RC4600 SERVO ANTENNA CONTROLLER BOARD SET OPERATOR MANUAL

RESEARCU CONCEPTS INC.

9501 Dice Lane

Lenexa, Kansas 66215 USA

VOICE: +1(913) 422-0210 FAX: +1(913) 422-0211

www.researchconcepts.com support@researchconcepts.com

Contents subject to change

Serial No_____

Revision History

DATE	MODIFICATION	SW VERSION	INITIALS
5 MAY 2017	Preliminary document, derived from RC4000 User's Manual	1.00	JDK
29 NOV 2017	Engineering Release	2.03	CJ
8 FEB 2019	Initial Production Release	2.10	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.

Repaired Products

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.

Repair fees for end users are a flat charge based on the equipment being repaired.

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. **

___

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.

Correct maintenance, repair, and use are important to obtain proper performance from this product. Therefore, read the instruction manual carefully and completely. This warranty does not apply to any defect that RCI determines is due to, but not limited to:

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.

For service: +1 (913)422-0210 support @researchconcepts.com

Table of Contents

1 INTRODUCTION

The RC4600 Servo Antenna Control Unit (ACU) board set consists of a stackable set of cards allowing for compact and flexible ACU packaging. The design and function of the RC4600 ACU is a continuation of development based on the RC4000 line of mobile antenna control systems.

PLEASE READ AND UNDERSTAND THE MANUAL. Due to the complexity of the functions performed by the RC4600, time invested in understanding its installation and operation will be well spent.

1.1 Manual Organization

The RC4600 board set allows for ACU functionality to be packaged in varied configurations. Also many hardware and software options are available for use with the RC4600 architecture. This manual is organized to:

1) Describe common hardware and software elements that will apply to all instances of the RC4600
2) Provide a structure to allow definition of elements unique to a specific use of the RC4600

Chapter 1 summarizes the contents of the manual and highlights the functionality and features of the RC4600.

Chapter 2 describes the core software features of the RC4600.

1.2 Manual Conventions

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

```
AZ:    0.000 STOW    BCN:2438         MANUAL
EL:   16.917         SAT:
PL:    0.000         SPD:FAST             CST
<0-9>JOG ANTENNA <MODE>MENU       14:25:47
```

The following table shows typical abbreviations used both on RC4600 screens and in the manual's text.

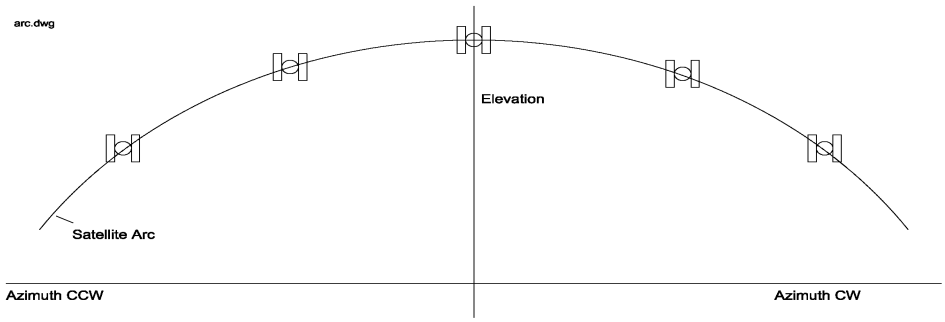
ITEM	ABREVIATION(S)
Platform angles relative to reference position	az, el
Horizontal angles relative to the local horizontal plane	AZ, EL
True Heading (estimate)	th
True Heading (fixed)	TH
Clockwise	CW
Counter-Clockwise (Anti-Clockwise)	CCW
Down	DN
Latitude	LAT
Longitude	LON
Satellite	SAT
Global Positioning 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/minute (38°56 N) format.

When referring to an RC4600 mode of operation, that mode's name will be capitalized – ex. LOCATE.

Throughout the RC4600 manual and software, the latitude, longitude and true heading of the mount are collectively referred to as the mount's "position".

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



1.3 RC4600 Features

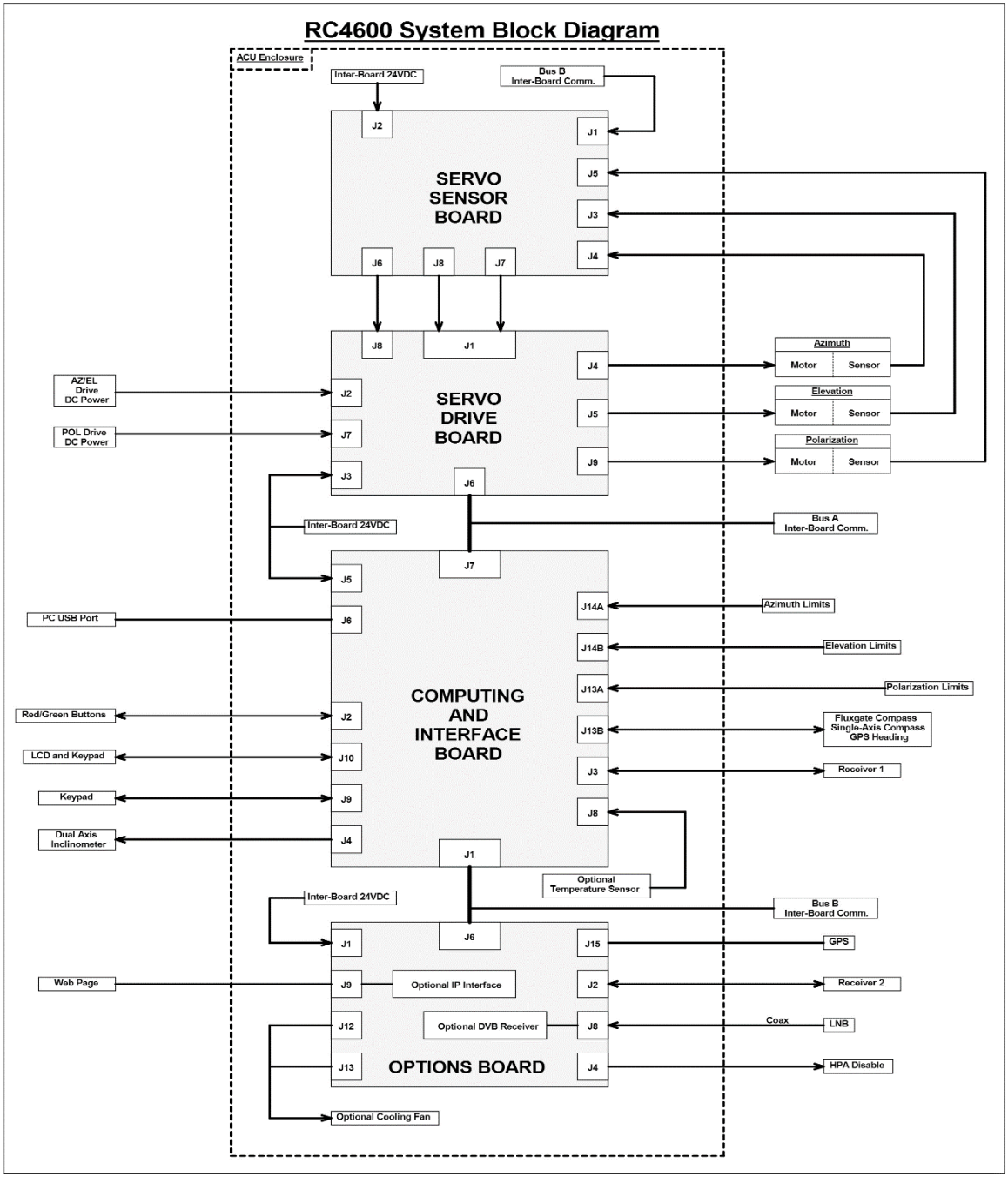
The RC4600 performs its functions via digital and analog electronic equipment interfaced to the antenna's motor drive and position sensor systems. This equipment is controlled through embedded software algorithms run by the RC4600's microcontroller.

The RC4600 ACU is designed to automate the operation of mobile (both vehicle mounted and deployable) mounts. Features provided include:

- Automatic azimuth and elevation pointing solution calculation
- Optional GPS receiver for determination of antenna latitude and longitude
- Automatic tracking of inclined orbit satellites
- Automatic polarization control of rotating feeds
- Battery backed-up non-volatile memory for storing satellite locations and configuration data
- Automatic repositioning to stored satellites
- Small stackable boards for flexible ACU packaging
- Continuous monitoring of antenna drive status
- Support for multiple band satellite operations
- Multiple Heading Sensor (Compass) Options
    - Fluxgate Compass
    - Three Axis Compass
    - Differential GPS Antenna Compass "GPS Compass"
- Multiple User Interface Options
- Optional Liquid Crystal Display (LCD) and keypad
- Ethernet (IP-based) remote control
    - Webpage Graphical User Interface (GUI)

1.4 Hardware Overview

The following figure is a block diagram showing the four major components of the RC4600 board set and how they interface with a typical antenna system.



Individual interfaces will be described in detail in Chapter 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 RC4600 allows easy antenna control via its mode-based operation. Multiple user interfaces (local and remote control) options exist. Section 1.5.1 highlights the software functions by showing data that would be presented if a user interface utilizes the 4x4 keypad and 4x40 LCD screen. Section 0 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 RC4600.

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 Manual

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

```
AZ:    0.000 STOW    BCN:2438         MANUAL
EL:   16.917         SAT:
PL:    0.000         SPD:FAST            CST
<0-9>JOG ANTENNA <MODE>MENU      14:25:47
```

1.5.1.1.2 Automatic Locate

In LOCATE mode, azimuth and elevation pointing angles are automatically calculated based on position data (Lat/Lon), platform heading, platform pitch/roll and the selected satellite. Position data may be obtained automatically from a GPS receiver, selected from a preset list of user defined positions or entered manually. Heading may be automatically obtained from a compass or entered manually. The platform pitch/roll will be automatically obtained from a tilt sensor. The user selects which satellite to locate from the satellite database or by manually entering satellite data. The RC4600 checks that the calculated pointing solution is within the antenna's range of movement and prompts the user to automatically position the antenna.

```
ANT:     38_57N   94_45W   178.7      LOCATE
SAT:WB-1          111.2W         AZ:    26.5
                                 EL:    41.8
<1>SELECT NEW SAT          READY TO LOCATE
```

1.5.1.1.3 Automatic Antenna Stow

From STOW mode, the user may ask for the antenna to be automatically moved to the stow position.

```
az:    0.000  (    0.0)                  STOW
el:   22.230  ( -75.5)

MOVING ANTENNA TO STOW          <STOP>HALT
```

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 RC4600 for use with a particular antenna. Note that most configuration items will be factory set for correct operation with a particular antenna.

```
MODE:2 ANT SIZE: 240        CONFIG-SYSTEM
 GPS:2 ANT LOOK:1             DRIVE:1
COMP:2 COMP OFF:    0.0     DISPLAY:2
<1-LOCATE 2-MENU 3-MANUAL 4-VSAT 5-POS>
```

