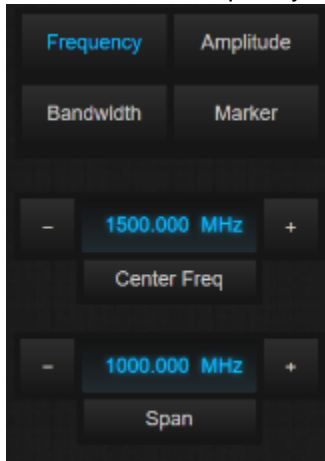
The Frequency control allows the Center Frequency and Span to be controlled. Both parameters may be incremented by using the + - keys. The Increment for Center frequency is 1/5th of one division. Additionally, the center frequency may be adjusted by direct entry in the numeric window. Center Frequency can be adjusted to be anywhere within the range of 950 to 2150MHz. The allowable spans are:

0.000 MHz, 0.010 MHz, 0.020 MHz, 0.050 MHz, 0.100 MHz, 0.200 MHz, 0.500 MHz, 1.000 MHz, 2.000 MHz, 5.000 MHz, 10.000 MHz, 20.000 MHz, 50.000 MHz, 100.000 MHz, 200.000 MHz, 500.000 MHz, 1000.000 MHz, and 1100, MHz.

Span is sometimes adjusted automatically based on changed in center frequency.

2.1.2.1.4.2.2   Amplitude Controls
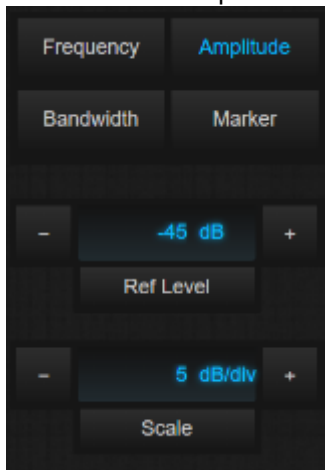
The Amplitude control allows the Reference Level and Vertical Scale (dB/division) to be adjusted. Again, both controls are incremented/ decremented via the + - buttons. The allowable values for Scale are 1, 2, 5, and 10 dB per division. The Reference Level increments by the amount a dB currently used in the dB/div field. For example, if the scale is set to 5 dB/div, the reference level will be incremented in 5 dB steps and can also be directly entered. The allowable Reference Level range is -70 to 0dB.

2.1.2.1.4.2.3   Bandwidth Controls
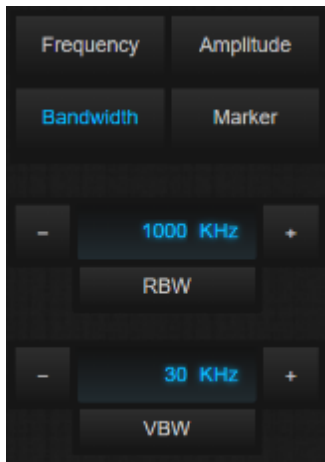
The Bandwidth Controls allows the Resolution Bandwidth (RBW) and Video Bandwidth (VBW) to be seen. The Resolution Bandwidth can be adjusted to:

30 KHz, 10 KHz, 30 KHz, 100 KHz, 300 KHz, and 1000 KHz.

The Video Bandwidth can be adjusted to:

300 Hz, 3 KHz, 30 KHz, and 300 KHz.

70

2.1.2.1.4.2.4   Marker Controls
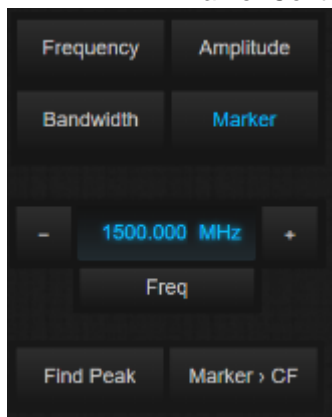
The Marker controls allows the position of the marker on the spectrum to be controlled. The Marker is designated by a red mark with a dotted line running to the vertical scale on the right. The Marker Level is displayed to the left of the red mark on each sweep. The Marker Frequency is displayed in the Freq. window. The Marker Frequency can be set by direct entry or using the + - buttons to increment by 1/5th of a frequency division.   The Find Peak Button positions the Marker on the highest level visible on the current sweep. The Marker -> CF changes the Center Frequency of the span to that of the Current Marker.

2.1.2.1.4.3   Tracking Diagnostic
When in the TRACK mode, the tracking diagnostic tab shows information about the current pointing position, track table points, and the last 2 minutes and 30 seconds of signal strength data.
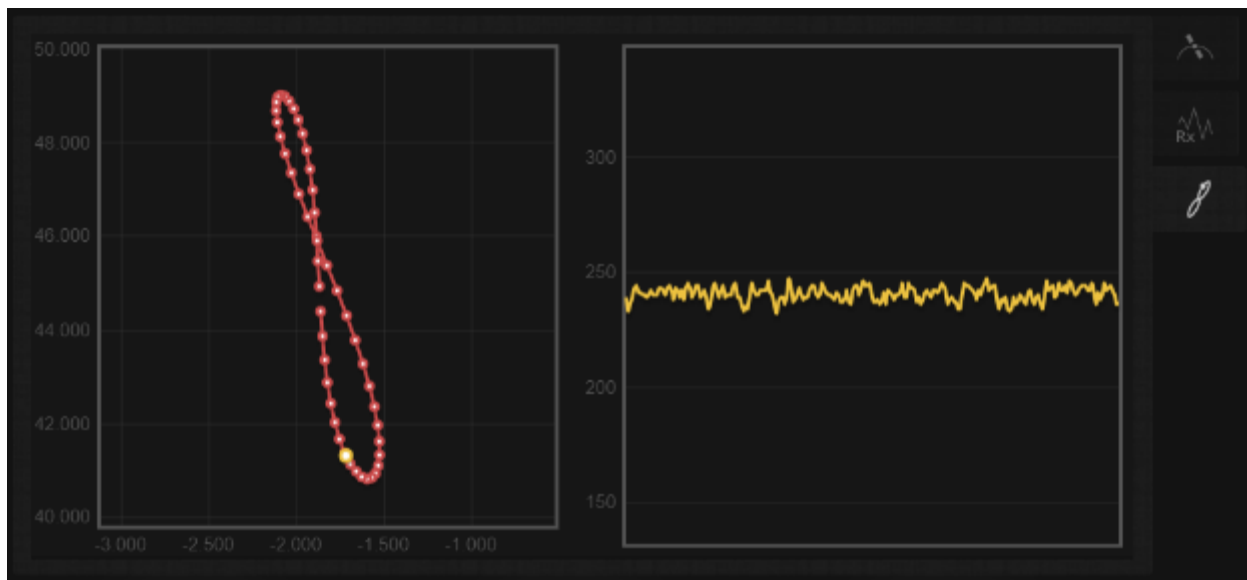
In the image above, the left box shows the current pointing angles in azimuth and elevation (yellow dot), and the track table points (red dots) and the path that the ACU will take between points.

The box on the right shows a graphical representation of the last 2 minutes and 30 seconds of signal strength.

The range on the vertical axis for both boxes, and the horizontal axis for the left box will adjust as needed to accommodate the data that is being displayed.

2.1.2.1.4.4 System Faults

The System Faults tab shows the status of each axis. In the image below, no faults are shown for any axis.
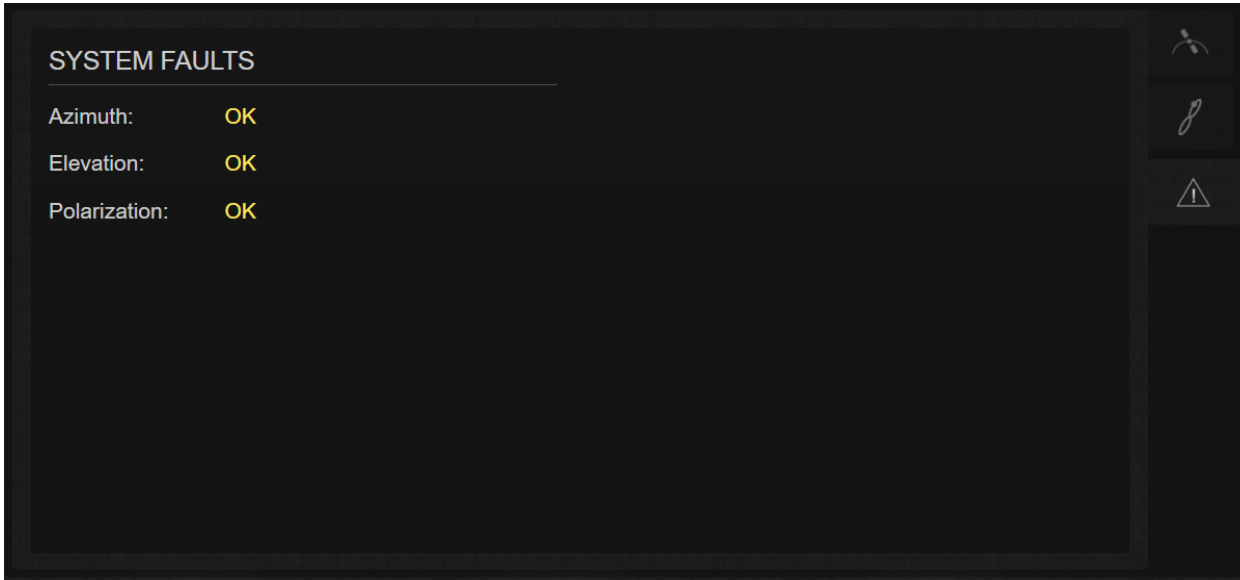
When a fault occurs, the fault will be displayed on the ACU status window and on the system faults page. If multiple faults occur, the System Faults tab will allow you to independently see faults for each axis.
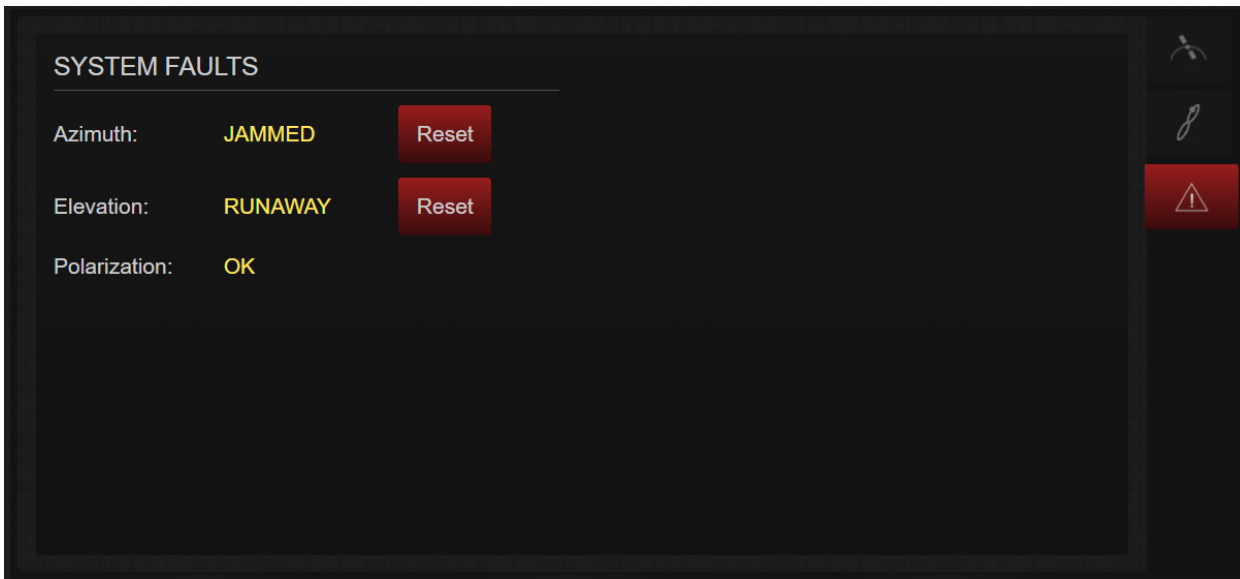

When an axis fault is present, the tab will turn red, and a Reset button will appear for each axis with an alarm. Clicking any of the reset buttons will clear all alarms.