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:10/22/18 16:57:45             TIME
DISPLAY:10/22/18 16:57:45         ZONE:UTC
GPS UTC:10/22/18 16:57:45      OFFSET:  0
1-DATE 2-TIME 3-SYNC 4-ZONE 5-OFFSET
```

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

	RC4600 BOARDSET
Physical	
Size	6 1/16" x 7" x 3 3/4" (with RCI plate and RF board)
Weight	2.6 lbs.
Input Power	Default: 20 - 28 VDC Other options available
Fusing	Mount and input power dependent
Temperature (Operational)	-40 to +60 deg. C.
Temperature (Storage)	-40 to +70 deg C.
Humidity	35% to 85% (optional special-environmental kit available)
Antenna Drive	
Azimuth/Elevation	Default: 24VDC, 20 Amps (combined AZ/EL) Other options available
Polarization	24VDC, 2 Amps
Electromechanical Brakes (optional)	24 VDC, 850 mA
Position Sense	
Azimuth/Elevation	ENDAT optical encoder (25 bit) or Resolver (16 bit)
Polarization	ENDAT optical encoder (23 bit), Resolver (16 bit), Multi-Turn Potentiometer
Limit Switch Inputs	5 VDC inputs, standard: EL Up, EL Down, EL Stow, AZ Stow, Pol Stow typical + additional inputs optional, mount dependent
Locate Mode	
AZ/EL Pointing Accuracy	±0.006° (Resolver), ±0.001° (Optical Encoder)
POL Pointing Accuracy	±0.08° (typical)
Pitch and Roll Sensing	±15° pitch and roll
VSAT Mode	Single key-press-to-locate-operation for untrained operators
Positive Satellite Identification	Multiple Beacon Tracking Receiver Options, DVB-S2, and Spectrum Analyzer.
External AGC	Support for external analog signal source and lock input
Track Mode	
Antenna Size	0.4 – 10.0 meters
Tracking Accuracy	0.1 to 3.0 dB selectable; mount dependent
Maximum Inclination	15°, standard
Inclined Orbit Tracking Modes	Step-Tracking, Step/Memory Tracking, Predictive Tracking, NORAD TLE tracking

2 SOFTWARE

2.1 Operation Overview

The RC4600 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 LCD display. Operation using this method will be described in section 0 and includes the following methods of control:

- Rackmount 4600 Front Panel
- Handheld Remote Front Panel
- IP based remote front panel

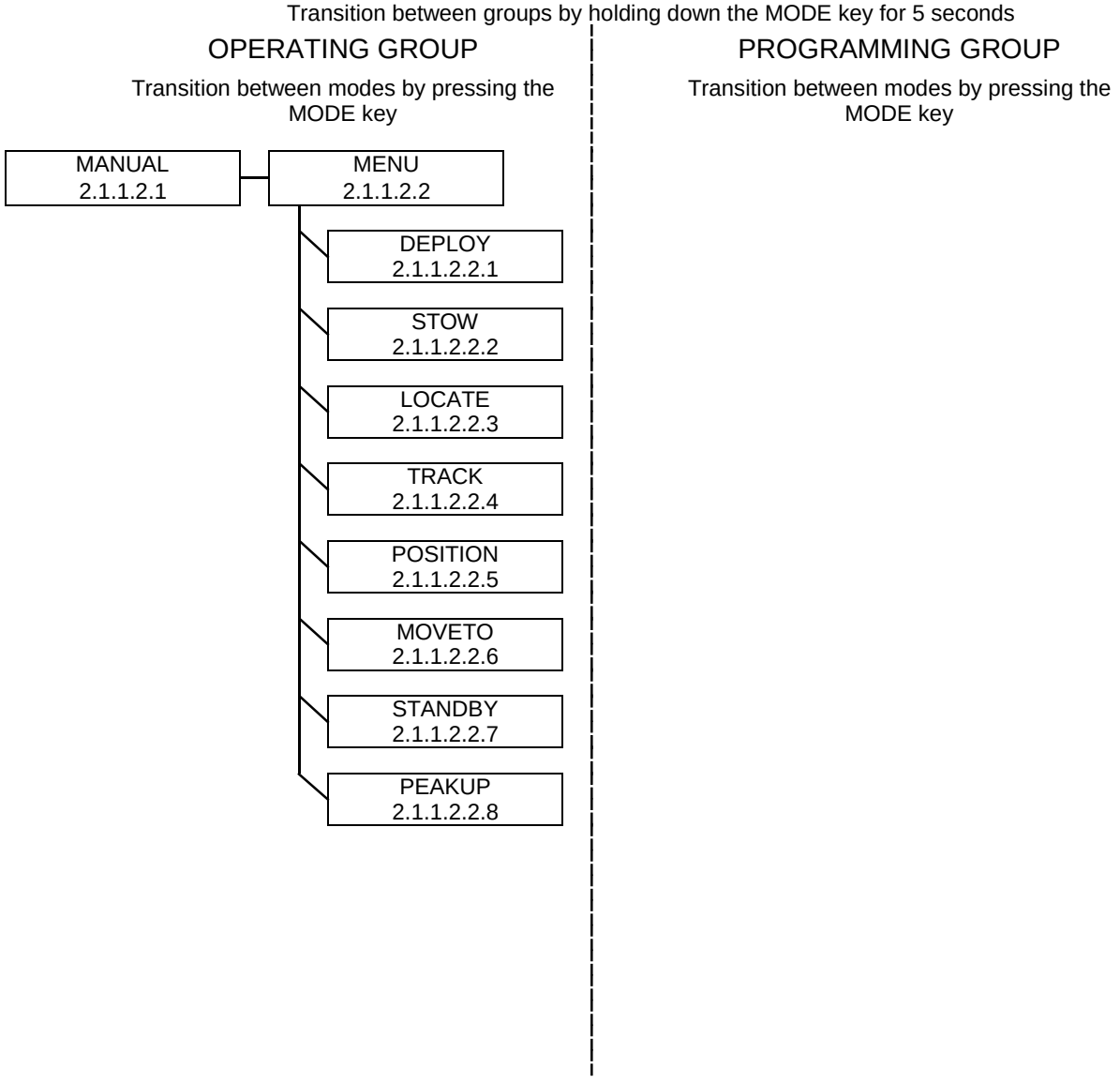
The second is an IP based graphical user interface (GUI) method of control. Operation using this method will be described in section 0.

2.1.1 Front Panel Software Operation

2.1.1.1 Front Panel Software Overview

2.1.1.1.1 Modes

The functionality of the RC4600 is achieved by placing the controller in the desired mode of operation. The diagram below shows the hierarchy of the RC4600's modes. Each mode has a unique display screen that presents the information applicable to that mode's operation.



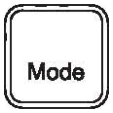
After initial pairing of an RC4600 to an antenna, the programming modes will typically not be used. Section 2.1.1.2 will give further details on the operating modes. The rest of section 2.1.1 introduces common elements of all modes.

2.1.1.1.2 Keypad Usage

The keypad provides a flexible method of controlling the functionality of the RC4600. While each RC4600 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	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 Up Angle/CT	Toggles between multiple az/el position display options in Manual Mode	Scrolls forward through lists. Provides “YES” answer to prompts.
	Scroll Dn RF/SS	Toggles between displayed signal strength sources in Manual Mode	Scrolls backward through lists. Provides “NO” answer to prompts.
	Enter	Heading Fix in Manual Mode	Complete entry of data. Select entry from list. Access sub-mode in CONFIG mode.
	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 El 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 Pol CW	Jogs polarization motor clockwise when pol is movement allowed	Supplies “3” for numeric entry.
	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	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 Data Entry

Many RC4600 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 very similar to entering integer values except that the decimal point is inserted by using the <Stop> key.

Degree/Minute Latitude/Longitude Entry (TRUCK LAT:38°56N)

Entering Latitude or Longitude is similar to entering a floating point value but the decimal point is used to place the degree sign delimiter. Following the degree sign, only values from 0 to 59 are valid since they represent minutes. 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 similar to 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 RC4600 mode displays.

```
AZ:   -4.434          BCN: 659 L       TRACK
EL:   44.762          SAT:GALAXY 28 (Ka)
                      TLE:IDLE          23:10
WAITING TO REPOSITION...             <0>-MENU
```

MODE TITLE: In the upper right corner the title of the current RC4600 mode is displayed – in this example TRACK designates that the RC4600 is currently in track 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 horizontal 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 platform azimuth angle (AZ:) is -4.434. Likewise the satellite being tracked (SAT:) is GALAXY 28 (Ka).

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, <0> tells the user that pushing the mode key will transition the RC4600 to TRACK 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 RC4600 is displayed. In the above example, "WAITING TO REPOSITION…" describes the fact that since the RC4600 is currently in the IDLE portion of the TLE track operation the controller is waiting until the appropriate calculated time to perform the next TLE reposition movement.

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 RC4600 is functioning. In the above example, the current system time (23:10) 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 RC4600 has detected. The alarm message will alternate with the text normally on row 4. See section 3.1.2 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 RC4600's automatic movement features. While in either one of these modes, a momentary push of the Mode key will transition the RC4600 to the other mode.

2.1.1.2.1 MANUAL Mode

```
AZ:    0.000 STOW    BCN:2438          MANUAL
EL:   16.917         SAT:
PL:    0.000         SPD:FAST             CST
<0-9>JOG ANTENNA <MODE>MENU         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:/TH:/MG:/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.

The value displayed may be changed by the <Scroll Up/Angle CT> key. The display will rotate between showing local horizontal relative (AZ), true heading horizontal relative (TH), magnetic heading horizontal relative (MG) and platform relative (az) values.

The local horizontal relative azimuth angle is calculated by taking the current platform relative azimuth and elevation angles along with the pitch and roll of the mount. If there is currently no mount pitch and roll. The local horizontal relative azimuth angle will display the same value as the platform relative azimuth angle.

The true heading horizontal azimuth angle is derived by taking the current heading estimate of the mount (see the LOCATE function) and adding local horizontal relative azimuth angle and the magnetic variation for the current location. If there is currently no mount heading estimate, the field will display "********". If the current heading estimate has not been "fixed" (either manually or automatically by the DVB receiver function), the field display th: instead of TH: to indicate that the heading value may be inaccurate due to compass error.

The magnetic heading horizontal azimuth angle is derived by taking the current heading estimate of the mount (see the LOCATE function) and adding local horizontal relative azimuth angle. If there is currently no mount heading estimate or lat/lon, the field will display "********". If the current heading estimate has not been "fixed" (either manually or automatically by the DVB receiver function), the field display mg: instead of MG: to indicate that the heading value may be inaccurate due to compass error.

EL:/el:

The EL 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.

The value displayed may be changed by the <Scroll Up/Angle> CT key. The display will rotate between showing local horizontal relative (EL) or platform relative (el) values.

The local horizontal relative elevation angle is calculated by taking the current platform relative azimuth and elevation angles along with the pitch and roll of the mount. If there is currently no mount pitch and roll. The local horizontal relative elevation angle will display the same value as the platform relative elevation angle.

Following a LOCATE operation, the azimuth and elevation limit fields will display the target angles in parenthesis. If a limit condition is active, the limit display will overwrite the target values.

PL:/pl:

The PL 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 LOCATE operation occurred prior to MANUAL, the H and V values will be those automatically calculated by the LOCATE 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. For example, if a cross polarization movement of 90

degrees clockwise will move the axis beyond the clockwise limit, the movement will be achieved by moving 90 degrees counter-clockwise.

RF/EXT/BCN/DVB:

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. If the controller is equipped with an optional internal DVB-S2 receiver, **DVB** will also be available as a signal source.

The current signal strength will be displayed as a value between 0 and 1023 for **RF** and **BCN** or 0 and 4096 for **EXT** or **DVB**.

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.

SPD:

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

TIME DISPLAY

MANUAL mode will display the "display time" and time zone in the lower right-hand corner.

2.1.1.2.1.1 Heading Fix

After a LOCATE operation has occurred, the operator is delivered to MANUAL mode and the user is given the ability to correct the mount's true heading based on where the selected satellite is found. This HEADING FIX capability is available when all the following conditions are true:

1) MANUAL mode was entered following a successful LOCATE
2) The selected satellite is geostationary (inclination = 0)
3) The mount's position has not already been saved
4) The heading has not already been fixed (automatically or manually)

When the above conditions are present, the "<0-9>JOG ANTENNA" message at the bottom of the LCD will alternate with "<ENTER>FIX HEADING" message. The user should positively identify that he is on the selected satellite and manually peak up in azimuth and elevation. When the Enter key is pressed, the MANUAL mode will switch to the following screen.

```
CURRENT HEADING: 178.7        HEADING FIX
 ACTUAL HEADING: 175.4  SAT:GALAXY 28
     DIFFERENCE:  -3.3
<BKSP>APPLY DIFF. TO HEADING  <MODE>EXIT
```

The HEADING FIX screen shows the name of the selected satellite in the SAT: field. The CURRENT HEADING field shows the heading originally determine by the LOCATE function based on the mount's current position. The ACTUAL HEADING field shows the where the user peaked up on the satellite while in MANUAL mode.

The DIFFERENCE field shows the value obtained by subtracting the CURRENT HEADING from the ACTUAL HEADING. This difference should reflect the error in the mount's true heading. Pushing the <BKSP> key will apply the difference to the mount's heading for use in subsequent LOCATE operations.

NOTE: to make this "fixed heading" persist through the next powering down of the RC4600, the mount's position would need to be "saved" via the POSITION mode. If the difference is applied, the RC4600 will proceed to the POSITION screen.

If the user is unsure that applying the difference is the correct thing to do, pressing the <Mode> key will return the RC4600 to the MANUAL mode.

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.

```
1-DEPLOY   2-STOW     3-LOCATE       MENU
4-TRACK                           0-PEAKUP
7-POSITION 8-MOVETO   9-STANDBY      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 DEPLOY

The DEPLOY mode automatically moves to the mount's predefined "deploy" position. See Appendix B for the list of deploy positions for the various mounts supported. The deploy command requires an explicit confirmation in order to initiate antenna movement.

```
                                        DEPLOY
<MODE>MENU (DO NOT DEPLOY)
<BKSP>CONTINUE DEPLOY
```

Pressing the <BKSP> key will initiate the DEPLOY movement. If the DEPLOY mode was inadvertently entered, pressing the Mode key will return to the MENU mode without initiating antenna movement.

```
az:    0.000   (    0.0)              DEPLOY
el:   13.236   (   16.0)

MOVING ANTENNA TO DEPLOY       <STOP>HALT
```

As each axis moves, its label (az/el/pl) will flash and the current position will update. The target deploy positions will be displayed in parenthesis. The sequence of axis movement will be mount dependent.

Following completion of movement to the deploy position, the RC4600 will return to MANUAL mode. The automatic movement may be terminated anytime by pressing the <Stop> key.

2.1.1.2.2.2 STOW

The STOW mode automatically moves to the mount's predefined "stow" position. See Appendix B for the list of stow positions for the various mounts supported.

Like the DEPLOY mode, STOW requires an explicit confirmation to initiate movement.

```
                                                STOW
<MODE>MENU (DO NOT STOW)
<BKSP>CONTINUE STOW
```

After initiation a sequence of movements will be performed to stow the antenna. The sequence of axis movements will be mount dependent. As each axis moves, its label (az/el/pl) will flash and the current position will update. The target stow positions will be displayed in parenthesis.

```
az:    0.000    (    0.0)                STOW
el:   13.236    (  -75.5)

MOVING ANTENNA TO STOW          <STOP>HALT
```

The following describes a typical sequence of movements:

- the azimuth axis is moved to its predefined stow position (typically az:0.000). After moving to this indicated position, the RC4600 will confirm the position by looking to see if the azimuth stow switch is active. If the azimuth stow switch is not recognized, the mount will be moved a short distance to either side of the current position trying to find the azimuth stow switch. If the controller fails to see the azimuth stow switch the following message will be displayed: "*CANNOT FIND AZ STOW SWITCH* <MODE>EXIT" and no further stow movements will be performed.

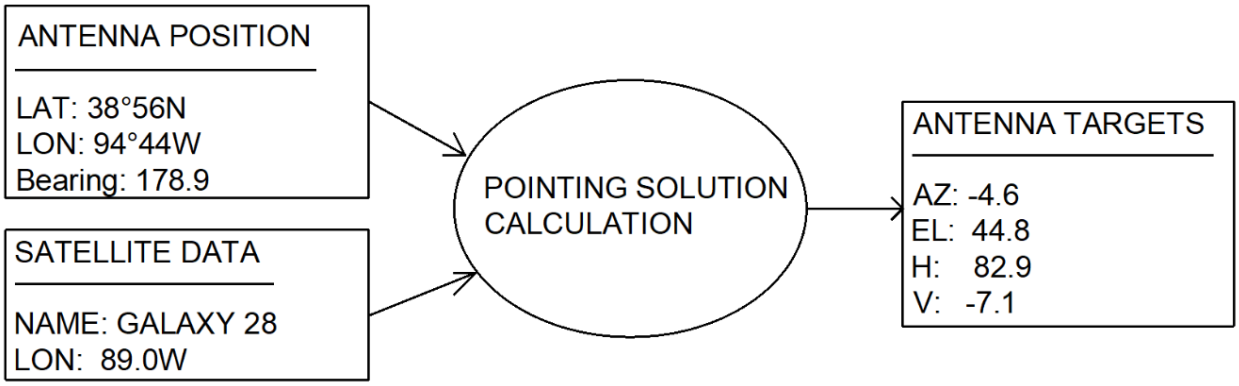
- if stowing of the polarization axis is enabled, the polarization axis will next move to its predefined stow position. As with the azimuth axis, if a polarization stow switch (if the mount is so equipped) is not confirmed then the message "*CANNOT FIND POL STOW SWITCH* <MODE>EXIT" will be displayed and no further stow movements will be performed.

- if the azimuth and optional polarization movements complete successfully, then the elevation axis will move to its predefined stow position. Typically, this movement ends when the elevation stow limit is encountered.

Following completion of movement to the stow position, the RC4600 will return to MANUAL mode. The automatic movement may be terminated anytime by pressing the <Stop> key.

2.1.1.2.2.3 LOCATE

The LOCATE mode performs a calculation of the pointing angle (3.2.1) to a selected satellite based on the RC4600's estimate of where the antenna is positioned (lat/lon) and oriented (Antenna Bearing). After the calculation is performed, the user may initiate an automatic antenna movement to locate the selected satellite.



When the LOCATE mode is first entered, the following screen appears.

```
ANT:    38_57N  94_45W  178.9      LOCATE
SAT:GALAXY 28    89.0W         AZ:    -4.6
                               EL:    44.8
<1>SELECT NEW SAT          READY TO LOCATE
```

ANT: 38_57N 94_45W 178.9

The ANT: field shows the RC4600's current estimate of antenna position. If no estimate of antenna position is available, the RC4600 will automatically attempt to obtain position information from the navigation sensors (GPS receiver and compass) if present prior to displaying the initial screen above.

Mount Position Initialization. In order to calculate a pointing solution, the RC4600 requires knowledge of the mount's "position". The three components of mount position are latitude, longitude, and true heading.

The current latitude, longitude and true heading where the RC4600 believes the antenna is positioned are displayed on the top line. The position data obviously affects the pointing angle that the RC4600 calculates and is displayed as a crosscheck for the user in case the vehicle has been moved and the RC4600's position has not been updated. If the lat/lon or heading data is not considered valid by the RC4600, asterisks will be displayed in the appropriate field and the "parameter needed" message will be triggered in the location readiness field.

The RC4600 polls the GPS receiver first to get latitude and longitude information. If no communication with the GPS is received, the error message "GPS OFFLINE" will be displayed. In this case the interface between the RC4600 and the GPS receiver would need to be checked. If the RC4600 is communicating with the GPS receiver but the GPS indicates it has not yet been able to generate a valid lat/lon, then the message "NAV NOT READY" will be displayed. The "NAV NOT READY" situation should typically not last for more than a minute. If it does, then investigate whether the GPS receiver's view of the sky is blocked by buildings, etc.

If a valid lat/lon is received from the GPS then the lat/lon information will be displayed. Next the RC4600 will flash “MAGVAR” while it calculates the local magnetic deviation as a function of latitude, longitude and time. After calculating the local magnetic variation, the RC4600 will poll the compass for magnetic heading information. The magnetic variation will be applied to the magnetic heading to form the estimated true heading of the mount.

If the navigation sensors (GPS and/or compass) are not working (or not available), the position information may be entered manually via the POSITION mode (2.1.1.2.2.5).

SAT: GALAXY 28 89.0W

<1>SELECT NEW SAT

The SAT: field shows the currently selected satellite’s name and longitude. When the mode is first entered, the name of the last satellite selected will be displayed. If the user wishes to locate another satellite, he may start the process of selecting the new satellite by pressing the "1" key. See 2.1.1.2.2.3.1 for further details on the three methods of selecting a satellite.

When the selected satellite is changed, the LOCATE mode will automatically calculate new azimuth and elevation pointing targets.

AZ: -4.6

EL: 44.8

These fields show the azimuth and elevation pointing angles calculated for the selected satellite based on the current mount position estimate. If one of the required parameters is missing or the calculation has yielded an invalid answer, asterisks will be displayed in these fields.

NOTE: the displayed AZ target is not a true heading display but rather a mount-relative angle. The elevation target is a true elevation value.

Location Readiness Status

In the lower right corner of the display, a message is displayed showing the status of the location calculation. Three messages may be displayed:

1) PARAMETER NEEDED. The pointing angle calculation requires 3 sets of data:

    a. Antenna lat/lon
    b. Antenna Bearing
    c. Satellite Information

    If lat/lon and/or heading is missing/invalid, the user will need to go to POSITION mode (2.1.1.2.2.5) to enter valid data. If satellite information is missing/invalid, the user will need to supply that information via the mechanisms described in section 2.1.1.1.3.

2) AZIM/ELEV RANGE ERROR. These messages will occur if the pointing solution calculation yields an azimuth angle that is outside the clockwise or counter-clockwise azimuth software limit or outside the up or down elevation software limits. The appropriate message will be displayed to indicate that the RC4600 does not think it can move the antenna to the correct position to acquire the satellite. The user may have to move the antenna to place it in an orientation that will allow the mount to move to the required position. Note that this message may indicate that the current position data is incorrect (example: wrong heading).

3) READY TO LOCATE / PRESS <ENTER>. This alternating message indicates that the RC4600 considers the calculated pointing solution valid. Pressing the <Enter> key will initiate automatic movement to find the selected satellite as described in section 2.1.1.2.2.3.2.

2.1.1.2.2.3.1 Satellite Selection

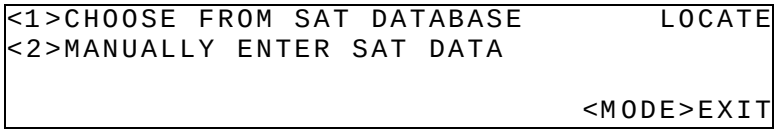
Several pieces of information must be provided to describe a satellite to the RC4600 before the satellite may be automatically located:

LONGITUDE: described in decimal degrees (180.0W to 180.0E)

INCLINATION: the number of degrees of orbital inclination. If a satellite is described as having an inclination greater than zero, the RC4600 will consider it an inclined orbit satellite and subsequently attempt to track its movement.

BAND: the RF band that the user's equipment will be receiving from the satellite. The band information helps determine tracking movement size and timing. Throughout the RC4600, the bands are assigned numbers from the following list: <0-C 1-Ku 2-L 3-X 4-Ka 5-S>

When the <1> key is selected from the main LOCATE screen, the following screen appears to allow the user to select new satellite information via three methods.



<1>CHOOSE FROM SAT DATABASE

```
                                          LOCATE
 #   NAME        LON  INC  BAND  EPH
 3 GALAXY 28   89.0W  0    KA    Y
<SCR>THRU LIST <ENTER>SELECT  <MODE>EXIT
```

When the user chooses to select a satellite from the satellite database, a screen appears allowing the user to scroll through the list and select a satellite by pressing the Enter key. The satellite database contains data for 20 satellites programmed into memory.

<2>MANUALLY ENTER SAT DATA

```
                                          LOCATE
 LON:                INCLIN:
BAND:
LONGITUDE <DDD.T DEG>
```

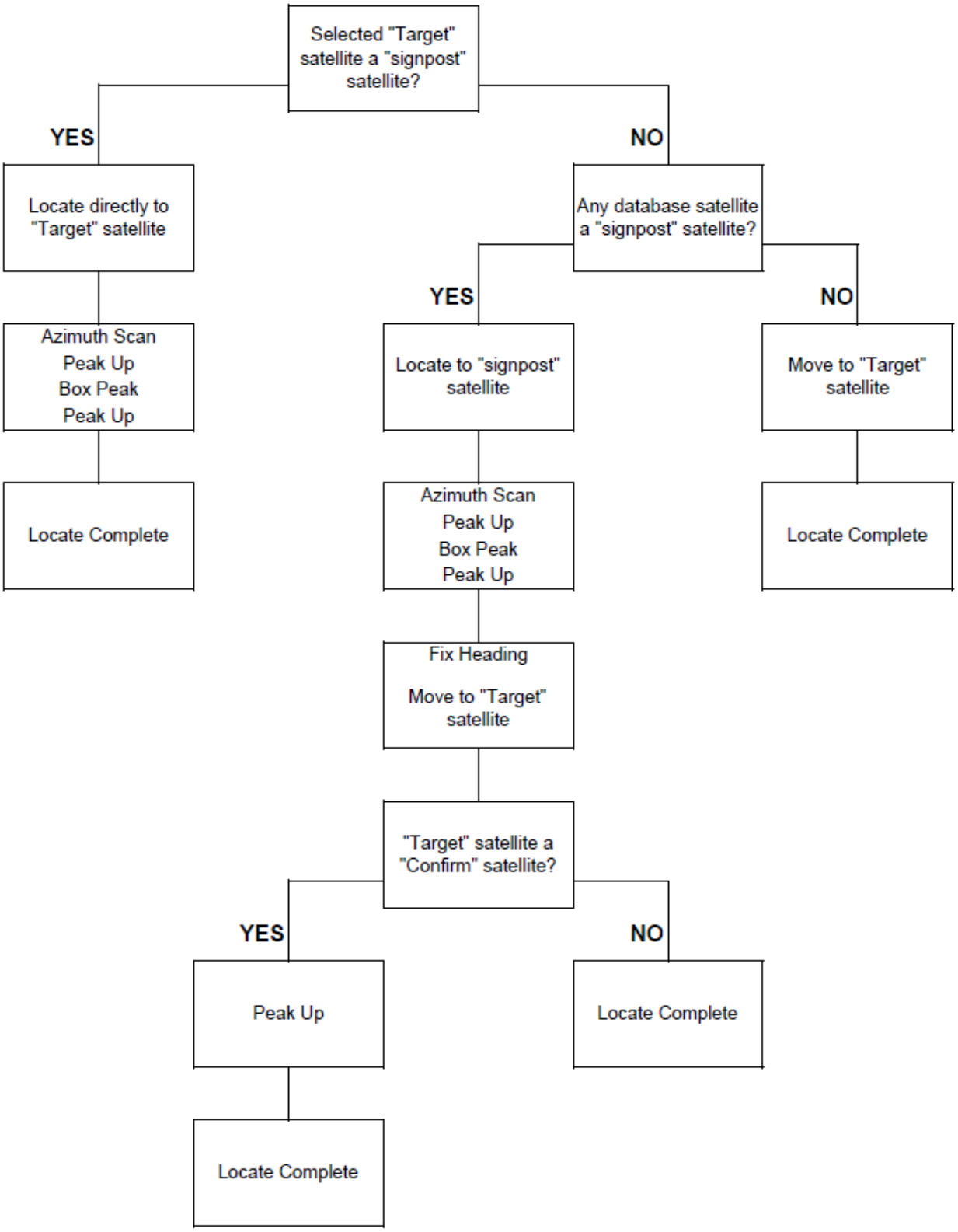
When the user chooses to manually enter the satellite data, a screen appears with fields to enter the three required pieces of data.

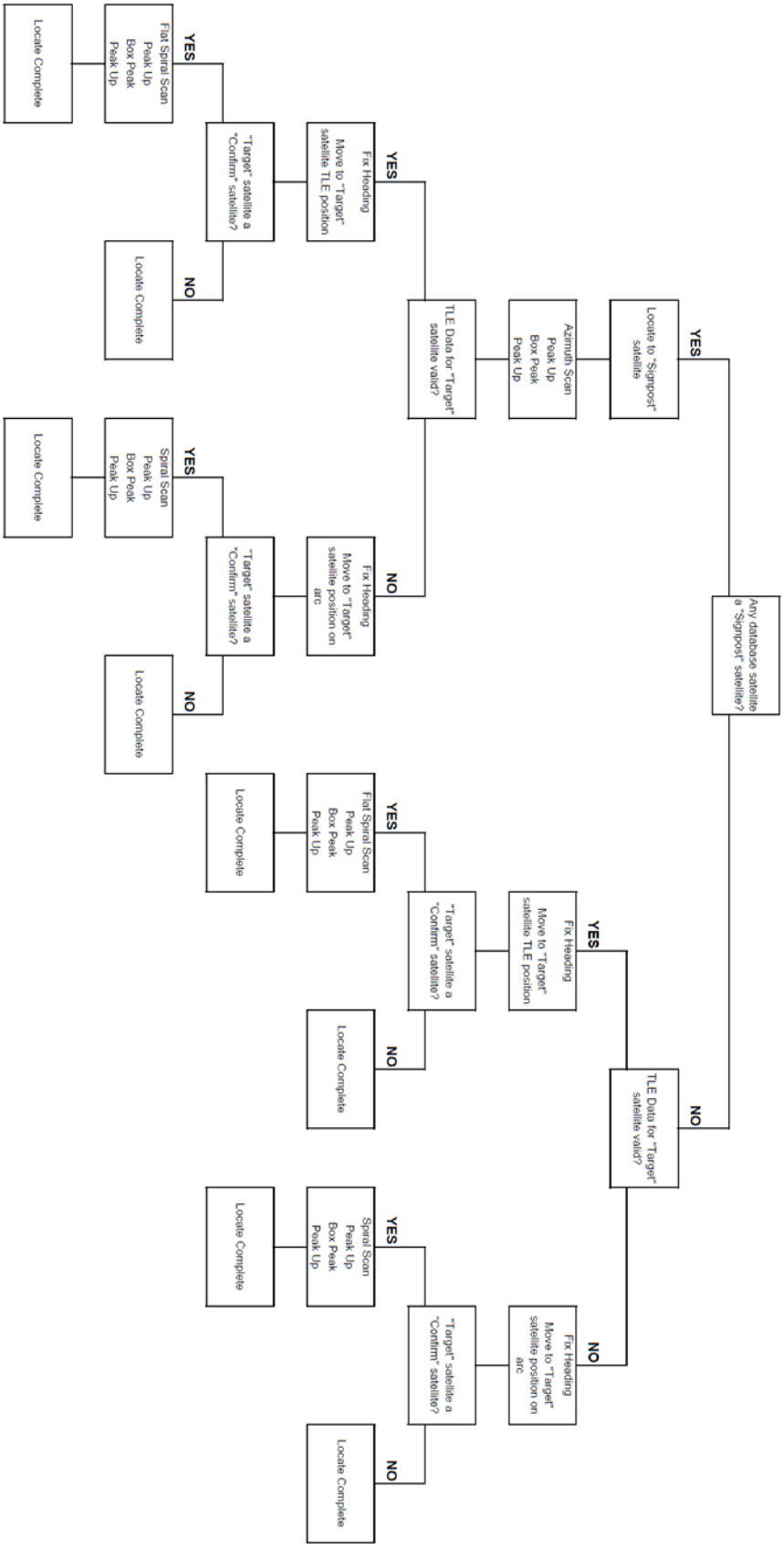
When locating a satellite, the RC4600 will use the information available in the satellite database to locate the selected satellite. The trees for selecting which satellite to use for a locate is shown in the flowchart on the following two pages.

The first tree is for satellites that have are not defined as inclined in the satellite database. The second tree, if for satellites that are defined as inclined in the satellite databased.

There are 3 types of satellites defined in the locate tree. The characteristics of each type of satellite are described below.

- "Target" Satellite
  - This is the satellite that was selected in the LOCATE mode.
  - It is the end location of any locate routine.
- "Signpost" Satellite
  - This is a satellite that has a DVB or Beacon frequency set to signpost.
  - Can also be the "Target" satellite.
  - Will be used to auto fix heading.
- "Confirm" Satellite
  - This is a satellite that has a DVB or Beacon set to confirm.


Selected "Target" satellite a "signpost" satellite?
YES
NO
Locate directly to "Target" satellite
Any database satellite a "signpost" satellite?
YES
NO
Azimuth Scan
Peak Up
Box Peak
Peak Up
Locate to "signpost" satellite
Move to "Target" satellite
Locate Complete
Azimuth Scan
Peak Up
Box Peak
Peak Up
Locate Complete
Fix Heading
Move to "Target" satellite
"Target" satellite a "Confirm" satellite?
YES
NO
Peak Up
Locate Complete
Locate Complete


Any database satellite a "Signpost" satellite?
YES
Locate to "Signpost" satellite
Azimuth Scan
Peak Up
Box Peak
Peak Up
TLE Data for "Target" satellite valid?
YES
Fix Heading
Move to "Target" satellite TLE position
"Target" satellite a "Confirm" satellite?
YES
Flat Spiral Scan
Peak Up
Box Peak
Peak Up
Locate Complete
NO
Locate Complete
NO
Fix Heading
Move to "Target" satellite position on arc
"Target" satellite a "Confirm" satellite?
YES
Spiral Scan
Peak Up
Box Peak
Peak Up
Locate Complete
NO
Locate Complete
NO
TLE Data for "Target" satellite valid?
YES
Fix Heading
Move to "Target" satellite TLE position
"Target" satellite a "Confirm" satellite?
YES
Flat Spiral Scan
Peak Up
Box Peak
Peak Up
Locate Complete
NO
Locate Complete
NO
Fix Heading
Move to "Target" satellite position on arc
"Target" satellite a "Confirm" satellite?
YES
Spiral Scan
Peak Up
Box Peak
Peak Up
Locate Complete
NO
Locate Complete

2.1.1.2.2.3.2 LOCATE Automatic Movement

Before automatic movement to the calculated position is initiated, the RC4600 requests that a polarization position be selected. This is so the polarization mechanism will be in the correct position to be able to detect received signal strength.

Note: this selection is not requested if the feed type is defined as “circular”. In this case the RC4600 will immediately begin the locate automatic movement after ENTER is pressed from the main LOCATE screen.