2.1.2.1.5   Automatic Operations

Down the left side of the display eight boxes that provide various automatic operations for the ACU. Each of those functions are described in the corresponding section below.

2.1.2.1.5.1   Setup
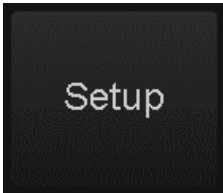
Operation of this function from the GUI is currently under development. Check back with the manufacturer for details on availability.

2.1.2.1.5.2   Recall
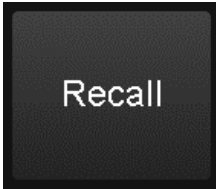
The <Recall> button allows the user to enter the RECALL mode (2.1.1.2.2.2). After clicking the <Recall> button, the user is presented with a list of satellites stored in memory. Selecting one of the satellites in the list will begin a recall operation. If the antenna is equipped with a linear feed, a box to select the receive polarization will also be presented.
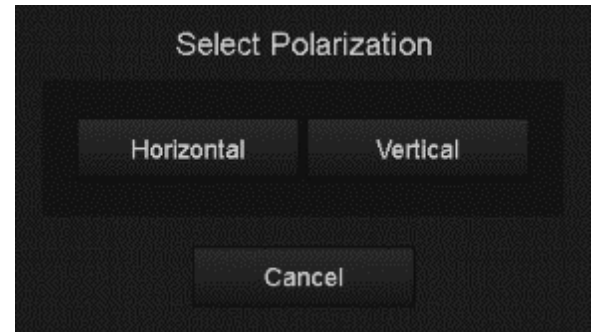
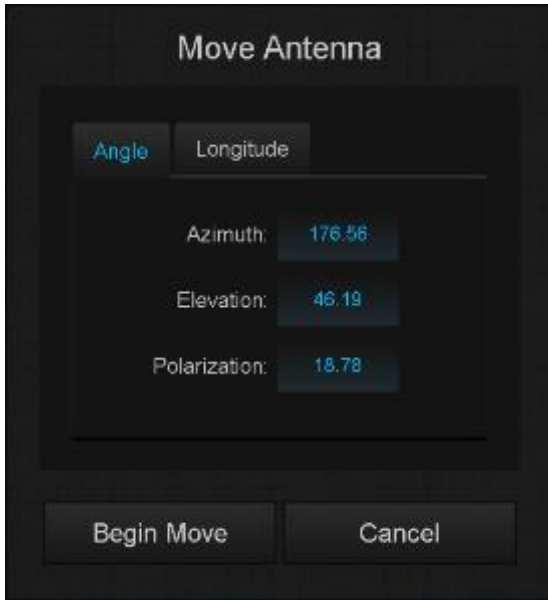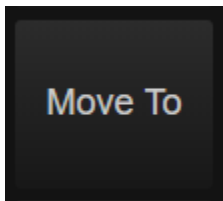Clicking the <Cancel> button at any time will return to the main page.

2.1.2.1.5.3   Delete
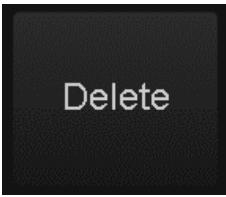
Operation of this function from the GUI is currently under development. Check back with the manufacturer for details on availability.

2.1.2.1.5.4   Peak Up
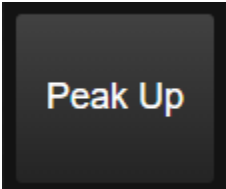
The <Peak Up> button immediately performs a Peak Up (2.1.1.2.2.8) using the currently selected signal source (2.1.2.1.6).

2.1.2.1.5.5 Move To

The <Move To> button allows the user to move the antenna to a specified azimuth, elevation,

and polarization angles. After clicking the <Move To> button, the user will be presented with a dialog box to enter azimuth, elevation, and polarization angles.

Additionally, by clicking the Longitude tab, the user can command the ACU to calculate the pointing angles for a specific longitudinal slot.
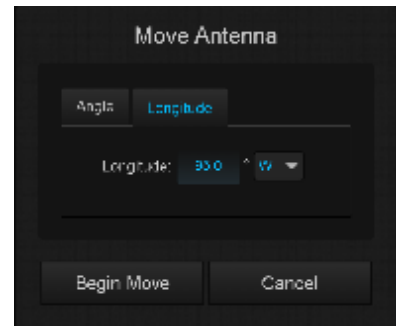
After entering the desired values, clicking <Begin Move> will begin an automatic movement to the specified position.

Clicking <Cancel> will return the user to the main page.

2.1.2.1.6   <u>Signal Strength and Transmit Status</u>

On the right side of the main display are two bars for signal strength, and two icons that indicate transmit and satellite status.

The left signal strength value will always display signal strength coming from the L-Band power detector. In addition to the graphical representation, the numeric value of the signal strength is displayed at the bottom.

The right signal strength value is the current signal strength source being used by the RC4500 for tracking and peaking.

It can be toggled between, BCN (Beacon Receiver), RF (L-Band Power), and EXT (External AGC). If the signal strength source being used supports a lock input, the green "LOCKED" box will show at the bottom of the graphical signal strength when the receiver is locked.

The indicator shown below indicates that the antenna is in a state where it is OK to transmit. When moving or at the down limit, the indicator will be grayed out.
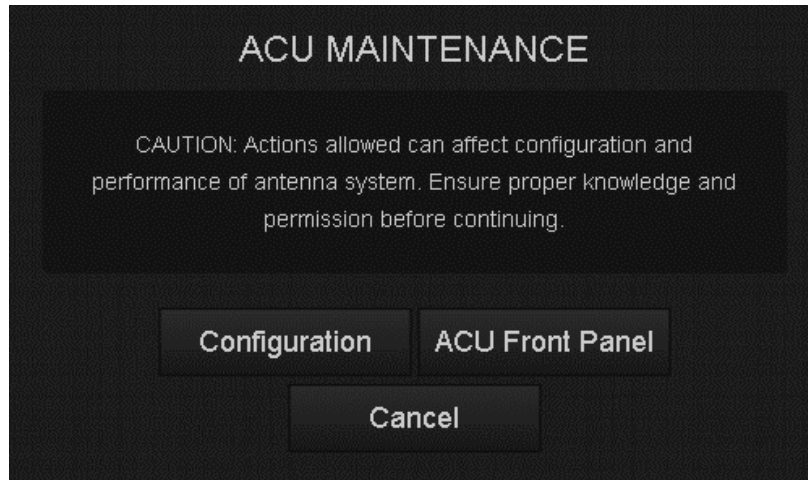
The indicator shown below indicates that the ACU is currently on satellite.
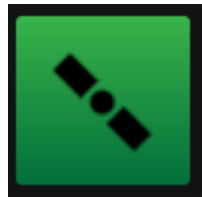
2.1.2.1.7   <u>Maintenance</u>

Clicking on the wrench and screwdriver in the upper right hand corner of the main page will open the dialog box below. This dialog box will allow you to access the remote front panel interface (2.1.1) and the configuration web page (2.1.2.2).

ACU MAINTENANCE

CAUTION: Actions allowed can affect configuration and performance of antenna system. Ensure proper knowledge and permission before continuing.

Configuration   ACU Front Panel

Cancel

2.1.2.2   Configuration Page

The main configuration page for the ACU is available by navigating a web browser to the IP address of the controller /config (192.168.1.1/config). Upon entry to the configuration page, the System Summary tab is selected by default.
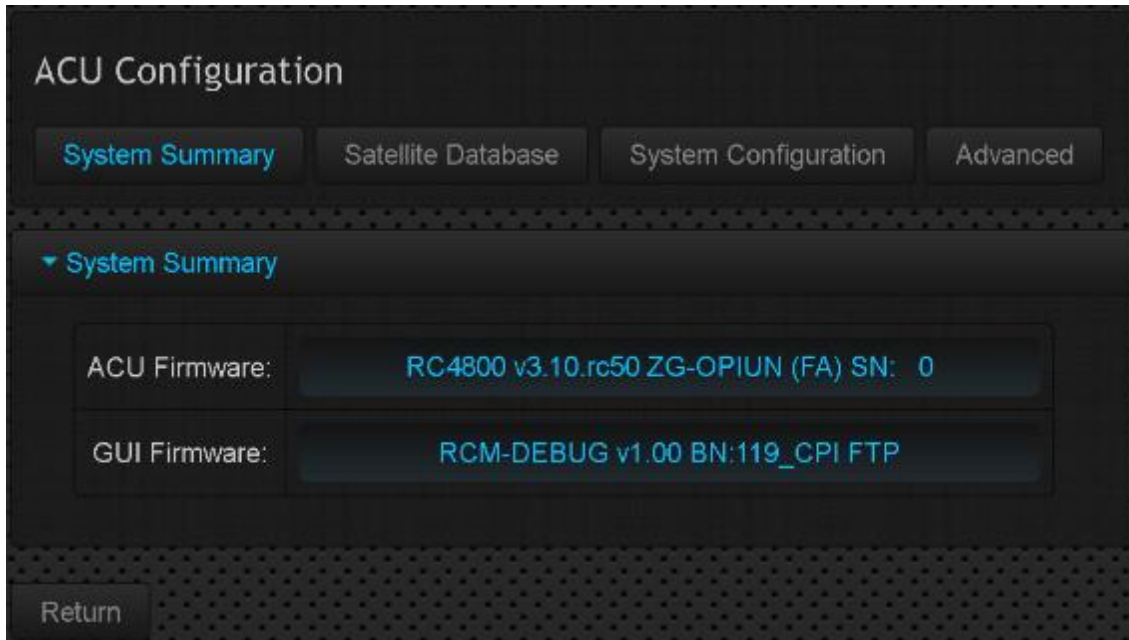

The System Summary tab will provide you with the current software on the ACU, as well as the serial number for the controller. At the bottom of the window is a <Return> button. Clicking this button will always return the user to the main page of the GUI (2.1.2.1).

Three additional tabs are available in addition to the System Summary. Each of these tabs is described in detail in the sections below.