```
H-HORIZONTAL:  -7.1                    LOCATE
V-  VERTICAL:  82.9
8-   NEUTRAL:  37.9
<H/V/8>SELECT RX POLARIZATION <MODE>MENU
```

The RC4600 calculates the vertical polarization position as a function of mount latitude/longitude and satellite longitude. The horizontal position is calculated as 90 degrees from the vertical in the direction (Clockwise/Counter-Clockwise) that will maintain the horizontal position within the polarization axis’ range of movement. The “neutral” position represents the polarization angle halfway between the calculated vertical and horizontal values. The neutral position may be appropriate if the Locate Source configuration item is set to 5 (RF).

Immediately following the polarization selection, the RC4600 will begin moving to the calculated position to continue the locate process. The progress of the movement is displayed on the following screen.

```
AZ:  -3.345 (   5.4)  BCN:         LOCATE
EL:  30.677 (  45.0)  SAT:GALAXY 28

MOVING TO START OF SCAN         <STOP>HALT
```

The current angular values for AZ/EL/PL are displayed along with the target position for each axis in parenthesis. The label for the current axis being moved will flash. Movement may be halted at any time by pressing the <Stop> key. Halting movement will return the controller to the MANUAL mode.

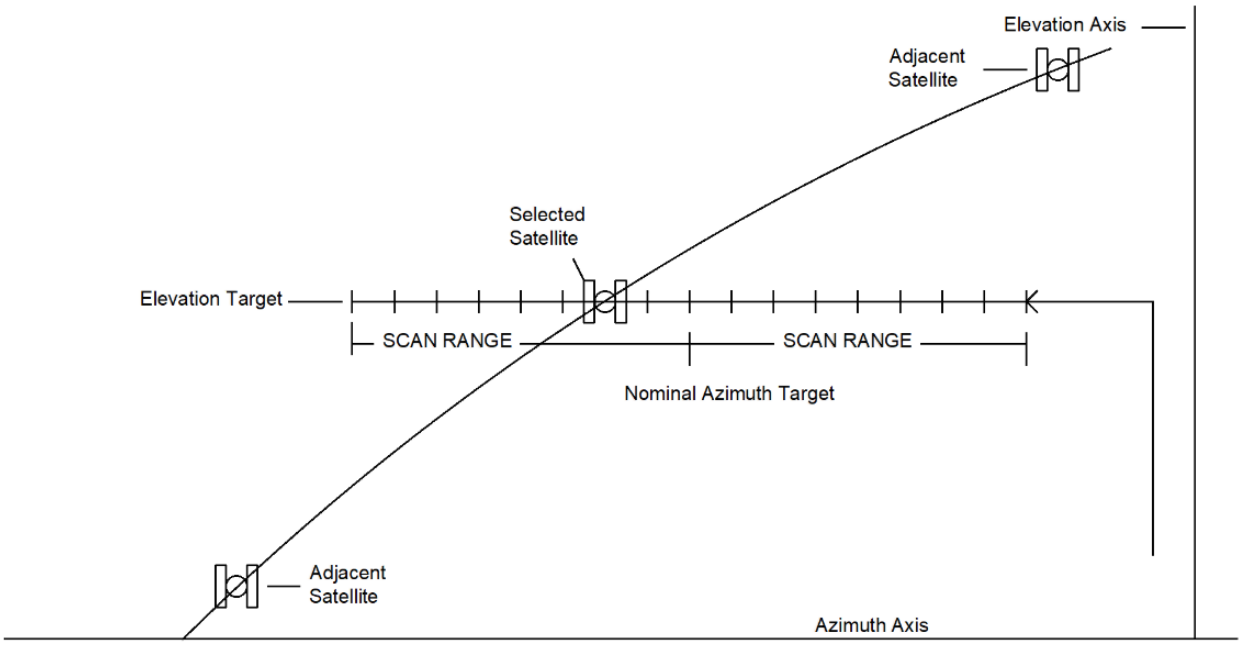
If below the down limit in elevation, the first automatic movement will be in the platform local elevation axis to ensure that the mount is brought out of the elevation stow and down regions. If above the down limit, or after moving above the down limit the RC4600 will then make an automated move in local horizontal angles to the first point of the locate routine.

If the Locate Source configuration item is set to 0 (NONE), the LOCATE mode will finish by moving to the nominal target azimuth position. A final movement to the target elevation will also be performed to account for change in mount elevation due to vehicle tilt. Following this movement, the controller will return to MANUAL mode where the user should peak up and confirm the identity of the satellite.

If configured, an azimuth scanning movement (2.1.1.2.2.3.3) will be performed if the selected satellite does not have an inclined orbit. If the satellite does have an inclined orbit, a spiral search movement (2.1.1.2.2.3.6) will be performed. For both scanning movements to be successful, the user is required to have the receiving equipment (prior to the movement) configured for the RC4600 to be able to detect signal strength.

2.1.1.2.2.3.3 Azimuth Scan

The figure shows the movements made to perform an azimuth scanning operation. This operation enables the RC4600 to try to compensate for any antenna bearing errors.



1) As part of the basic LOCATE movement, the mount will be moved to the target elevation position and the polarization axis will be moved to the correct orientation.

2) Azimuth Scan moves to the end of the “scan range” that is shortest distance away from the current azimuth position. Azimuth Scan will begin trying to detect a satellite from this position.

3) Azimuth Scan moves across the “scan range” and samples the lock signal or signal strength for the current locate source. Note that in order to compensate for any vehicle tilt, occasionally elevation movements are also made to stay on the target elevation. Note also that the Azimuth Scan movement may be truncated due to the limits of azimuth movement.

4) After completing the Azimuth Scan, the RC4600 will return the antenna to the “Center of Lock” or location of peak signal strength.

During the Azimuth Scan, line 4 of the display will provide information on what step of the locate is currently being performed. In the display below, the RC4600 is currently “SCANNING AZIM FOR LOCK”.

```
AZ:  -0.549 (  -8.3)  BCN:  50    LOCATE
EL:  44.811 (  44.8)  SAT:GALAXY 28

SCANNING AZIM FOR LOCK          <STOP>HALT
```

The “scan range” is a receiver specific user-defined angular value that determines the range to be searched by the Azimuth Scan routine. Since the angular range is user-selectable, there are two factors to take into consideration when setting this value.

1) The scan range should be larger than the accuracy of the compass. For example, if the compass is accurate to ±5° the scan range should be at least ±5. A scan range of double the compass accuracy is usually recommended for optimum operation.

2) Always ensure that there are not multiple satellites within the “scan range” that have the same carrier or beacon frequency. When this occurs, the RC4600 will have difficulty determining which satellite is the desired target.

Following the completion of the Azimuth Scan, the RC4600 will immediately move to performing an azimuth and elevation peak up.

2.1.1.2.2.3.4 Peak Up

The Peak Up routine will automatically begin at the end of an Azimuth Scan. If the heading has already been fixed, it will also perform this routine automatically at the end of a locate if configured.

If Azimuth Scan finds a lock or signal strength peak, it will return to the azimuth position where it noted the lock or peak. This position may not be the absolute peak position due to the lag of signal strength sensing during the Azimuth Scan. The Peak Up routine will next perform a “fine tune” peaking process. While executing this, line 4 will display “PERFORMING PEAKUP”.

During the Peak Up, small jogs in azimuth and elevation will be made to find the local peak position. The step sizes taken will approximate a theoretical signal strength change of 0.3 dB (according to antenna size, operating band, etc.).

The Peak Up routine can also be manually activated from the MENU mode (2.1.1.2.2.8).

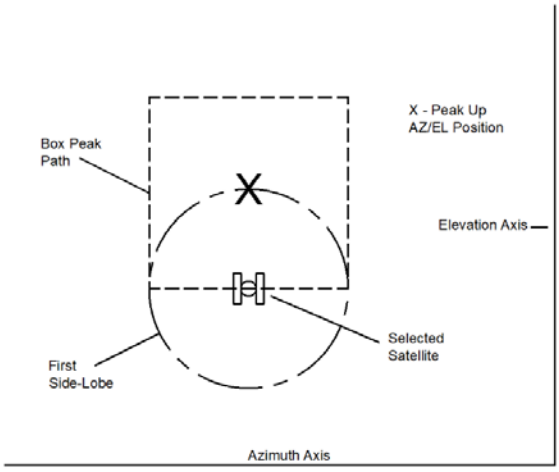
During the Peak Up operation, line 4 of the display shows “PERFORMING PEAK UP (***)”. Where *** corresponds to the size of the current peaking step in thousandths of a degree (i.e. 113=0.113°). The axis that is currently moving will also flash during the Peak Up operation.

```
AZ:  26.250 (  26.2)  BCN: 597L    LOCATE
EL:  41.769 (  41.7)  SAT:WB-1

PERFORMING PEAK UP (113)       <STOP>HALT
```

2.1.1.2.2.3.5 Box Peak

The Box Peak is a second peak operation that can be used to move the antenna from a first side-lobe and onto the main beam. If configured, the RC4600 will perform this operation immediately at the end of a Peak Up during all locates.



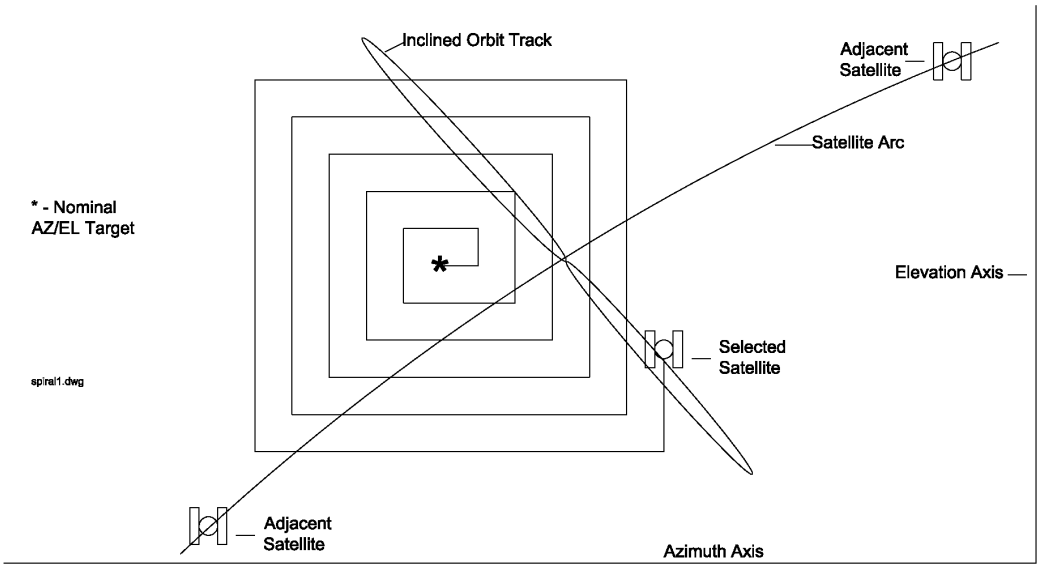
During the Box Peak routine, the antenna will scan a box that is calculated (according to antenna size, operating band, etc.) by the RC4600 to be the distance from the Peak Up routine final location. After completing this process, the RC4600 will then move to the location of peak signal strength perform a second Peak Up (2.1.1.2.2.3.4).

During the Box Peak operation, line 4 of the display shows the current direction and step number so the user can keep track of the progress of the operation.

```
AZ:  25.714 (  26.2)  BCN: 250L   LOCATE
EL:  41.098 (  41.7)  SAT:WB-1
                                      SIG
BOX PEAK (CW 1)                <STOP>HALT
```

2.1.1.2.2.3.6 Spiral Search

The Spiral Search operation performs somewhat differently from the Azimuth Scanning operation. Whereas Azimuth Scanning counts on the fact that a non-inclined orbit satellite should be at the calculated elevation, Spiral Search must account for the fact that at a particular time an inclined orbit satellite may be above or below the nominal target elevation. The figure shows the movements made to perform the Spiral Search operation.



1) As part of the basic LOCATE movement, the mount will be moved to the target elevation position and the polarization axis will be moved to the correct orientation.

2) Spiral Search will move to the target azimuth (correcting for elevation if needed) and take an initial signal strength sample. Note that the target azimuth may be slightly off due to initial compass error.

3) If no hot spot is initially found, Spiral Search will begin searching an area around the target position by stepping in a CW/UP/CCW/DN sequence using increasing number of steps in each direction to create a spiral-like pattern. Spiral Search looks for a signal strength above a defined threshold to declare an end to the Spiral Search operation. If TLE information is available for the satellite, the Spiral Search will perform a search that is wide in azimuth and short in elevation. The term for this is a “Flat Spiral Search”

4) At the end of the Spiral Search, the RC4600 will perform a Peak Up (2.1.1.2.2.3.4) and a Box Peak (2.1.1.2.2.3.5).

During the Spiral Search operation, line 4 of the display shows the current direction and step number so the user can keep track of the operation’s progress.

```
AZ:  -1.817 (  -2.0)  BCN:  50    LOCATE
EL:  44.868 (  44.8)  SAT:OG1
                                      SIG
SPIRAL SEARCH (CW 1)           <STOP>HALT
```

2.1.1.2.2.4 TRACK

Prior to entering TRACK mode, a LOCATE operation should be performed to initially place the antenna on the satellite. When the TRACK mode is first entered, the following screen appears.

```
<1>CHOOSE FROM SAT DATABASE          TRACK
<2>MANUALLY ENTER SAT DATA

                                  <MODE>EXIT
```

Several pieces of information must be provided to describe a satellite to the RC4600 before the satellite may be automatically tracked:

LONGITUDE: described in decimal degrees (180.0W to 180.0E)

INCLINATION: the number of degrees of orbital inclination. If a satellite is described as having an inclination greater than zero, the RC4600 will consider it an inclined orbit satellite and subsequently attempt to track its movement.

BAND: the RF band that the user's equipment will be receiving from the satellite. The band information helps determine tracking movement size and timing. Throughout the RC4600, the bands are assigned numbers from the following list: <0-C 1-Ku 2-L 3-X 4-Ka 5-S>

<1>CHOOSE FROM SAT DATABASE

When the user chooses to select a satellite from the satellite database, a screen appears allowing the user to scroll through the list and select a satellite by pressing the Enter key. The satellite database contains data for 20 satellites programmed by the user. **It is strongly suggested that the user program and use the satellite database.**

```
                                     TRACK
 #   NAME        LON   INC   BAND   EPH   TBL
 1 OG1         92.8W   4     KA     Y   ----
<SCR>THRU LIST <ENTER>SELECT   <MODE>EXIT
```

<2>MANUALLY ENTER SAT DATA

```
                                     TRACK
 LON:                INCLIN:
BAND:
LONGITUDE <DDD.T DEG>
```

When the user chooses to manually enter the satellite data, a screen appears with fields to enter the three required pieces of data.

Once a satellite is selected the RC4600 will display the screen below to prompt the user to verify that the antenna is currently peaked on target.

```
                                     TRACK
  *   CONFIRM ANTENNA IS PEAKED UP   *
  * ON TARGET SATELLITE IN AZ/EL/POL *
<ENTER>CONTINUE                <MODE>EXIT
```

If the satellite selected is a Preset Satellite that has been previously tracked, the screen below will appear before prompting the user to confirm that the antenna is peaked on target. The user should choose if a new track is desired or if they would like to resume an existing track.

```
                                                TRACK
 *   TRACK TABLE DATA ALREADY EXISTS    *
 * RESUME PREVIOUS OR START NEW TRACK *
<ENTER>RESUME <BKSP>NEW         <MODE>EXIT
```

Once the user has confirmed the antenna is currently peaked on the satellite, the controller will begin the TRACK operation.

Details of TRACK mode are available in the separate appendices TRK and TLE describing inclined orbit tracking. The following descriptions give an overview of how tracking is performed.

The RC4600 tracking algorithm can be divided into four distinct stages:

- Step Track
    - 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 maintained in the controller's memory. The interval between Step Track operation is determine from antenna size, frequency band, satellite inclination and a specified maximum allowable error. When a track table entry exists for the current sidereal time, Step Track can transition to Memory Track or TLE Track depending on the TRACK MODE configuration.
- Memory Track
    - In Memory Track, the controller smoothly moves the antenna to azimuth and elevation positions derived from entries in the track table. The time between movements is determined by the same factors which govern the time between Step Track operations. By increasing the maximum allowable error, antenna movements can be performed less frequently. In Memory Track, the accuracy of the track table is monitored by periodically peaking up on the selected signal source. If the error exceeds the maximum allowable error, all entries in the track table are flagged for update.
- Two-Line Element (TLE) Track
    - In TLE track, the controller smoothly moves the antenna to azimuth and elevation positions derived from the two-line element data set. The RC4600 will be constantly calculating pointing angles from the TLE data set. Anytime the current position is different from the calculated position, the RC4600 will move the antenna to close this error.
- Track Search
    - Track Search is entered when the satellite signal has been lost. The RC4600 utilizes Intelli-Search, an efficient search algorithm that minimizes errors associated with traditional box searches and frees the user from having to update vague search window parameters. This scheme accounts for the specific mount geometry, 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 mode.

2.1.1.2.2.5 POSITION

The POSITION mode allows the user to set the latitude, longitude and heading of the antenna for subsequent use in calculating pointing angles to satellites. The first screen that appears shows the current mount position used in the RC4600. Also shown are the source that was used to acquire the current position data. If any field was not already populated, *** would be shown.

```
L/L:38_57N  94_45W GPS          POSITION
 ANT BEARING:178.9 COMPASS     NOT SAVED
P:  0.51 R:  0.37  AUTO          <4>SAVE
<1>LAT/LON <2>HEADING <3>TILT <MODE>MENU
```

The position shown in the screen will not be retained at power off unless the position is explicitly saved by pressing the <4> key. Starting a track on a satellite will also force a position save. If the position is saved, the date and time the position was saved is noted.

2.1.1.2.2.5.1 LAT/LON

When the user chooses to modify latitude and longitude, a screen appears showing three options for updating the current lat/lon.

```
<1>ENTER MANUAL LOCATION          LAT/LON
<2>SELECT PRESET LOCATION
<3>GET LOCATION FROM GPS
                                <MODE>EXIT
```

<1>ENTER MANUAL LOCATION

```
                                  LAT/LON
LAT:        LON:

<0-9 .>ENTER DEG.MIN         <SCR UP>EXIT
```

The user is provided two fields to manually enter lat and lon. See 2.1.1.1.3 for instructions on how to enter latitude and longitude.

<2>SELECT PRESET LOCATION

```
 #  LAT      LON      NAME         LAT/LON
 1  38_57N   94_45W   RCI

<SCR>THRU LIST <ENTER>SELECT  <BKSP>EXIT
```

The user scrolls through the list of preset locations and selects the displayed location by pressing the Enter key. Note that the number within the list (1) is displayed along with the name and lat/lon.

<3>GET LOCATION FROM GPS

```
                                        LAT/LON
GPS:38_57N 94_45W
UTC:21:42:00
                                    <MODE>EXIT
```

When option 3 is selected, the RC4600 will pull in the lat/lon from the GPS. Once complete the controller will automatically move back to the main POSITION screen. Note that if movement is required to acquire the GPS information, the following screen will be displayed so the user can confirm the movement.

```
                                        LAT/LON
    *  ANTENNA MOVEMENT REQUIRED  *
    *    TO DETERMINE LOCATION    *
<ENTER>CONFIRM MOVE              <MODE>EXIT
```

2.1.1.2.2.5.2 HEADING

When the user chooses to modify latitude and longitude, a screen appears showing three options for updating the current lat/lon.

```
<1>ENTER MAGNETIC HEADING          HEADING
<2>ENTER TRUE HEADING
<3>GET HEADING FROM COMPASS
                                    <MODE>EXIT
```

<1>ENTER MAGNETIC HEADING

```
   MAG:                             HEADING
MAGVAR:    1.7
  TRUE:
<0-9 .>ENTER DEGREES          <SCR UP>EXIT
```

When option 1 is selected, the user is prompted to ender a magnetic heading of the antenna. After magnetic heading is entered, the RC4600 will apply the magnetic variation to generate the true heading of the mount's azimuth centerline.

<2>ENTER TRUE HEADING

```
   MAG:                             HEADING
MAGVAR:    1.7
  TRUE:
<0-9 .>ENTER DEGREES          <SCR UP>EXIT
```

When option 2 is selected, the user is prompted to ender a true heading of the antenna. After true heading is entered, the RC4600 will apply the magnetic variation to generate the magnetic heading of the mount's azimuth centerline.

<3>GET HEADING FROM COMPASS

```
CMP HDG: 176.9                    HEADING
 OFFSET:   0.0
 MAGVAR:   1.7
HEADING: 178.6                  <MODE>EXIT
```

When option 3 is selected, the RC4600 will pull in the heading from the compass. After the compass heading has been pulled in, the RC4600 will apply the offset and the magnetic variation to generate the heading of the mount's azimuth centerline. Once complete the controller will automatically move back to the main POSITION screen. Note that if movement is required to acquire the compass information, the following screen will be displayed so the user can confirm the movement.

```
                                  HEADING
    *  ANTENNA MOVEMENT REQUIRED  *
    *     TO DETERMINE HEADING    *
<ENTER>CONFIRM MOVE             <MODE>EXIT
```

2.1.1.2.2.5.3 TILT

```
                                  POSITION
PITCH:  0.51
 ROLL:  0.37
```

When option 3 is selected, the RC4600 will pull in the tilt from the dual axis inclinometer. Once complete the controller will automatically move back to the main POSITION screen. Note that if movement is required to acquire the pitch and roll information, the following screen will be displayed so the user can confirm the movement.

```
                                  POSITION
    *  ANTENNA MOVEMENT REQUIRED  *
    *   TO DETERMINE PITCH/ROLL   *
<ENTER>CONFIRM MOVE             <MODE>EXIT
```

2.1.1.2.2.6 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:    0.000 (    0.00)                MOVETO
EL:   15.996 (   16.00) <5>SENSOR:PLATFORM
PL:    0.000 (    0.00) <0> SPEED:NORMAL
SET<1>AZ<2>EL<3>PL          <4>START MOVE
```

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:NORMAL

The state of this field when this mode is entered will be “NORMAL”. This means that any move will be using the standard speed control of the RC4600. 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:PLATFORM

The state of this field when this mode is entered will be “PLATFORM”. This means that all of the angles displayed, and all movements requested will occur in platform relative angles. When the <5> key is pressed this field will change to “HORIZON”. This means that the angles displayed, and all movements requested will occur in local horizontal relative platform angles.

2.1.1.2.2.7 STANDBY

The STANDBY mode allows the user to enable or disable the servo drive amplifiers. When the drives are inactive, all azimuth and elevation movements will not be allowed. Additionally, while in this state “* ANTENNA IN STANDBY – DRIVES INACTIVE *” will flash on line 4 of the display.

```
                                      STANDBY
DRIVES: INACTIVE

<ENTER>MAKE DRIVES ACTIVE        <MODE>MENU
```

When the drives are inactive, pressing the <ENTER> key will switch them to the active state.

```
                                      STANDBY
DRIVES: ACTIVE

<ENTER>MAKE DRIVES INACTIVE      <MODE>MENU
```

When the drives are active, pressing the <ENTER> key will switch them to the inactive state. At power on, the drives will be in the inactive state. The only exception will be if the controller was powered cycled while tracking. When this occurs, the controller will make the drives active at power on and resume tracking.

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 LOCATE operation (2.1.1.2.2.3.4).