2.1.2.2.1   <u>Satellite Database</u>

The Satellite Database tab gives the user to edit information about the satellites stored in memory. Each satellite entry can be expanded individually. The following screen shows an example of a satellite list with 3 stored satellites.
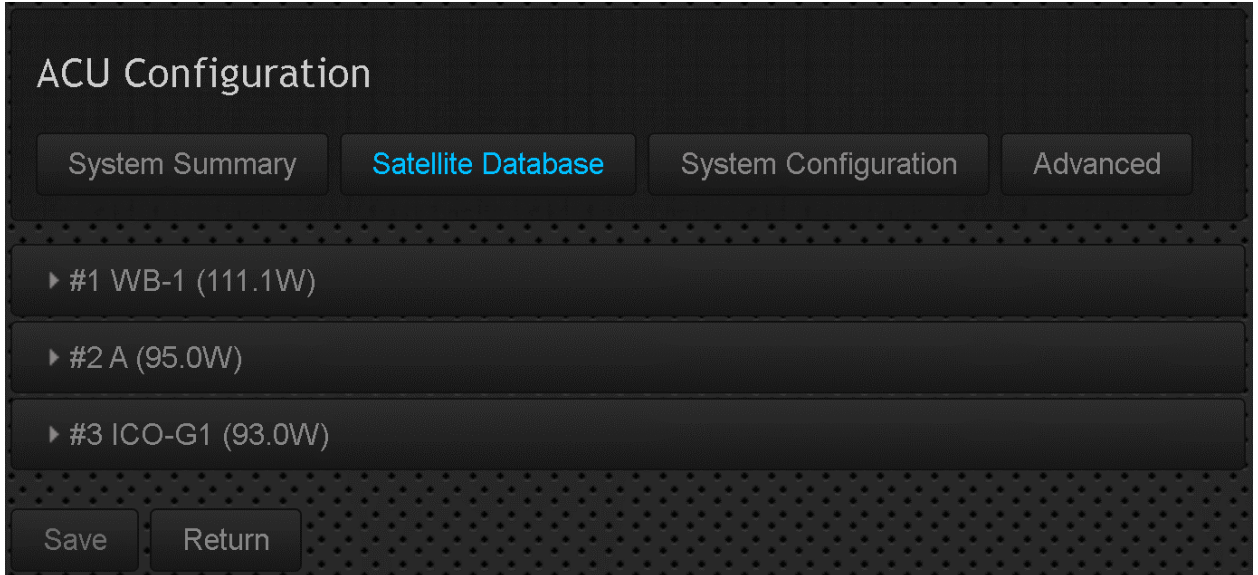
At the bottom of the screen there is a <Save> button in addition to the <Return> button. The <Save> button will become active anytime the webpage detects that information about a satellite has changed. If the <Save> button is not clicked after changing the satellite information, the database will not be updated.

2.1.2.2.1.1   Satellite Configuration

Clicking on a satellite in the database will expand the satellite to show additional fields. All fields in the satellite dropdown are editable by typing on a keyboard. Additionally, the Two-Line Element data can be copied and pasted into the window.

The satellite configuration window allows the user to set the items configured during the SETUP mode (2.1.1.2.2.1) and that are found in the following configuration screens:

- Beacon Detection Points (2.1.1.3.1.1.2)
- TLE 1 Data (2.1.1.3.1.1.3)
- TLE 2 Data (2.1.1.3.1.1.4)

After adjusting the desired parameters for the satellite ensure that the <Save> button at the bottom of the page is clicked prior to any further operations.

In addition to setting parameters, the satellite dropdown also allows the user to view the track table basepoints in a .xml format or download the table to a comma separated data file.

2.1.2.2.2   System Configuration

The System Configuration tab allows the user to modify various information about the ACU.

2.1.2.2.2.1   ACU Configuration

The ACU configuration window allows the user to adjust information about the current feed that is being used. For systems that have the multi-feed sensing system (0), there may be additional antenna specific feed configuration items available here. Consult the mount specific appendix for more information on these.

2.1.2.2.2.2   GUI Configuration

The GUI Configuration window allows the user to adjust the IP characteristics of the controller. If changes are made to any of these setting a reset of the IP interface will occur automatically.

2.1.2.2.2.3   Additional IP Devices

If there are any other IP devices on the system that the ACU needs to communicate with (Spectrum Analyzer, Modem, etc.), an additional window will exist to notify the ACU of the IP parameters of that device. The example below if for an IP based beacon receiver and spectrum analyzer combination.

2.1.2.2.3 Advanced

The Advanced tab provides the user with the ability to upload and download configuration data from the ACU. Additionally, the Advanced tab provides the user with the ability to load new firmware and user interface software onto the ACU.

2.1.2.2.3.1 Satellite Database

The Satellite Database window allows the user to download a text file that contains all the information contained in the Satellite Database (2.1.2.2.1). Additionally, by clicking <Choose File>, the user would be able to browse to a previously downloaded Satellite Database text file and load the database into the current RC4500.

2.1.2.2.3.2   Configuration Data

The Configuration Data window allows the user to download a text file that contains all the configuration items contained in the ACU (2.1.1.3.1). Additionally, by clicking <Choose File>, the user would be able to browse to a previously downloaded Configuration Data text file and load the configuration into the current ACU. After uploading a configuration file, the dialog box will confirm what number of items were uploaded. Some items, such as serial number, cannot be changed via a configuration file.

2.1.2.2.3.3   TLE Data

The TLE Data window allows the user to upload TLE data from a text file. Any satellite in the database that has TLE data will have the NORAD catalog number associated with it. When a text file is loaded, the ACU will match the catalog number with the corresponding data in the config file and update the TLE data in the controller. Reliable TLE data text files can be downloaded from www.celestrak.com/elements.
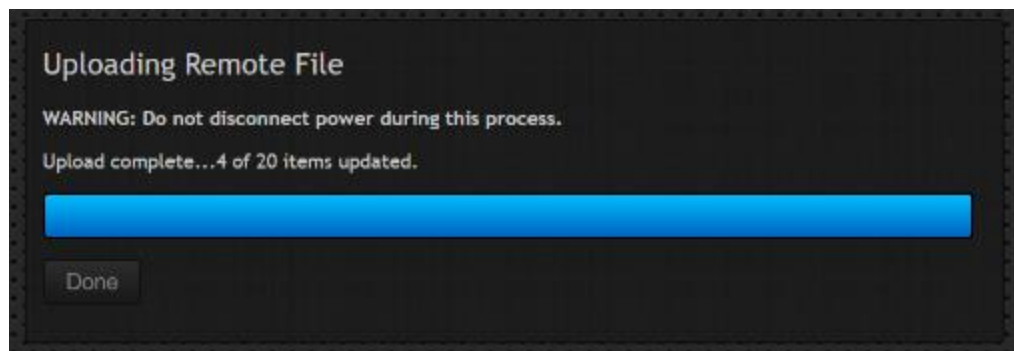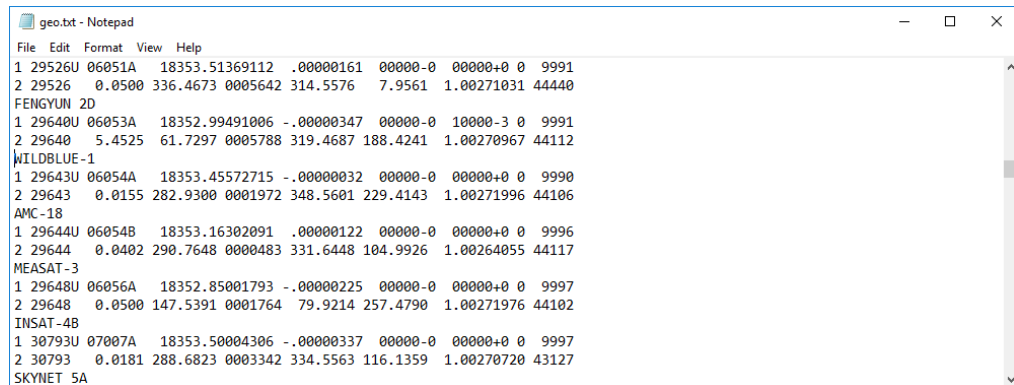
2.1.2.2.3.4   ACU Firmware

The ACU Firmware window allows the user to update the current software on the ACU. Prior to updating the ACU Firmware, the configuration data from the controller should be downloaded via the Configuration Data window (2.1.2.2.3.2).

After clicking the <Start Update> button, the window will change to show the status of the software update. Once the software is fully transferred and installed, the <Done> button will change from grayed out to active. Clicking the <Done> button will return the user to the main configuration page.
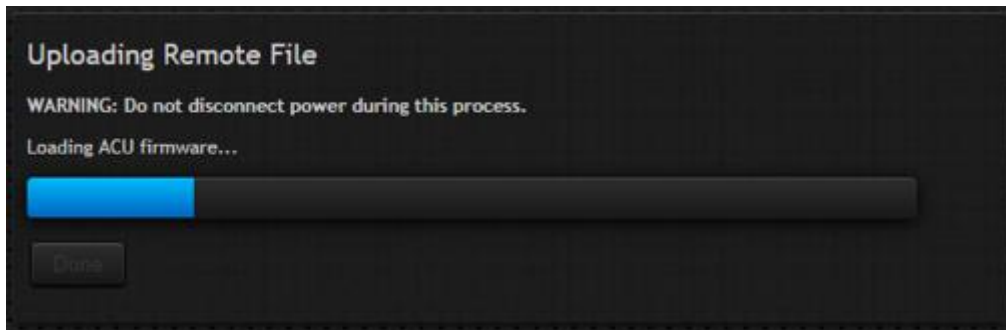
After installing the new software, the user should reset defaults on the ACU (2.1.1.3.1.3.11) and load the configuration data file that was downloaded prior to upgrading the software.

2.1.2.2.3.5   User Interface Firmware

The User Interface Firmware window allows the user to update the current user interface software on the ACU.

NOTE: Updating the user interface firmware may cause the IP settings of the ACU to be reset to factory defaults. The default IP address of the ACU is 192.168.1.1.

After clicking the <Start Update> button, the window will change to show the status of the software update. Once the software is fully transferred and installed, the <Done> button will change from grayed out to active. Clicking the <Done> button will return the user to the main configuration page.
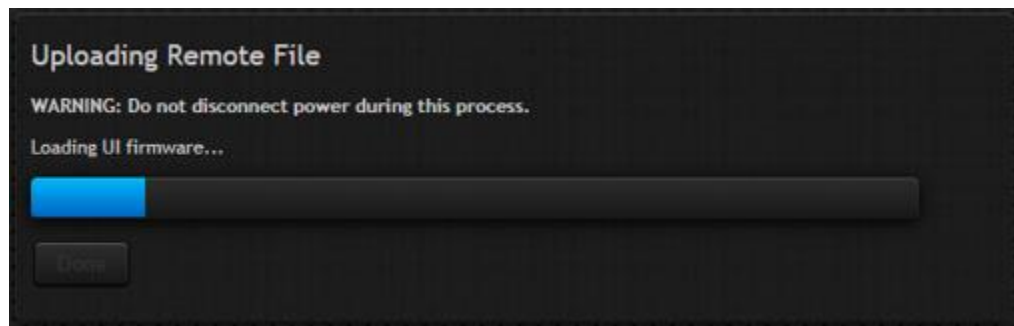
2.1.3   Additional IP Based Features

In addition to the items described in the baseline manual, the following sections also cover additional items that are described in further appendices that are available on demand. These can be accessed via the website www.researchconcepts.com or by contacting RCI at support@researchconcepts.com.

2.1.3.1   Remote Monitor and Control Protocol

The RC4500 offer an extensive remote protocol based on the SABUS protocol. The protocol is mechanized via the IP interface using UDP. The protocol will allow for full antenna monitoring, control, and configuration. For a full version of the protocol please contact RCI support.

2.1.3.2   SNMP and Security

The RC4500 offers full antenna monitoring and control via SNMP v1, v2c, and v3 as well as password protection for ACU related web interfaces. For more information on how to utilize these features or for a mib file please contact RCI support.

3   INSTALLATION

3.1 Mechanical and Electrical Installation

This section describes mechanical and electrical installation of a rackmount RC4500 into an antenna system. For other enclosures, consult the enclosure specific appendix found at the back of the manual that was provided with the system.

3.1.1 Mechanical Mounting

The ACU is packaged inside a standard, two rack unit (2U) chassis. The front panel has four (4) 10-32 screws for mounting.