2.1.2 Graphical User Interface Software Overview

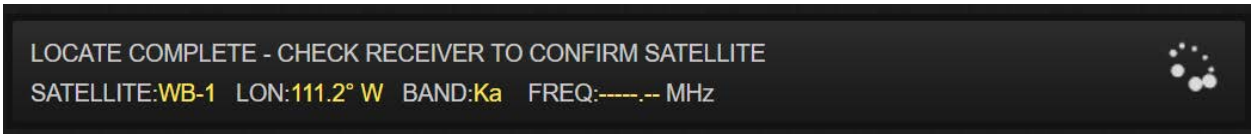
The Graphical User Interface to the RC4600 can be accessed by navigating to the IP address of the controller using a web browser. The default IP address of the RC4600 is 192.168.1.1

2.1.2.1 Graphical User Interface Main Page

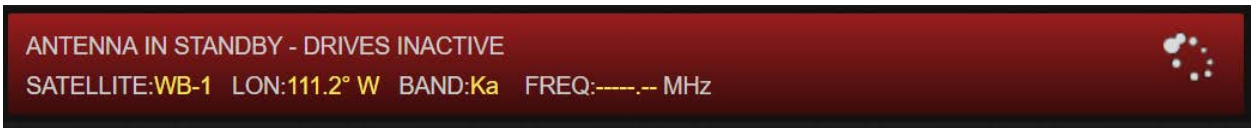
The main page contains all important information about the current status of the RC4600 as well as the antenna. The main page offers easy access to automatic operations needed for daily used (Locate/Stow/Deploy), and manual jog control of the antenna. Sub-menus will be displayed when there is additional 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 RC4600 and the last satellite located.



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.



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.

Targets for auto-moves are also displayed in the smaller boxes. In this case, the elevation target for the last locate was 41.800. If the antenna was at a limit, the limit would show inside of the box as well.

2.1.2.1.2.1 Alternate Position Displays

By default, the GUI always displays the local horizontal azimuth, elevation and polarization angles. Additional readouts such as local platform angles, or true azimuth angles can be switched to by clicking on the label under each gauge.

2.1.2.1.2.1.1 Azimuth

The table below shows each of the options for the azimuth display.

Local Horizontal	True Horizontal	Magnetic Horizontal	Local Platform
Platform Angle + Pitch/Roll	Platform Angle + Pitch/Roll + Bearing + Magnetic Deviation	Platform Angle + Pitch/Roll + Bearing	Platform Angle
			

2.1.2.1.2.1.2 Elevation

The table below shows each of the options for the elevation display.

Local Horizontal	Local Platform
Platform Angle + Pitch/Roll	Platform Angle
	

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.

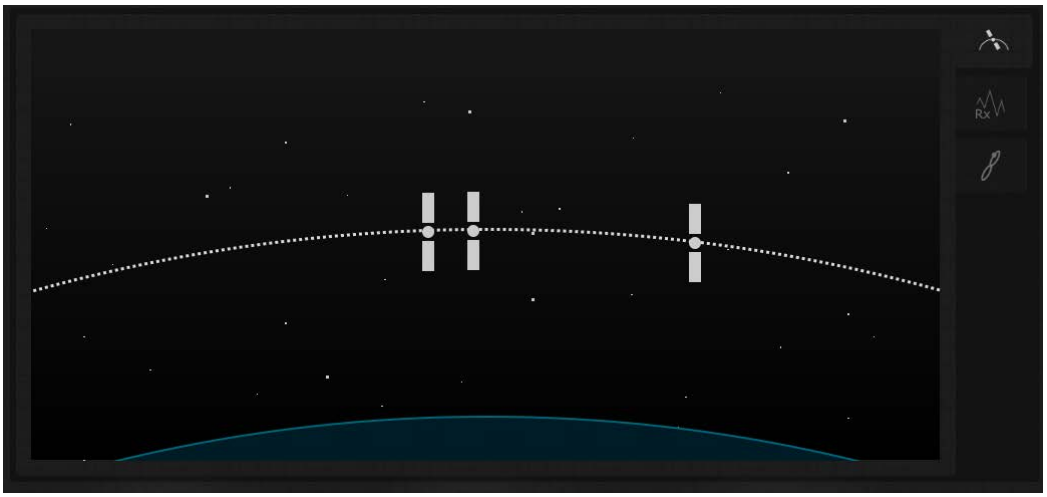
The keypad also provides a <STOP> key. This key can be used during any automatic movement to stop the current operation.

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.

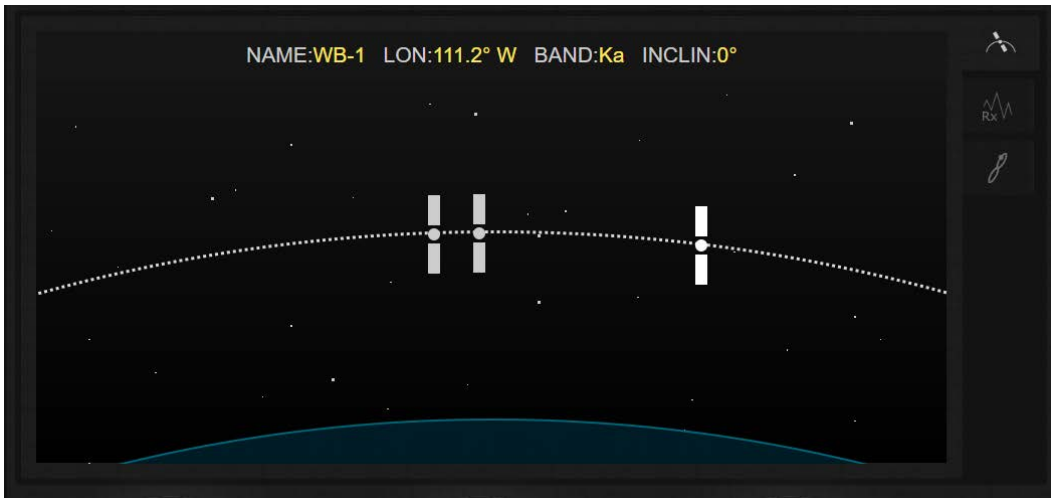
2.1.2.1.4.1 Satellite Arc Display

The center section of the display is used to display the satellite arc of the current satellites in the satellite database (2.1.2.2.1).



The preset satellites shown will be specific to the current band the RC4600 is configured to use. In the window above, the RC4600 is set for a Ka-Band feed. Since only three preset satellites are configured for Ka-Band, only 3 are shown.

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 LOCATE automatic movement as described in section 2.1.1.2.2.3.2.



2.1.2.1.4.2 Spectrum Analyzer Display

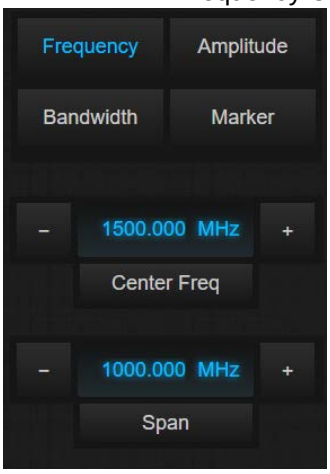
If the RC4600 is equipped with the spectrum analyzer option, a button will be available on the left side of the main display that will allow you to switch to the spectrum analyzer display.

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:

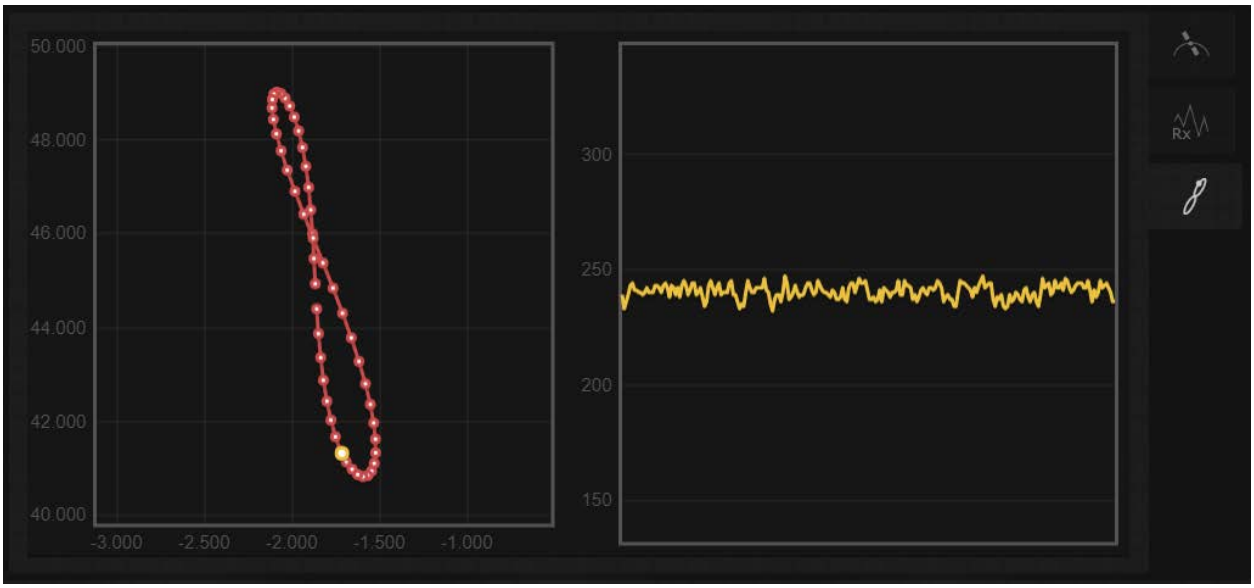
300 Hz, 3 KHz, 30 KHz, and 300 KHz.

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 RC4600 will take between points.

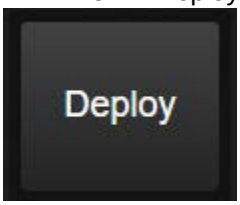
The box on the right shows a graphical representation of the last 2 minutes and 30 seconds of signal strength.

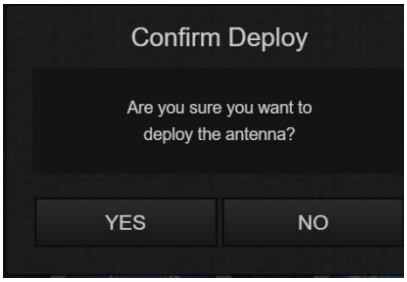
The range on the vertical axis for both boxes, and the horizontal axis for the left box will adjust as needed to accommodate the data that is being displayed.

2.1.2.1.5 Automatic Operations

Down the left side of the display eight boxes that provide various automatic operations for the RC4600. Each of those functions are described in the corresponding section below.

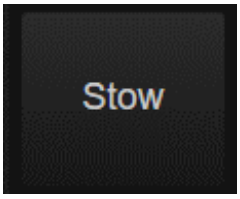
2.1.2.1.5.1 Deploy

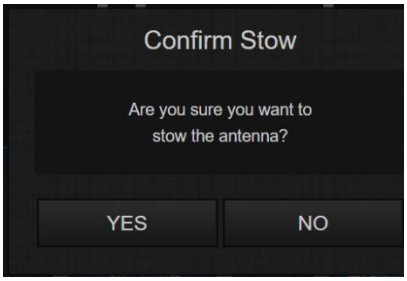




The <Deploy> button automatically moves the antenna to the predefined “deploy” position. Further discussion of the DEPLOY mode can be found in section 2.1.1.2.2.1. Prior to entering the DEPLOY mode, the RC4600 will confirm that you want to deploy the antenna. Clicking <YES> will enter the DEPLOY mode. Clicking <NO> will return the GUI to the main page. When the deploy operation is finished, the RC4600 will exit DEPLOY mode, and the ACU Status Window (2.1.2.1.1) will notify the user.

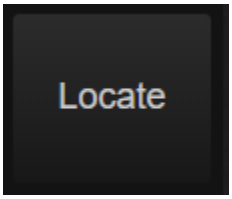
2.1.2.1.5.2 Stow



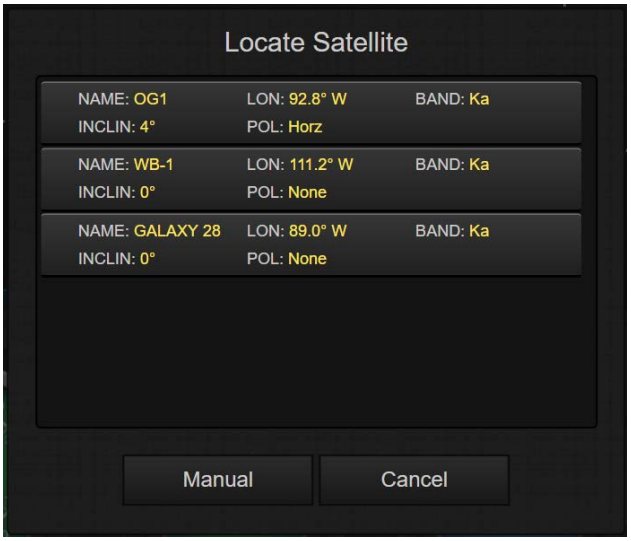


The <Stow> button automatically moves the antenna to the predefined “stow” position. Further discussion of the STOW mode can be found in section 2.1.1.2.2.2. Prior to entering the STOW mode, the RC4600 will confirm that you want to stow the antenna. Clicking <YES> will enter the STOW mode. Clicking <NO> will return the GUI to the main page. When the stow operation is finished, the RC4600 will exit STOW mode, and the ACU Status Window (2.1.2.1.1) will notify the user.

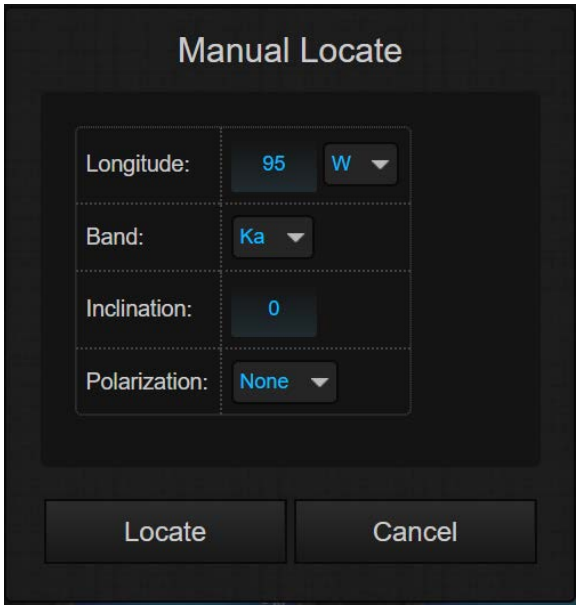
2.1.2.1.5.3 Locate



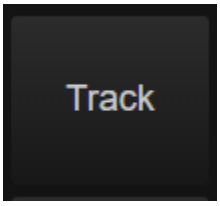
The <Locate> button allows the user to enter the LOCATE mode (2.1.1.2.2.3). After clicking the <Locate> button, the user is presented with a list of preset satellites. The list of satellites is the set of satellites from the database that have the same band as the current feed. Selecting one of the satellites in the list will begin an automatic locate (2.1.1.2.2.3.2).