The following diagram shows the typical dimensions (in inches) of the rack-mount chassis.
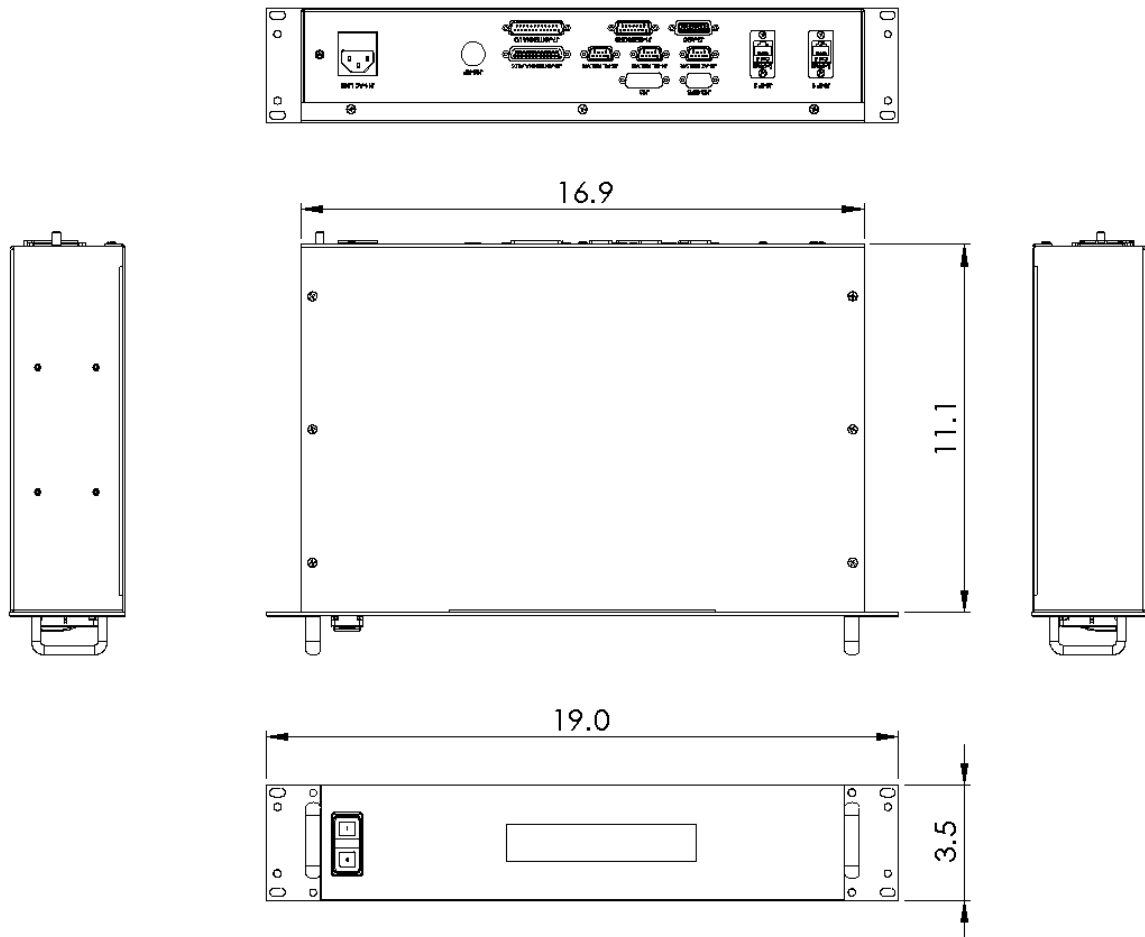
3.1.2 Electrical Interface

The interface cables should be made long enough to allow the unit to be partially removed from the rack while still connected to the system. Connections are only made to the back panel of the unit. The location and description of each connector is shown below.
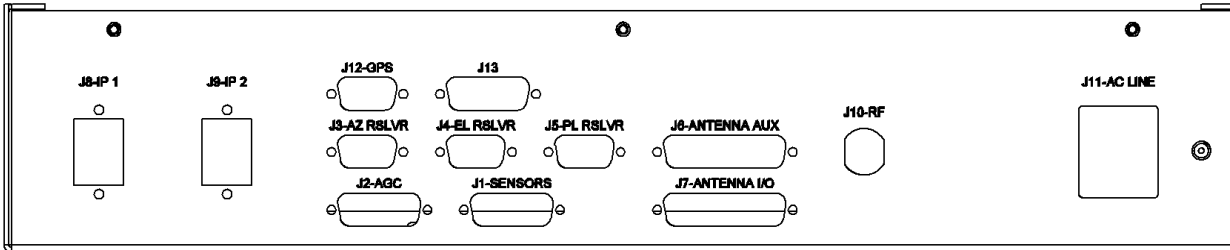
Ref Des	Part Number or Connector Type	Description
J1-SENSORS	15-pin D-subminiature receptacle	Analog Sensor
J2-AGC	15-pin D-subminiature receptacle	External Receiver (AGC)
J3-AZ RSLVR	9-pin D-subminiature receptacle	AZ Resolver
J4-EL RSLVR	9-pin D-subminiature receptacle	EL Resolver
J5-PL RSLVR	9-pin D-subminiature receptacle	POL Resolver
J6-ANTENNA AUX.	25-pin D-subminiature receptacle	Antenna Auxiliary
J7-ANTENNA I/O	25-pin D-subminiature plug	Antenna I/O
J8-IP 1	RJ-45	Ethernet Remote
J9-IP 2	RJ-45	Ethernet Remote
J10-RF	N jack, Amphenol 172129	Optional RF
J11-AC LINE	Filtered AC inlet with fuse holder[1]	Power Input (AC Line)
J12-GPS	9 pin D-subminiature placeholder	Optional External GPS
J13	15 pin D-subminiature placeholder	Spare

[1] Fuse holder accepts 5mm X 20mm fuses such as Littelfuse # 215005.XP or Bussmann # BK/S505-5-R.
Fuse rating is 250V, 5A time delay/slow blow. One of the two fuses in the holder is a spare.

3.1.2.1 J1-SENSORS

J1 is a 9-pin D-subminiature female receptacle that allows a Polarization potentiometer to provide position sensing to the ACU.

NOTE: A shielded wire should be used to minimize external noise pickup on the wiper line. The shield should be connected to Pin 3 at the ACU and NOT connected at the antenna.

The individual pin descriptions are as follows:
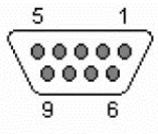
From Front

Pin #	Description
1	NC
2	NC
3	Polarization Potentiometer Shield
4	Polarization Potentiometer Wiper
5	NC
6	NC
7	NC
8	NC
9	NC
10	NC
11	Polarization Potentiometer +5V (CW)
12	Polarization Potentiometer Gnd (CCW)
13	NC
14	NC
15	NC
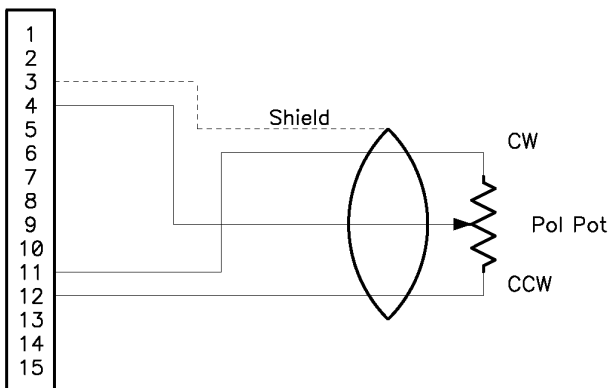
3.1.2.2   J2-AGC

J2 is a 9-pin D-subminiature female receptacle that connects to receivers/modems to provide signal strength indication for tracking. The received signal strength must be between -10 VDC and +10 VDC. The signal may be of either positive or negative polarity.

NOTE: A shielded wire should be used to minimize external noise pickup on the signal strength line. The shield should be connected to Pin 5 at the ACU and NOT connected at the receiver.

The individual pin descriptions are as follows:

DA-15S (Female Socket Front View)
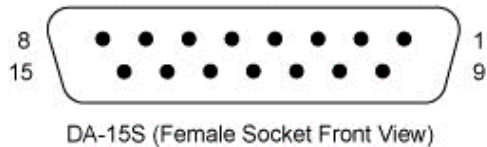
Pin #	Description
1	+24VDC
2	Ext Rec Lock Input
3	Ext Rec RS232 In
4	Ground
5	+24VDC
6	/RS422 In
7	/RS422 or RS232 Out
8	Ground
9	+5VDC
10	Ext Rec Signal Strength Input
11	Ext Rec RS232 Out
12	GPS Loopout (If Equipped)
13	Ground
14	RS422 or RS232 In
15	RS422 Out

3.1.2.3   J3-AZ RSLVR

J3 is a 9-pin D-subminiature female receptacle that allows an azimuth resolver to provide position sensing to the ACU.

IMPORTANT: Shielded cable is required for the resolver connections. The shield must be connected to chassis ground at the ACU and NOT connected at the antenna.

The resolver requires three (3) shielded twisted-pairs for each resolver to minimize noise pickup and cross-coupling, which can result in antenna positioning errors. A cable such as Belden 8777 (RCI p/n CBL-3X2_22STP1) is recommended. Most resolvers have flying lead connections. Wire-to-wire interconnects can be accomplished with solder and heat shrink tubing or a waterproof crimp connector such as 3M™ Scotchlok™ UY2 (RCI p/n CN-JIZR-2).

The individual pin descriptions are as follows:

3.1.2.4   J4-EL RSLVR

J4 is a 9-pin D-subminiature female receptacle that allows an elevation resolver to provide position sensing to the ACU.

IMPORTANT: Shielded cable is required for the resolver connections. The shield must be connected to chassis ground at the ACU and NOT connected at the antenna.

The resolver requires three (3) shielded twisted-pairs for each resolver to minimize noise pickup and cross-coupling, which can result in antenna positioning errors. A cable such as Belden 8777 (RCI p/n CBL-3X2_22STP1) is recommended. Most resolvers have flying lead connections. Wire-to-wire interconnects can be accomplished with solder and heat shrink tubing or a waterproof crimp connector such as 3M™ Scotchlok™ UY2 (RCI p/n CN-JIZR-2).

The individual pin descriptions are as follows:

3.1.2.5   J5-PL RSLVR

J5 is a 9-pin D-subminiature female receptacle that allows a polarization resolver to provide position sensing to the ACU.

IMPORTANT: Shielded cable is required for the resolver connections. The shield must be connected to chassis ground at the ACU and NOT connected at the antenna.

The resolver requires three (3) shielded twisted-pairs for each resolver to minimize noise pickup and cross-coupling, which can result in antenna positioning errors. A cable such as Belden 8777 (RCI p/n CBL-3X2_22STP1) is recommended. Most resolvers have flying lead connections. Wire-to-wire interconnects can be accomplished with solder and heat shrink tubing or a waterproof crimp connector such as 3M™ Scotchlok™ UY2 (RCI p/n CN-JIZR-2).