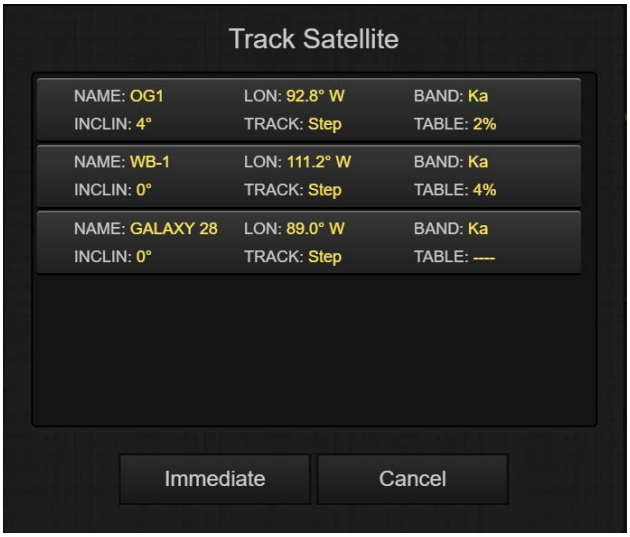
Clicking the <Manual> button will present the user with a box that allows them to type in the details of the satellite they want to locate. After entering the details, clicking the <Locate> button will start an auto locate based on the data input.



2.1.2.1.5.4 Track



The <Track> button allows the user to enter the TRACK mode (2.1.1.2.2.4). After clicking the <Track> button, the user is presented with a list of preset satellites. The list of satellites is the set of satellites from the database that have the same band as the current feed. Selecting one of the satellites in the list will begin an automatic locate will then present the user with one of the options listed in the next few sub sections.



Clicking the <Immediate> button will start a track in the current position, using the currently selected signal source.

2.1.2.1.5.4.1 Start Track

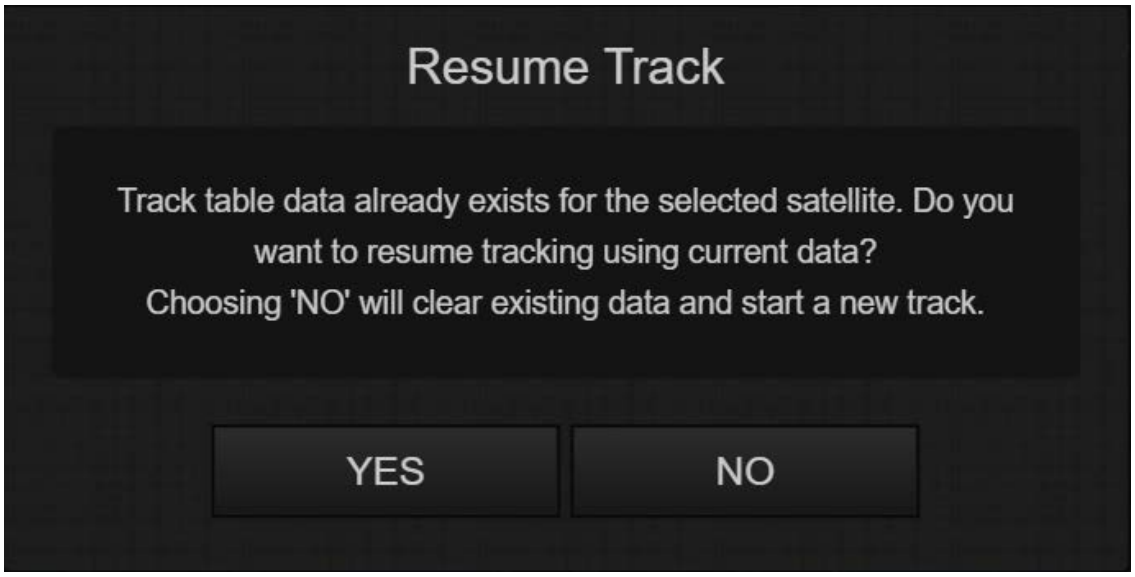
If the satellite currently being selected for tracking has not been tracked before, the user will be prompted with the following screen.

Clicking <YES> will perform a Peak Up (2.1.1.2.2.3.4) using the track source and then begin the track, or immediately start a TLE track.

Clicking <NO> will return the user to the main page.

2.1.2.1.5.4.2 Resume Track

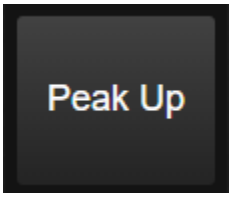
If the satellite currently being selected for tracking has been tracked before, the user will be prompted with the following screen.



Clicking <YES> will use the track table data, or TLE data that already exists for the satellite. If there is data for the current time, the RC4600 will position the antenna to the appropriate angles automatically. If there is not data for the current time, the RC4600 will perform a Peak Up (2.1.1.2.2.3.4) using the track source and then begin the track.

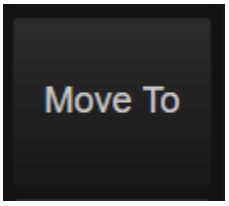
Clicking <NO> will return the user to the main page.

2.1.2.1.5.5 Peak Up

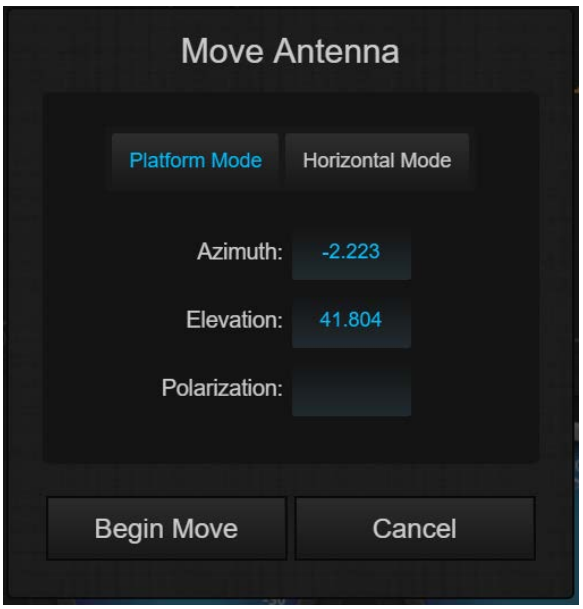


The <Peak Up> button immediately performs a Peak Up (2.1.1.2.2.3.4) using the currently selected signal source.

2.1.2.1.5.6 Move To



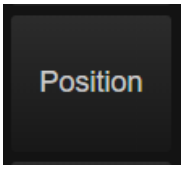
The <Move To> button allows the user to move the antenna to a specified azimuth, elevation, and polarization angles. After clicking the <Move To> button, the user will be presented with a dialog box to enter azimuth, elevation, and polarization angles.



The angles can be entered in both local platform angles or local horizontal angles. After entering the angles, clicking <Begin Move> will begin an automatic movement to the specified position.

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

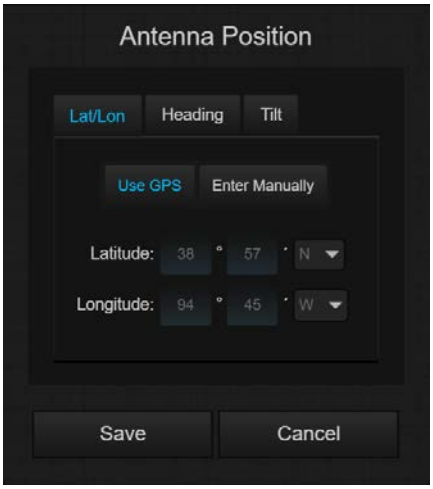
2.1.2.1.5.7 Position

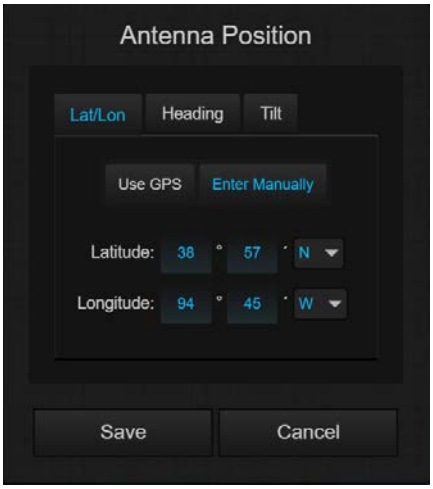


The <Position> button will open a dialog box that allows the user to specify the values and the source of the Lat/Lon, heading, and Tilt.

2.1.2.1.5.7.1 Lat/Lon

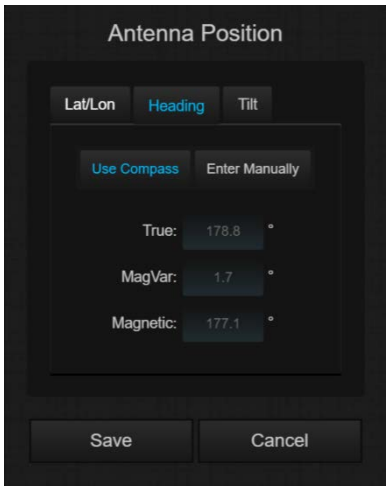
The Lat/Lon dialog allows the user to select between <Use GPS> and <Enter Manually>. If the RC4600 already has a value for Latitude and Longitude, they will be shown. When set to <Use GPS>, the fields will be grayed out to show that they can't be modified. When set to <Enter Manually>, the fields will be blue to indicate that they can be modified.

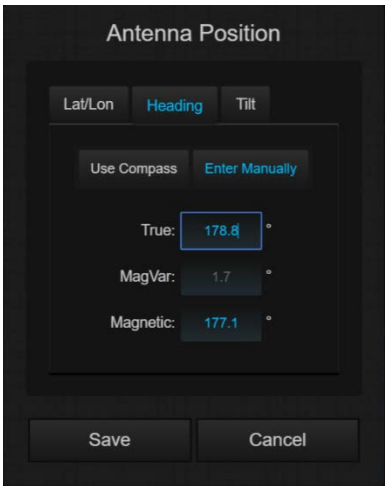




2.1.2.1.5.7.2 Heading

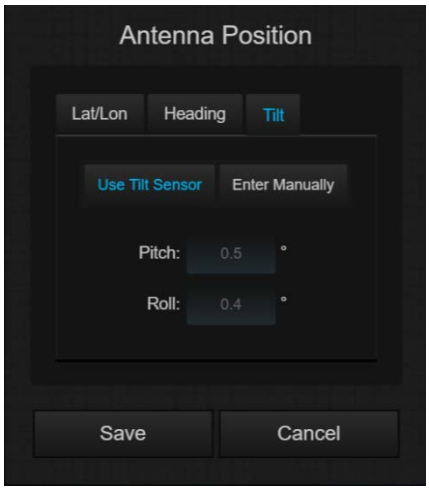
The Heading dialog allows the user to select between <Use Compass> and <Enter Manually>. If the RC4600 already has a value for True and Magnetic, they will be shown. When set to <Use Compass>, the fields will be grayed out to show that they can't be modified. When set to <Enter Manually>, the fields will be blue to indicate that they can be modified.

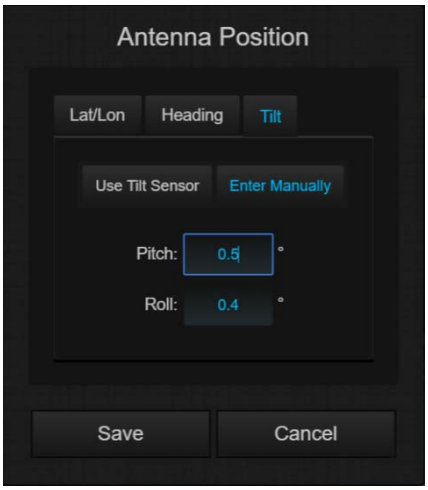




2.1.2.1.5.7.3 Tilt

The Tilt dialog allows the user to select between <Use Tilt Sensor> and <Enter Manually>. If the RC4600 already has a value for Pitch and Roll, they will be shown. When set to <Use Tilt Sensor>, the fields will be grayed out to show that they can't be modified. When set to <Enter Manually>, the fields will be blue to indicate that they can be modified.



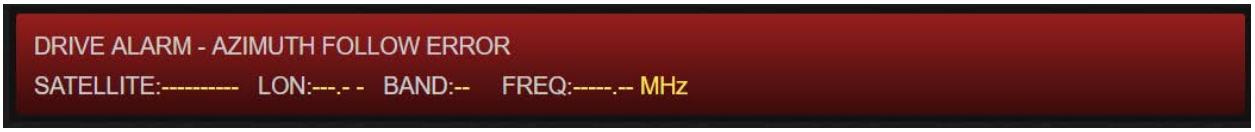


2.1.2.1.5.8 Toggle Standby

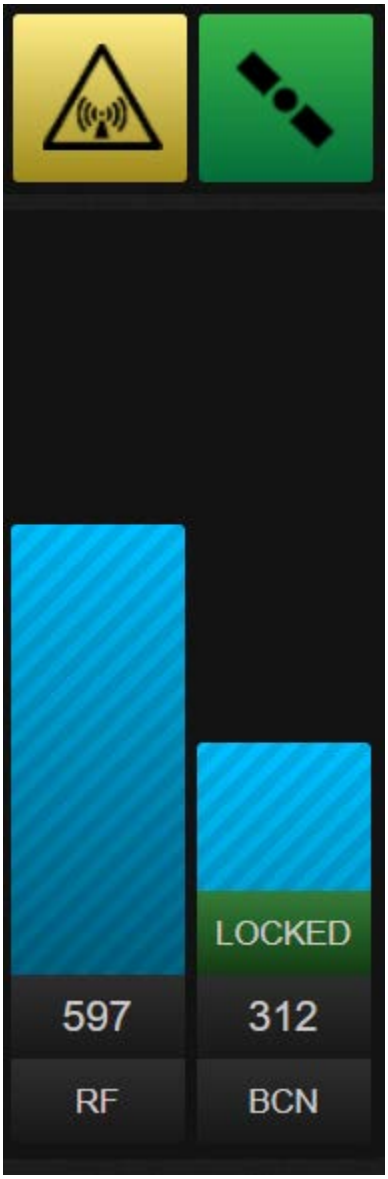
The <Toggle Standby> button transitions the drives between the active and inactive state. When in the inactive state, the ACU Status Window will indicate as shown below.