The individual pin descriptions are as follows:

3.1.2.6 J6-ANTENNA AUX.

J6 is a 25-pin D-subminiature female receptacle used for Antenna Auxiliary I/O. This port provides six (6) optically-isolated (as shown), axis-specific limit inputs. Each input is rated for +24 VDC and draws 5mA. The individual pin descriptions are as follows:

From Front
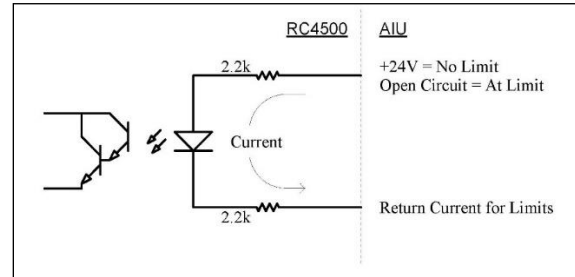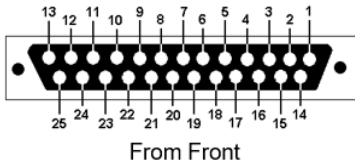
Pin #	Description
1	Relay 1 COM
2	Relay 1 NO
3	Azimuth CW Limit Return
4	Azimuth CCW/Summary Limit Return
5	Elevation Down Limit Return
6	Elevation Up Limit Return
7	Polarization CW Limit Return
8	Polarization CCW Limit Return
9	Drive Common (return path, same as J7 pins 2, 5, 8)
10	Relay 0 NC
11	NC
12	NC
13	ACU Chassis Ground
14	Relay 1 NC
15	Azimuth CW Limit Input (0V = limit active)
16	Azimuth CCW/Summary Limit Input (0V = limit active)
17	Elevation Down Limit Input (0V = limit active)
18	Elevation Up Limit Input (0V = limit active)
19	Polarization CW Limit Input (0V = limit active)
20	Polarization CCW Limit Input (0V = limit active)
21	NC
22	Relay 0 COM
23	Relay 0 NO
24	NC
25	ACU +24 VDC Unregulated, 750mA max, referenced to Chassis Ground

3.1.2.7   J7-ANTENNA I/O

J7 is a 25-pin D-subminiature male receptacle used for Antenna I/O. This port provides nine (9) optically-isolated, pull-down driver outputs. Each output can tolerate up to 27 VDC and can sink 70mA. Current is returned via the Drive Common lines. This port also provides four (4) additional optically-isolated, limit inputs for drive faults, emergency stop, and maintenance indication. Each input is rated for +24 VDC and draws 5mA. The individual pin descriptions are as follows:

From Front
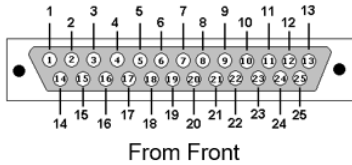
Pin #	Description
1	Azimuth CW Output (1.5V = move CW)
2	Drive Common (Azimuth output return, same as J6 pin 9)
3	Azimuth CCW Output (1.5V = move CCW)
4	Elevation Up Output (1.5V = move Up)
5	Drive Common (Elevation output return, same as J6 pin 9)
6	Elevation Down Output (1.5V = move Down)
7	Polarization CW Output (1.5V = move CW)
8	Drive Common (Polarization output return, same as J6 pin 9)
9	Polarization CCW Output (1.5V = move CCW)
10	Summary Limit Input (0V = limit active)
11	NC (future expansion for Azimuth Enable command)
12	NC (future expansion for Elevation Enable command)
13	NC (future expansion for Elevation Brake command)
14	Azimuth Drive Fault Input (0V = fault active)
15	Elevation Drive Fault Input (0V = fault active)
16	Emergency Stop Return
17	Summary Limit/Azimuth Drive Fault Return
18	Summary Limit/Elevation Drive Fault Return
19	Emergency Stop Input (0V = stop active)
20	NC (future expansion for Azimuth Brake command)
21	Azimuth Fast Output (1.5V = fast)
22	Elevation Fast Output (1.5V = fast)
23	Drive Enable Output (1.5V = drive enable)
24	Maintenance Input (0V = maintenance active)
25	Maintenance Return

The following drawings illustrate the axis move and speed command output circuits:

Axis Command Output

RC4500   AIU

Axis Drive Output Pulls Low
to Command Move

Current

Drive Common (Return Current)

AZ/EL Fast Command

RC4500   AIU

Axis Drive Output Pulls Low
to Select Fast Speed

Current

Drive Common (Return Current)
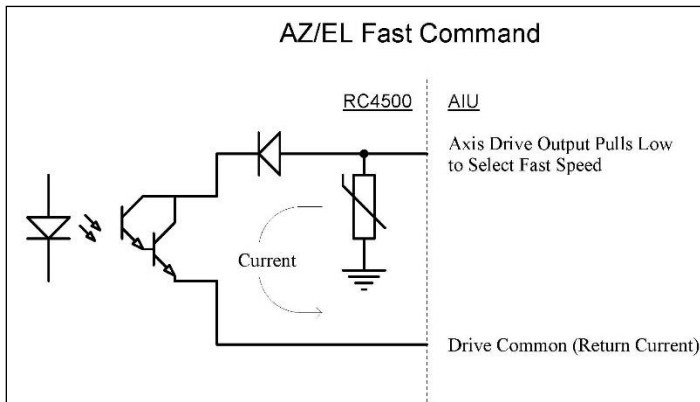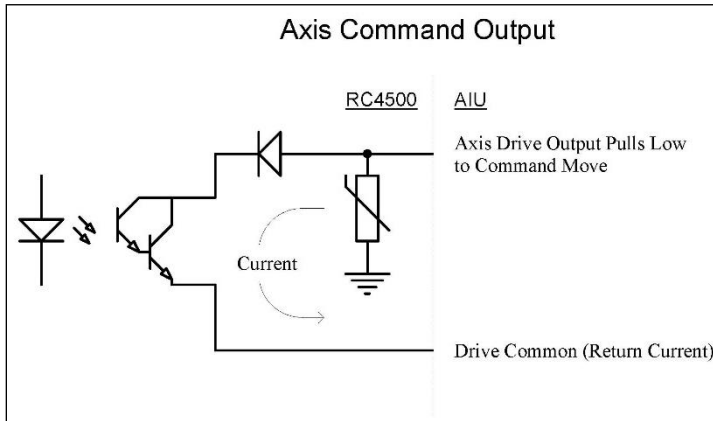
The following drawings illustrate the drive fault, emergency stop, and maintenance input circuits:

Summary Limit Input / Fault Input

RC4500   AIU

2.2k

+24V = No Limit / No Fault
Open Circuit = At Limit / Fault Detected

Current

Return Current for Summary Limit / Faults

2.2k

Emergency Stop Input

RC4500   AIU

2.2k

+24V = Emergency Stop not active
Open Circuit = Emergency Stop active

Current

Return Current for Summary Limit / Faults

2.2k
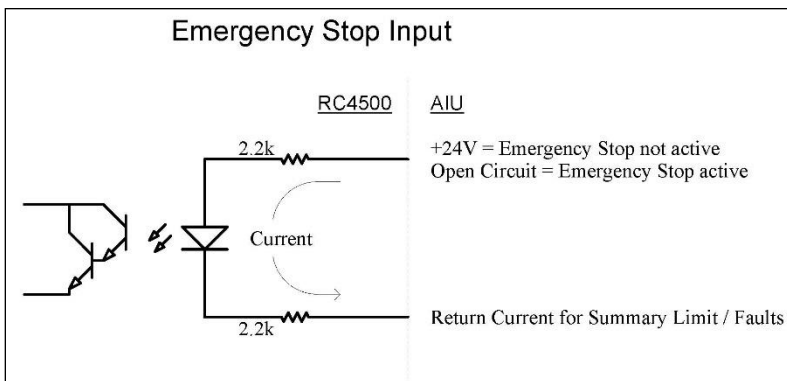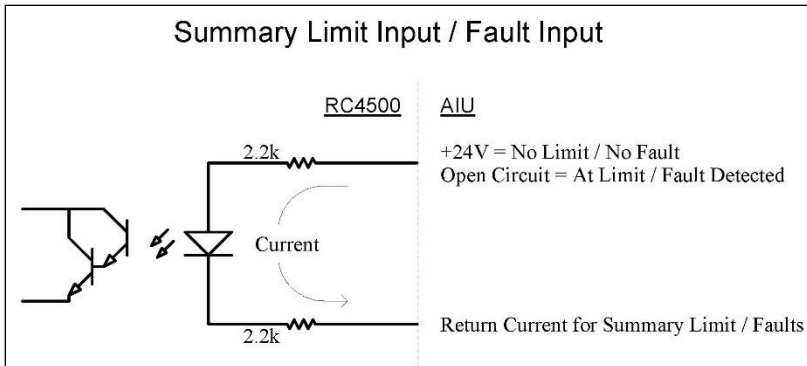
Maintenance Input – When current flows through this circuit the controller assumes that the AIU is able to accept drive commands from the ACU. If current is not flowing the ACU disables antenna control and displays the 'Maintenance' alarm message.

This terminal also powers all of the ACU's isolated output drive circuits. 17 to 27 VDC is required to power the controller's output circuits. The current that powers the output drive circuits flows back to the AIU through the drive common pins.

Maintenance Input

RC4500   AIU

Drive Circuit +24V

2.2k

+24V = Drive Commands OK
Open Circuit = Drive Commands Disabled

Current

Return Current for Summary Limit / Faults

2.2k
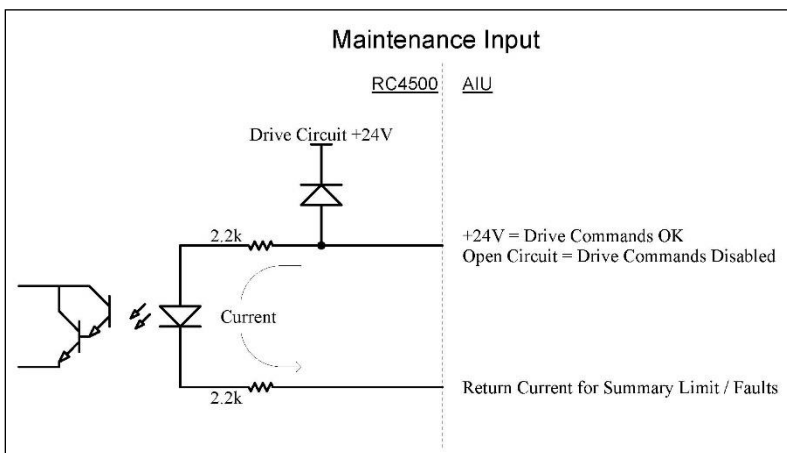
3.1.2.8   J8-IP 1

All standard RC4500 controllers are equipped with Ethernet based remote control. J8 is an RJ-45 socket to allow the connection of the RC4500 to a computer or network. The default IP settings of the controller are listed below:

- IP Address: 192.168.1.1
- Subnet Mask: 255.255.0.0

Setting the IP settings a PC to the following, will allow for easy direct connection to the ACU.

- IP Address: 192.168.1.45
- Subnet Mask: 255.255.255.0

All IP settings for the controller are configurable to allow the ACU to exist in a previously established network. See section 2.1.2.2.2.2 for more information on adjusting these settings.

3.1.2.9   J9-IP 2

A second RJ-45 socket is provided to provide connection flexibility. This may be used in an application where an M&C system is permanently connected and a second connection to a computer is used for troubleshooting.

3.1.2.10 J10-RF

J10 is a 50Ω N Type female connector and is the input to an optional internal beacon receiver or spectrum analyzer. This input accepts the L-band output of an LNB (950-2150 MHz, -115 to -15 dBm).

3.1.2.11 J11-AC LINE

J11 is an IEC-C14 male power socket on the back panel for supplying AC power. The line cord shipped with the ACU has an IEC-C13 plug. The ACU can accept 85 to 265 VAC at 50/60 Hz.

3.2 Software Initialization

NOTE: Extreme caution should be used during initial installation. Limit switches and polarity of motors/sensors may not be configured correctly.

!!! After Completing the Installation Section, Save a known good configuration file !!!

This section describes the steps that would be used for initial pairing of an RC4500 with an antenna.

Initial Power Application. Before powering the unit on for the first time, please confirm that the input voltage the unit is configured for matches the intended input supply voltage.

Antenna Location: Upon initial power up, the Lat/Lon of the antenna will need to set prior to advancing further into the operation of the controller.

```
                                    INITIAL SETUP
LAT:              LON:

ENTER  LATITUDE  DEGREES  (dd.dddd)
```

Enable Expert Access. To perform installation steps described below, expert access permission must be enabled. Expert access permission is disabled as the factory default. See section 2.1.1.3.1.1.1 for instructions on enabling expert access permission.

After installation is complete, expert access may be turned off to lessen risk of configuration settings being unintentionally modified. Disabling expert access will also present a less complex set of screens for normal operation.

System Definition. The SYSTEM DEFINITION configuration screen (2.1.1.3.1.3.1) allows the user to indicate the antenna diameter.

```
MODE:2   ANT  SIZE:  420       CONFIG-SYSTEM
         ANT  LOOK:1

<2-MENU  3-MANUAL>
```

Azimuth/Elevation/Polarization Calibration. The next three sections calibrate the mount's elevation, azimuth, and polarization axes. Prior to beginning this calibration, each axis should be placed in the center of travel.

For each axis, motor direction, position feedback, limit switch status will be confirmed, and total range of movement will be tested.

Throughout axis calibration, the maintenance (2.1.1.3.2) and configuration (2.1.1.3.1) modes will be used extensively. Before beginning axes calibration, the installer should become familiar with accessing these modes and screens.

3.2.1   Motor Direction Calibration

3.2.1.1   Elevation Axis

NOTE: Prior to beginning the Elevation Motor Direction Calibration the antenna should be manually moved to the center of elevation travel.

With the elevation axis in the center of travel, go to MANUAL mode.

In fast speed jog up in elevation and verify that the antenna moves up. If the antenna moves down, the motor leads reversed prior to proceeding.

If the elevation moved in the correct direction during this test, the motor is wired correctly and no modification to wiring is needed.

3.2.1.2   Azimuth Axis

NOTE: Prior to beginning the Azimuth Motor Direction Calibration the antenna should be manually moved to the center of azimuth travel.

With the azimuth axis in the center of travel, go to MANUAL mode.

In fast speed jog CW in azimuth and verify that the antenna moves clockwise as defined in section 1.2. If the antenna moves counterclockwise, the motor leads need to be reversed prior to proceeding.

If the azimuth moved in the correct direction during this test, the motor is wired correctly and no modification to wiring is needed.

3.2.1.3   Polarization Axis

NOTE: Prior to beginning the Polarization Motor Direction Calibration the feed should be manually moved to the center of polarization travel.

With the polarization axis in the center of travel, go to MANUAL mode.

In fast speed jog CW in polarization and verify that the polarization axis moves clockwise as defined in section 1.2. If the polarization axis moves counterclockwise, the motor leads need to be reversed prior to proceeding.

If the polarization axis moved in the correct direction during this test, the motor is wired correctly and no modification to wiring is needed.

3.2.2   Position Sense Direction

3.2.2.1   Elevation Axis

With the elevation axis in the center of travel, go to MANUAL mode.

In fast speed jog up in elevation and verify that the elevation angle counts up. If the elevation angle counts down, the elevation sensor direction configuration item (2.1.1.3.1.2.2) should be changed.

If the elevation angle moved in the correct direction during this test, no modification to the configuration is needed.

3.2.2.2   Azimuth Axis

With the azimuth axis in the center of travel, go to MANUAL mode.

In fast speed jog CW in azimuth and verify that the azimuth angle counts up. If the azimuth angle counts down, the azimuth sensor direction configuration item (2.1.1.3.1.2.1) should be changed.

If the azimuth angle moved in the correct direction during this test, no modification to the configuration is needed.

3.2.2.3   Polarization Axis

With the polarization axis in the center of travel, go to MANUAL mode.

In fast speed jog CW in polarization and verify that the polarization angle counts up. If the polarization angle counts down, a change is required.

If the polarization axis sensor is a resolver, or optical encoder the polarization sensor direction configuration item (2.1.1.3.1.2.3) should be changed.

If the polarization axis sensor is a potentiometer, the outer 2 legs of the potentiometer need to be swapped.

If the polarization angle moved in the correct direction during this test, no modification to the configuration is needed.

3.2.3 Motor Speed Calibration

This section will cover properly setting the fast and slow speeds for each axis. Please consult the hardware installation appendix that came with your AIU for instructions on how to adjust the speed for each axis.

3.2.3.1 Elevation

3.2.3.1.1 Fast Speed

The fast speed for Elevation can usually be set to the maximum adjustable speed without issue with regards to controlling the antenna. Other items not related to the ACU may need to be considered when setting this value. These may include wear on motor or actuators, coast distance when a limit switch is active, etc.

3.2.3.1.2 Slow Speed

For optimum peaking and operation, it is important to set the Elevation slow speed relative to the Half Power Beamwidth (HPBW) of the antenna. The HPBW can be calculated using the equation below:

$$HPBW \ (degrees) \approx \frac{21}{Frequency \ (GHz) \times Diameter \ (Meters)}$$

Using this number, the slow speed should be adjusted such that the antenna travels this distance in approximately 4 seconds.

3.2.3.2 Azimuth

3.2.3.2.1 Fast Speed

The fast speed for Azimuth can usually be set to the maximum adjustable speed without issue with regards to controlling the antenna. Other items not related to the ACU may need to be considered when setting this value. These may include wear on motor or actuators, coast distance when a limit switch is active, etc.

3.2.3.2.2 Slow Speed

For optimum peaking and operation, it is important to set the Azimuth slow speed relative to the Half Power Beamwidth (HPBW) of the antenna. The HPBW can be calculated using the equation below:

$$HPBW \ (degrees) \approx \frac{21}{Frequency \ (GHz) \times Diameter \ (Meters)}$$

Using this number, the slow speed should be adjusted such that the antenna travels this distance in approximately 4 seconds.

3.2.3.3 Polarization

Currently all RCI RC4500 products support single speed polarization. No adjustment is necessary on the AIU or ACU to set the polarization speed.

3.2.4   Primary Position Sensor Calibration

3.2.4.1   Azimuth and Elevation Axis

Prior to beginning this step, the antenna should be manually peaked on a geostationary satellite. This peaking can be done via an external device such as a beacon receiver or spectrum analyzer or can be done via the ACU's beacon maintenance mode (2.1.1.3.2.8).

With the ACU properly peaked on a geostationary satellite, the user should navigate to the SNS OFF maintenance screen.

```
         TRUE        RAW        REF        SNS  OFF
az:  212.24       32.24     180.00    (     0.00)
el:   39.80       39.80     180.00    (     0.00)
<1-AZ,3-EL>REF <5>LON <7-AZ,9-EL>OFFSET
```

STEP 1: Input Satellite Longitude

The user should press the <5> key to activate the longitude input function of the sensor offset screen. The user should then enter the longitude of the satellite the ACU is peaked on.

```
         TRUE        RAW       111.1W       SNS  OFF
az:  212.24       32.24     205.01    (     0.00)
el:   39.80       39.80      41.80    (     0.00)
<1-AZ,3-EL>REF <5>LON <7-AZ,9-EL>OFFSET
```

At this point, the 'REF' values that were shown upon entry to the screen will be replaced with the calculated angles for the longitude entered.

Pressing the <7> key will update the SOFF: item in the Azimuth Calibration configuration screen (2.1.1.3.1.2.1). Pressing the <9> key will update the SOFF: item in the Elevation Calibration configuration screen (2.1.1.3.1.2.2). The offsets and update 'TRUE' angles will be displayed as shown below.

If either of the sensor offset values are greater than 15°, the on axis sensor should be mechanically loosened and adjusted to reduce the required offset to under 15°.

```
         TRUE        RAW       111.1W       SNS  OFF
az:  205.01       32.24     205.01    (   -7.23)
el:   41.80       39.80      41.80    (    2.00)
<1-AZ,3-EL>REF <5>LON <7-AZ,9-EL>OFFSET
```

The user should now exit the Sensor Offset screen, and then hold down the mode button for 5 seconds to trigger a flash save of the configuration items.

3.2.4.2   Polarization Axis

NOTE: The following procedure is not required for non-motorized or circular feeds.

3.2.4.2.1   Resolver or Optical Encoder

Prior to beginning this step, the polarization axis should be moved via MANUAL mode to the center of travel.

While still in MANUAL mode, the user should record the true polarization angle.

The user should then enter appropriate value into the SOFF: field in the polarization calibration screen (2.1.1.3.1.2.3). For example, if the true angle in the servo maintenance screen is 2.346, the user would enter in a sensor offset of -2.346.

3.2.4.2.2   Potentiometer

Prior to beginning this step, the feed should be moved via MANUAL mode to the polarization center of travel.

The following procedure should then be followed to configure the polarization potentiometer. The values determined during this process will be input into the Polarization Calibration configuration screen (2.1.1.3.1.2.3).

```
         VREF:2.50   OFF:   0.000 CONFIG-POL
 CCW:  -90.000 CW:   90.000 SF:  45.00

ZERO DEG VOLTAGE <1.00-4.00 VOLTS>
```

STEP 1: Polarization Potentiometer Reference Voltage.

Move to the 12-Bit Voltage maintenance screen. The polarization voltage shown on the screen should be 2.500 ± 0.05 volts. If the value is not within this range, loosen the potentiometer restraining collar and rotate the shaft such that the displayed value is as near 2.500 volts as possible. Secure the collar and record the voltage.

RECORDED POLARIZATION CENTER VOLTAGE_____ V

Move to the Polarization Calibration screen and enter the recorded value in the VREF item. This will define to the ACU's software the voltage that should be seen when the polarization axis is in its center position. To verify that data has been entered correctly, return to the MANUAL mode screen. The displayed polarization angle should be 0.0 ± 0.5 degrees.

STEP 2. Polarization Scale Factor.

To calculate the polarization scale factor, move the feed between two known physical polarization positions and note the difference in the sensed polarization voltage between the two locations.   If definite reference points are available on the feed (±90 degree positions for example), these may be used. Otherwise use the difference in polarization between the horizontal and vertical of a satellite. Record the voltages corresponding to each.

Example: at +90 degree reference position the polarization voltage is 4.358. At the –90 degree reference position the azimuth voltage is 0.642. The azimuth scale factor is calculated as:

180 degrees / (4.358 – 0.642) = 48.44 degrees / volt.

48.44 would be entered as the scale factor.

3.2.5   Range of Travel and Limits Calibration

3.2.5.1   Elevation Axis

3.2.5.1.1   Up Limit

If the antenna being used has a physical UP limit switch, from MANUAL mode move the axis to the limit switch and verify that the "UP" limit is displayed.

If the controller displays "up" prior to hitting the switch, this means that a software limit has been reached prior to the physical switch. The software limit should be adjusted to a position beyond the physical limit for limit switch testing, and then set properly after switch testing.

The user should then move back out of the physical UP limit switch and verify that the "UP" limit is no longer displayed in MANUAL mode. The software Up limit should be set 1° lower than the Up limit switch in the elevation calibration screen (2.1.1.3.1.2.2).

If the antenna being used does not have a physical UP limit switch, the antenna should be moved to the mechanical end of travel, and a software up limit should be set 3° below the end of mechanical travel in the elevation calibration screen (2.1.1.3.1.2.2).

For example, if the mechanical end of travel is at an elevation angle of 85°, the user should set the software up limit to 82°. If the antenna has mechanical travel above 92°, it is recommended that the software up limit is set to 90°.

3.2.5.1.2   Down Limit

If the antenna being used has a physical Down limit switch, from MANUAL mode move the axis to the limit switch and verify that the "DOWN" limit is displayed.

If the controller displays "down" prior to hitting the switch, this means that a software limit has been reached prior to the physical switch. The software limit should be adjusted to a position beyond the physical limit for limit switch testing, and then set properly after switch testing.

The user should then move back out of the physical Down limit switch and verify that the "DOWN" limit is no longer displayed in MANUAL mode. The software Down limit should be set 1° higher than the Down limit switch in the elevation calibration screen (2.1.1.3.1.2.2).

If the antenna being used does not have a physical DOWN limit switch, the antenna should be moved to the mechanical end of travel, and a software down limit should be set 3° above the end of mechanical travel in the elevation calibration screen (2.1.1.3.1.2.2).

For example, if the mechanical end of travel is at an elevation angle of 10°, the user should set the software down limit to 13°. If the antenna has mechanical travel below 2°, it is recommended that the software down limit is set to 5°.

3.2.5.2   Azimuth Axis

NOTE: The setting of Azimuth limits described here is for the Northern hemisphere. The same procedure should be followed, but the values should be adjusted for antennas in the Southern hemisphere.

3.2.5.2.1   CW Limit

If the antenna being used has a physical CW limit switch, from MANUAL mode move the axis to the limit switch and verify that the "CW" limit is displayed.

If the controller displays "cw" prior to hitting the switch, this means that a software limit has been reached prior to the physical switch. The software limit should be adjusted to a position beyond the physical limit for limit switch testing, and then set properly after switch testing.

The user should then move back out of the physical CW limit switch and verify that the "CW" limit is no longer displayed in MANUAL mode. The software CW limit should be set 1° CCW from the CW limit switch in the Azimuth Calibration screen (2.1.1.3.1.2.1).

If the antenna being used does not have a physical CW limit switch, the antenna should be moved to the mechanical end of travel, and a software CW limit should be set 3° inside the end of mechanical travel in the azimuth calibration screen (2.1.1.3.1.2.1).

For example, if the mechanical end of travel is at an azimuth angle of 275°, the user should set the software CW limit to 272°.

3.2.5.2.2   CCW Limit

If the antenna being used has a physical CCW limit switch, from MANUAL mode move the axis to the limit switch and verify that the "CCW" limit is displayed.

If the controller displays "ccw" prior to hitting the switch, this means that a software limit has been reached prior to the physical switch. The software limit should be adjusted to a position beyond the physical limit for limit switch testing, and then set properly after switch testing.

The user should then move back out of the physical CCW limit switch and verify that the "CCW" limit is no longer displayed in MANUAL mode. The software CCW limit should be set 1° CW from the CCW limit switch in the Azimuth Calibration screen (2.1.1.3.1.2.1).

If the antenna being used does not have a physical CCW limit switch, the antenna should be moved to the mechanical end of travel, and a software CCW limit should be set 3° inside the end of mechanical travel in the azimuth calibration screen (2.1.1.3.1.2.1).

For example, if the mechanical end of travel is at an azimuth angle of 85°, the user should set the software CCW limit to 88°.

3.2.5.3   Polarization Axis

NOTE: If the antenna uses potentiometer-based hardware limits, the polarization potentiometer scale factor should be set prior to testing the CW limit.

3.2.5.3.1   CW Limit

If the feed being used has a physical CW limit switch, from MANUAL mode move the feed to the limit switch and verify that the "CW" limit is displayed.

If the controller displays "cw" prior to hitting the switch, this means that a software limit has been reached prior to the physical switch. The software limit should be adjusted to a position beyond the physical limit for limit switch testing, and then set properly after switch testing.

The user should then move back out of the physical CW limit switch and verify that the "CW" limit is no longer displayed in MANUAL mode. The software CW limit should be set 1° CCW from the CW limit switch in the Polarization Calibration screen (2.1.1.3.1.2.3).

If the feed being used does not have a physical CW limit switch, the feed should be moved to the mechanical end of travel, and a software CW limit should be set 3° inside the end of mechanical travel in the polarization calibration screen (2.1.1.3.1.2.3).

For example, if the mechanical end of travel is at a polarization angle of 93°, the user should set the software CW limit to 90°. If the feed has mechanical travel above 95°, it is recommended that the software CW limit is set to 92°.

3.2.5.3.2   CCW Limit

If the feed being used has a physical CCW limit switch, from MANUAL mode move the feed to the limit switch and verify that the "CCW" limit is displayed.

If the controller displays "ccw" prior to hitting the switch, this means that a software limit has been reached prior to the physical switch. The software limit should be adjusted to a position beyond the physical limit for limit switch testing, and then set properly after switch testing.

The user should then move back out of the physical CCW limit switch and verify that the "CCW" limit is no longer displayed in MANUAL mode. The software CCW limit should be set 1° CW from the CCW limit switch in the Polarization Calibration screen (2.1.1.3.1.2.3).

If the feed being used does not have a physical CCW limit switch, the antenna should be moved to the mechanical end of travel, and a software CW limit should be set 3° inside the end of mechanical travel in the polarization calibration screen (2.1.1.3.1.2.3).

For example, if the mechanical end of travel is at a polarization angle of -93°, the user should set the software CW limit to -90°. If the feed has mechanical travel above -95°, it is recommended that the software CW limit is set to -92°.

3.2.6   Axis Pointing Calibration

This section will cover how to tune parameters in the ACU to optimally point the antenna. These steps are important for all RECALL and TRACK operations to work as expected.

3.2.6.1   Elevation

All parameters set during this process can be found in the Elevation Angle Movement configuration screen (2.1.1.3.1.3.4).

3.2.6.1.1   <u>COAST</u>

The first item set during the pointing calibration is the COAST configuration item. To determine this value, set the parameters in the Elevation Angle Movement configuration screen as listed below:

- FAST/SLOW: 5.000
- COAST: 0.000
- MAX ERROR: 2.000
- TRIES: 3

With the parameters configured as listed above, use the MOVETO mode (2.1.1.2.2.4) of the ACU to request an Elevation Up or Down movement of 4 degrees. When the move completes record the overshoot of the Elevation axis relative to the target. Repeat the process moving in the opposite direction and record the value of the overshoot.

The COAST configuration item should now be set to the average of the overshoot in the up and down direction.

3.2.6.1.2   <u>FAST/SLOW</u>

This item will only have an affect on variable speed systems. For single speed systems, this step can be skipped.

The second item set during the pointing calibration is the FAST/SLOW configuration item. This item sets the angular distance from the target that the ACU will switch the axis from Fast speed to Slow speed.

To determine this value, use the MOVETO mode of the ACU to request an Elevation move that is 10 degrees. The FAST/SLOW item should then be adjusted until there is at least 2 seconds of slow speed movement at the end of the move prior to reaching the target.

3.2.6.1.3   <u>MAX ERROR</u>

The third configuration item set during the pointing calibration is the MAX ERROR items. This item sets the minimum amount of error that the ACU should try to correct.

To determine this value, first set the MAX ERROR item to 0.000. Then attempt to request the smallest move that the ACU will attempt. This will be 0.01 degrees for most systems. This movement will result in the smallest move that the ACU can command. Repeat this step in both directions and record the values.

If the value determined is greater than 0.03 degrees, set the MAX ERROR item to half of the value determined. If the value is less than or equal to 0.03, set the value to 0.01 degrees.

3.2.6.2 Azimuth

All parameters set during this process can be found in the Azimuth Angle Movement configuration screen (2.1.1.3.1.3.2).

3.2.6.2.1 <u>COAST</u>

The first item set during the pointing calibration is the COAST configuration item. To determine this value, set the parameters in the Azimuth Angle Movement configuration screen as listed below:

- FAST/SLOW: 5.000
- COAST: 0.000
- MAX ERROR: 2.000
- TRIES: 3

With the parameters configured as listed above, use the MOVETO mode (2.1.1.2.2.4) of the ACU to request an Azimuth CW or CCW movement of 4 degrees. When the move completes record the overshoot of the Azimuth axis relative to the target. Repeat the process moving in the opposite direction and record the value of the overshoot.

The COAST configuration item should now be set to the average of the overshoot in the up and down direction.

3.2.6.2.2 <u>FAST/SLOW</u>

This item will only have an affect on variable speed systems. For single speed systems, this step can be skipped.

The second item set during the pointing calibration is the FAST/SLOW configuration item. This item sets the angular distance from the target that the ACU will switch the axis from Fast speed to Slow speed.

To determine this value, use the MOVETO mode of the ACU to request an Azimuth move that is 10 degrees. The FAST/SLOW item should then be adjusted until there is at least 2 seconds of slow speed movement at the end of the move prior to reaching the target.

3.2.6.2.3 <u>MAX ERROR</u>

The third configuration item set during the pointing calibration is the MAX ERROR items. This item sets the minimum amount of error that the ACU should try to correct.

To determine this value, first set the MAX ERROR item to 0.000. Then attempt to request the smallest move that the ACU will attempt. This will be 0.01 degrees for most systems. This movement will result in the smallest move that the ACU can command. Repeat this step in both directions and record the values.

If the value determined is greater than 0.03 degrees, set the MAX ERROR item to half of the value determined. If the value is less than or equal to 0.03, set the value to 0.01 degrees.

3.2.6.3 Polarization

All parameters set during this process can be found in the Polarization Angle Movement configuration screen (2.1.1.3.1.3.6).

3.2.6.3.1 <u>COAST</u>

The first item set during the pointing calibration is the COAST configuration item. To determine this value, set the parameters in the Polarization Angle Movement configuration screen as listed below:

- FAST/SLOW: 5.000
- COAST: 0.000
- MAX ERROR: 2.000
- TRIES: 3

With the parameters configured as listed above, use the MOVETO mode (2.1.1.2.2.4) of the ACU to request a Polarization CW or CCW movement of 4 degrees. When the move completes record the overshoot of the Polarization axis relative to the target. Repeat the process moving in the opposite direction and record the value of the overshoot.

The COAST configuration item should now be set to the average of the overshoot in the up and down direction.

3.2.6.3.2 <u>FAST/SLOW</u>

This item will only have an affect on variable speed systems. For single speed systems, this step can be skipped.

The second item set during the pointing calibration is the FAST/SLOW configuration item. This item sets the angular distance from the target that the ACU will switch the axis from Fast speed to Slow speed.

To determine this value, use the MOVETO mode of the ACU to request a Polarization move that is 10 degrees. The FAST/SLOW item should then be adjusted until there is at least 2 seconds of slow speed movement at the end of the move prior to reaching the target.

3.2.6.3.3 <u>MAX ERROR</u>

The third configuration item set during the pointing calibration is the MAX ERROR items. This item sets the minimum amount of error that the ACU should try to correct.

To determine this value, first set the MAX ERROR item to 0.000. Then attempt to request the smallest move that the ACU will attempt. This will be 0.01 degrees for most systems. This movement will result in the smallest move that the ACU can command. Repeat this step in both directions and record the values.

If the value determined is greater than 0.03 degrees, set the MAX ERROR item to half of the value determined. If the value is less than or equal to 0.03, set the value to 0.01 degrees.

3.2.7 Locate Source Calibration

The RC4500 can sense satellite signal strength via the L-Band power detector, multiple internal receivers, and external signal strength inputs. This section describes how to configure the signal strength input circuits for use with various locate sources. Correct adjustment of the signal strength parameters is required for the TRACK mode to work correctly.

3.2.7.1 L-Band Power Detector

The simplest detection scheme is to connect the LNB output to the L-band power detector. For best results, insert inline attenuation or amplification so that the RF display is approximately -50.0 when the reflector is pointed at open sky. The L-band input power detector makes use of a 10-bit ADC labeled "5-RF" (2.1.1.3.2.1.1). See the RF Sig Factors section (2.1.1.3.1.2.7) for a discussion of the characteristics of the L-Band power detector.

3.2.7.2 Beacon Tracking Receiver

If the ACU is configured with an internal beacon tracking receiver (BTR), the Beacon Sig Factors configuration items (2.1.1.3.1.2.6) should be adjusted for optimal performance. The table below shows items that are preset by the factory, and which may need to be adjusted to the integrator.

Set By Factory	Set by Integrator
LOCK	TIME
SENSE	THRES

3.2.7.3 External Receiver

The ACU external receiver allows for the use of a wide range of analog voltage input signal sources. If using an external receiver as the locate source, all items in the External Sig Factors configuration screen (2.1.1.3.1.2.5) should be configured for optimal performance.

4   SUPPORT

4.1 Troubleshooting

4.1.1 Warning Displays

4.1.1.1 General Warnings

Alarm	Description/Recommended Action
Low Battery	Battery used to backup NVRAM and Date/Time is low. Replace internal battery backup.
Invalid Date/Time	Date/Time is corrupt. Reset the Date/Time via maintenance or GPS time sync.
Limits Inactive	The software limits of the controller are currently disabled. Reactivate limits via Limits maintenance screen.
Local Jog Connected	A local jog panel or handheld remote front panel is currently connected to the ACU. Disconnect the local jog panel or handheld remote front panel.

4.1.1.2 Azimuth

Warning	Description/Recommended Action
CCW, ccw	Antenna is at the azimuth hardware limit (CCW) or azimuth software limit (ccw), move the antenna azimuth CW out of the limit.
CW, cw	Antenna is at the azimuth hardware limit (CCW) or azimuth software limit (ccw), move the antenna azimuth CCW out of the limit.

4.1.1.3 Elevation

Warning	Description/Recommended Action
DOWN, down	Antenna is at the elevation hardware limit (DOWN) or azimuth software limit (down), move the antenna elevation up out of the limit.
UP, up	Antenna is at the elevation hardware limit (UP) or elevation software limit (up), move the antenna elevation down out of the limit.

4.1.1.4 Polarization

Warning	Description/Recommended Action
CCW, ccw	Antenna is at the polarization hardware limit (CCW) or polarization software limit (ccw), move the antenna polarization CW out of the limit.
CW, cw	Antenna is at the polarization hardware limit (CCW) or polarization software limit (ccw), move the antenna polarization CCW out of the limit.

4.1.1.5 GPS

Warning	Description/Recommended Action
GPS Offline	ACU is not receiving information from the GPS receiver
Waiting For GPS	ACU is waiting for the GPS to report that it has a valid Lat/Lon

4.1.2 Alarm Displays

4.1.2.1 General Alarms

Alarm	Description/Recommended Action
Flash Version Mismatch	Flash Memory Structure error. Reset defaults, recalibration of controller will be required.
Flash Data Corrupt	Items in Flash Memory are corrupt. Reset defaults, recalibration of controller will be required.
NVRAM Version Mismatch	NVRAM version doesn't match Flash Memory version. Reset Defaults, recalibration of controller will be required.
NVRAM Data Corrupt	Items in NVRAM are corrupt. Reset defaults, recalibration of controller will be required.
Emergency Stop	The emergency stop input on the controller is currently open. Reset the input to clear alarm.

4.1.2.2 Azimuth

Alarm	Description/Recommended Action
Jam	The ACU commanded the azimuth axis to move and no movement was detected. This condition must be reset via the MAINTAINANCE > DRIVE mode before further movement in any axis may occur.
Runaway	The ACU sensed movement in the azimuth axis when no movement was commanded. This condition must be reset via the MAINTAINANCE > DRIVE mode before further movement in any axis may occur.
Drive	The current sensed from the azimuth axis was higher than the current limit configuration item. Verify axis movement working as expected and that the current limit configuration item is set properly.
Off-Axis	An alarm in a different axis has occurred that disables movement in this axis. Clear the error from the off axis.

4.1.2.3 Elevation

| Alarm	Description/Recommended Action
Jam	The ACU commanded the elevation axis to move and no movement was detected. This condition must be reset via the MAINTAINANCE > DRIVE mode before further movement in any axis may occur.
Runaway	The ACU sensed movement in the elevation axis when no movement was commanded. This condition must be reset via the MAINTAINANCE > DRIVE mode before further movement in any axis may occur.
Drive	The current sensed from the elevation axis was higher than the current limit configuration item. Verify axis movement working as expected and that the current limit configuration item is set properly.
Off-Axis	An alarm in a different axis has occurred that disables movement in this axis. Clear the error from the off axis.

4.1.2.4   Polarization

Alarm	Description/Recommended Action
Jam	The ACU commanded the elevation axis to move and no movement was detected. This condition must be reset via the MAINTAINANCE > DRIVE mode before further movement in any axis may occur.
Runaway	The ACU sensed movement in the elevation axis when no movement was commanded. This condition must be reset via the MAINTAINANCE > DRIVE mode before further movement in any axis may occur.
Drive	The current sensed from the azimuth axis was higher that the current limit configuration item. Verify axis movement working as expected and that the current limit configuration item is set properly.
Off-Axis	An alarm in a different axis has occurred that disables movement in this axis. Clear the error from the off axis.

4.2 ACU Topics

4.2.1 Polarization Control

The ACU automatically moves the polarization axis as part of the satellite RECALL function. The following diagram shows the polarization axis sign convention used. The diagram depicts looking at the arc of satellites from behind the antenna.
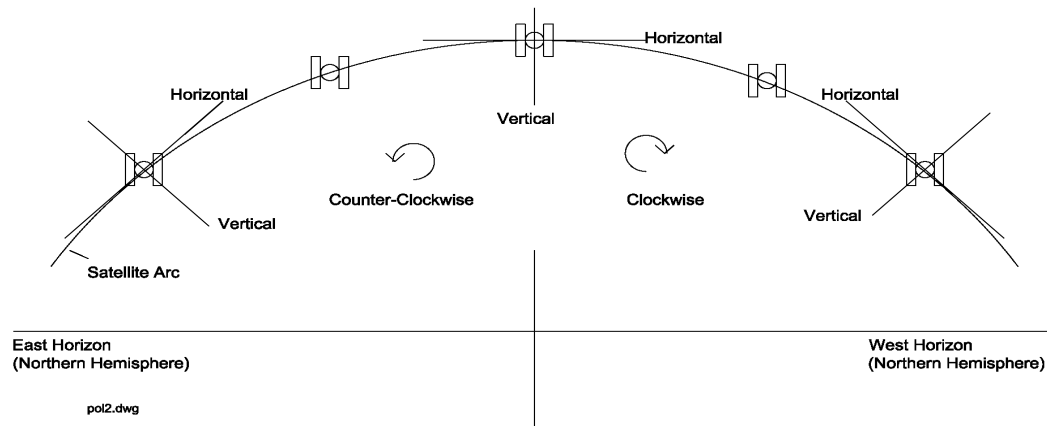
The ACU allows the user to specify the type of polarization axis mechanism present. If a circular polarized feed is present, no automatic movement of the polarization axis is performed.

4.2.2 Drive System

The RC4500 implements several mechanisms for the driving and monitoring of the azimuth, elevation and polarization axis.

4.2.3 Position Sensing and Limits

The RC4500 senses absolute axis position using feedback from various sensors (potentiometers, resolvers, encoders, etc). The sensed information is scaled appropriately for the antenna. This sensed position is displayed in angular format.

The boresight of the antenna is displayed for the azimuth and elevation axis. In elevation, this angle is with respect to the local horizontal. In azimuth, this angle the true azimuth pointing angle.

The following diagram shows a typical range of movement for an earth station antenna
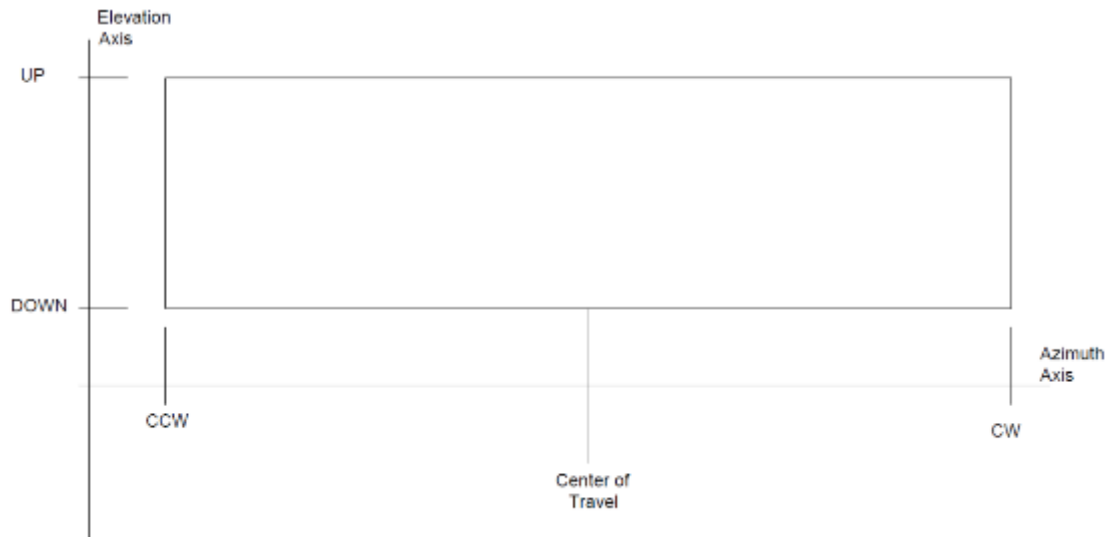
In the azimuth axis, movement in one direction is disabled when clockwise and counterclockwise limit switches are activated.

In the elevation axis, movement in one direction is disabled when up and down limit switches are activated.

4.2.3.1   Jam, Runaway, and Drive Error Sensing

The RC4500 continuously monitors the axis positions to detect incorrect movement of the antenna. If an axis has been commanded to move and no movement has been detected, the controller will declare a "JAM" condition and not allow further movement until the condition has been reset.

Similarly, if the ACU sensed movement in the elevation axis when no movement was commanded, the ACU will declare a "RUNAWAY" condition and not allow further movement until the condition has been reset.

The RC4500 also continuously monitors the azimuth and elevation motor drive current. If at any time the current sensed rises above the value set in the system configuration, the ACU will declare a "DRIVE" condition and not allow further movement until the condition has been reset.

In some applications, the current output from each drive is also limited by the setting of the servo drive. This value can only be changed by factory technicians.

4.2.4 Timekeeping

There are several versions of time (system, sidereal, display and GPS) discussed within this manual.

System time is maintained by the ACU's real time clock. The real-time clock is backed up by battery so that system time is available as soon as the ACU powers up. The system time is used to calculate **sidereal time** for maintaining track tables. Since satellite's do not experience time shifts (such as from Standard Time to Daylight Savings Time or when moving from one time zone to another), it is recommended that system time not be modified while active track tables are present. If system time is changed, the information stored in track tables for inclined orbit satellites will no longer be valid.

The ACU's system time is set to approximately **Universal Coordinated Time (UTC)** at the factory.   It will vary from UTC due to the tolerance of the real-time clock.

The GPS receiver allows the ACU to parse UTC from the data sent by the GPS receiver. This data is only available when the GPS receiver is sufficiently locked on to GPS satellites to determine UTC. The ACU allows the user to synchronize system time to the UTC reported by the GPS receiver. The ACU will also automatically synchronize time shortly after power on, and at an 11 hour interval during operation.

The period of a satellite's motion is one sidereal day (approximately 23 hours 56 minutes 4 seconds). Base points in the track table for an inclined orbit satellite are stored at intervals of 1/48th of a sidereal day. The ACU determines at what point in a sidereal day (with respect to the reference) it is by calculating how many sidereal days have passed from January 1, 2000 until the present system time.

In several screens the ACU displays a **display time**. The user may designate a three-letter time zone designation and an hourly offset from system time. This allows the user to display local time or some other time without modifying system time. If system time is maintained close to UTC, the time displayed may be of use to operators for coordinating events.

See section 2.1.1.3.2.3 for details on time maintenance.