2.1.2.1.5.9 Drive Reset

If a drive alarm is currently present on the RC4600, the <Drive Reset> button will appear. Clicking the <Drive Reset> button will reset all drive errors that are currently present. When a drive alarm is present the ACU status window will indicate as shown below.



2.1.2.1.6 Signal Strength and Transmit Status



On the right side of the main display are two bars for signal strength, and two icons that indicate transmit and locate 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 RC4600 for tracking, locates, and peaking.

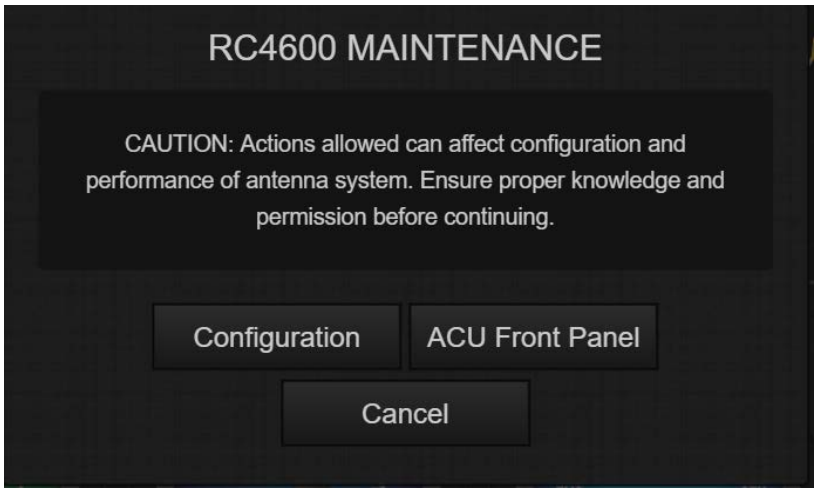
It can be toggled between, BCN (Beacon Receiver), RF (L-Band Power), DVB (DVB Receiver), and EXT (External AGC). If the signal strength source being used supports a lock input, the green "LOCKED" box will show at the bottom of the graphical signal strength when the receiver is locked.

The indicator shown below indicates that the antenna is in a state where it is OK to transmit. When moving or below the down limit, the indicator will be grayed out.

The indicator shown below indicates that the previous LOCATE finished successfully. This indicator will stay green until the RC4600 is powered off, or a new LOCATE is started. The indicator will be grayed out at the end of a LOCATE if it was unsuccessful.

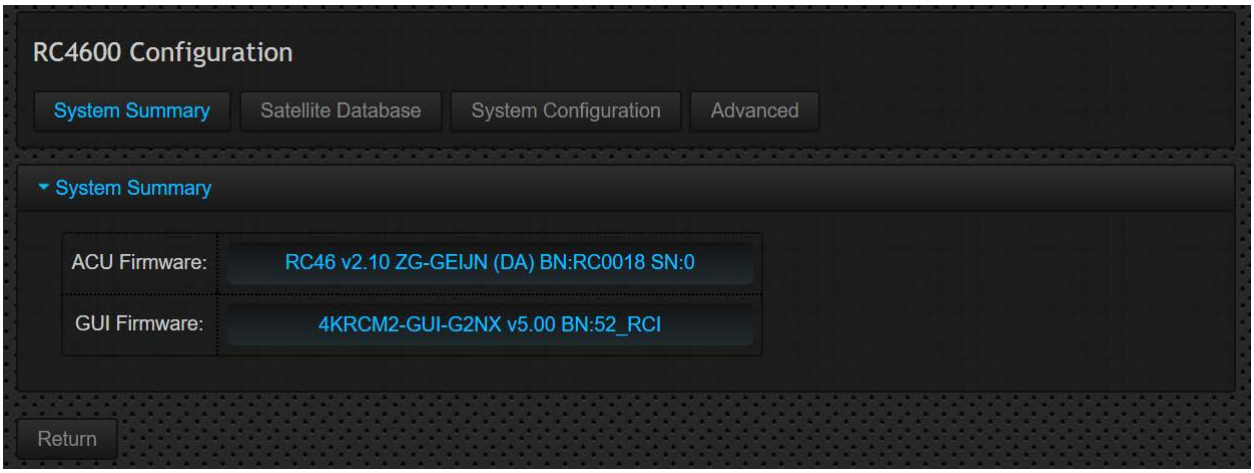
2.1.2.1.7 Maintenance

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).



2.1.2.2 Configuration Page

The main configuration page for the RC4600 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.

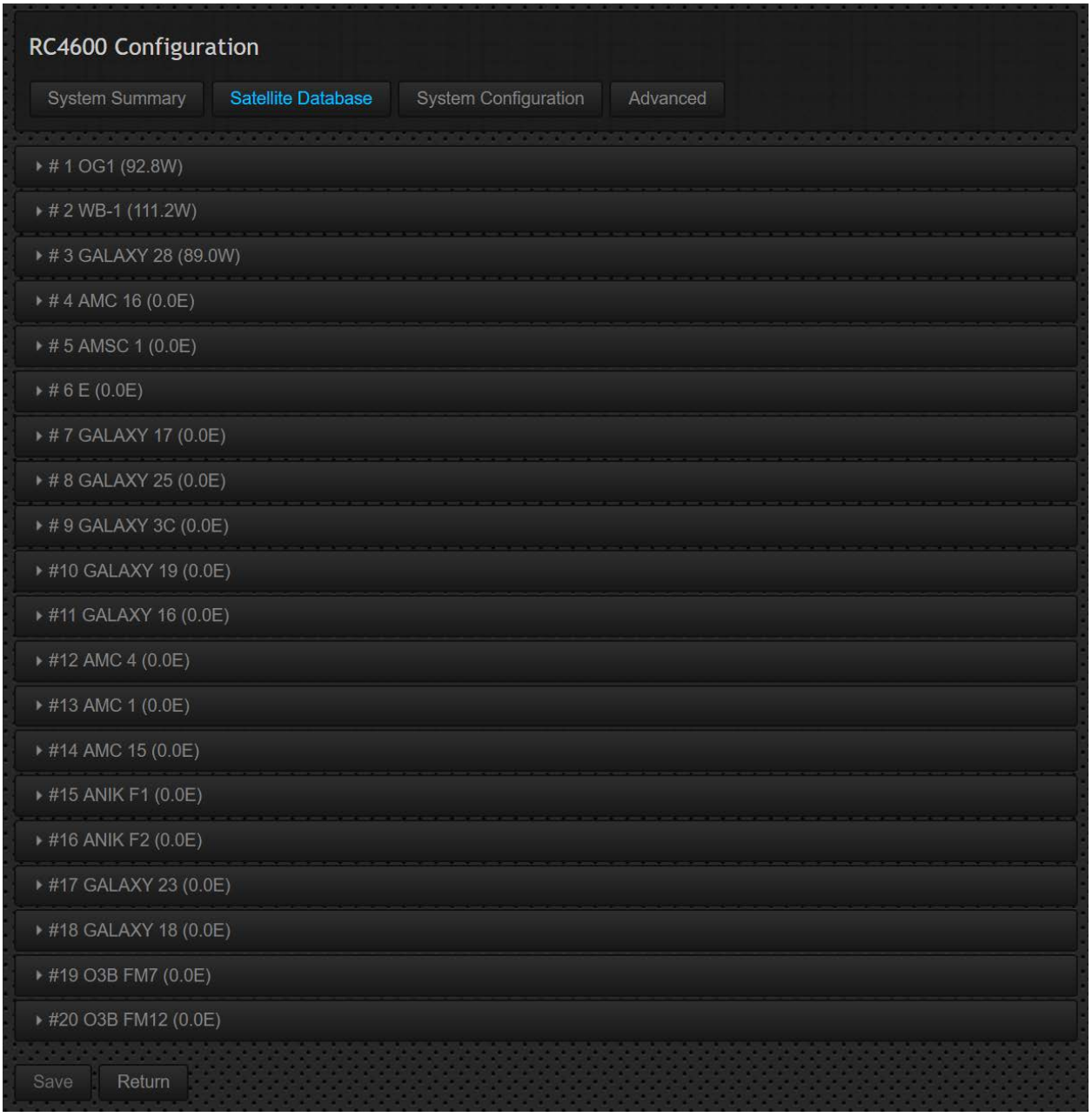


The System Summary tab will provide you with the current software on the RC4600, as well as the serial number for the controller. At the bottom of the window is a <Return> button. Clicking this button will always return the user to the main page of the GUI (2.1.2.1).

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 Satellite Database

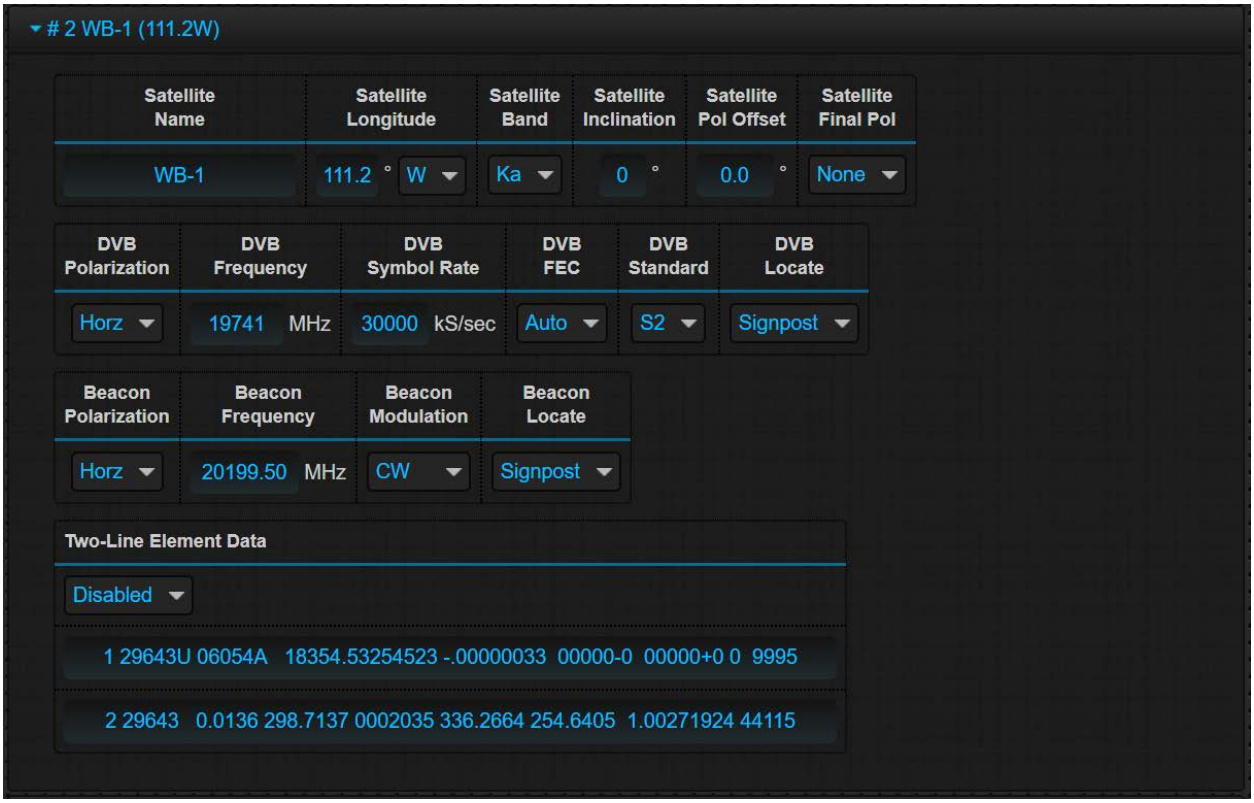
The Satellite Database tab gives the user to edit information about the preset list of 20 satellites. Each satellite entry can be expanded individually. The following screen shows an example full satellite database list.



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 field. All fields in the satellite preset 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 that are found in the following configuration screens:

- Satellite Presets
- DVB Detection Points
- Beacon Detection Points
- TLE 1 Data
- TLE 2 Data

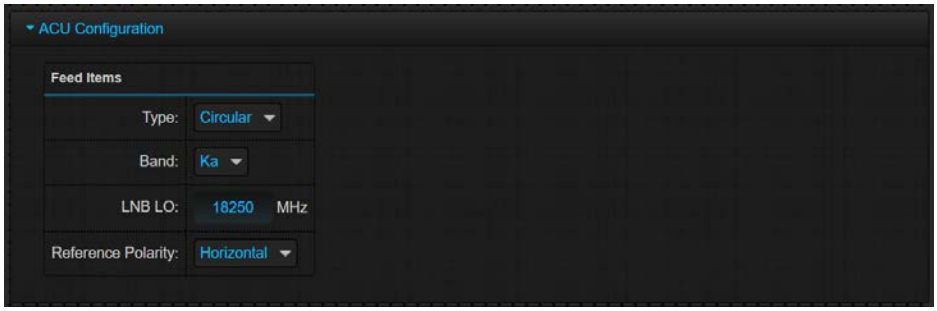
After adjusting the desired parameters for the satellite preset, ensure that the <Save> button and the bottom of the page is clicked prior to any further operations.

2.1.2.2.2 System Settings

The System Configuration tab allows the user to modify various information about the RC4600.

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, this window will not be available. In addition to the feed information, there may be additional antenna specific ACU 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

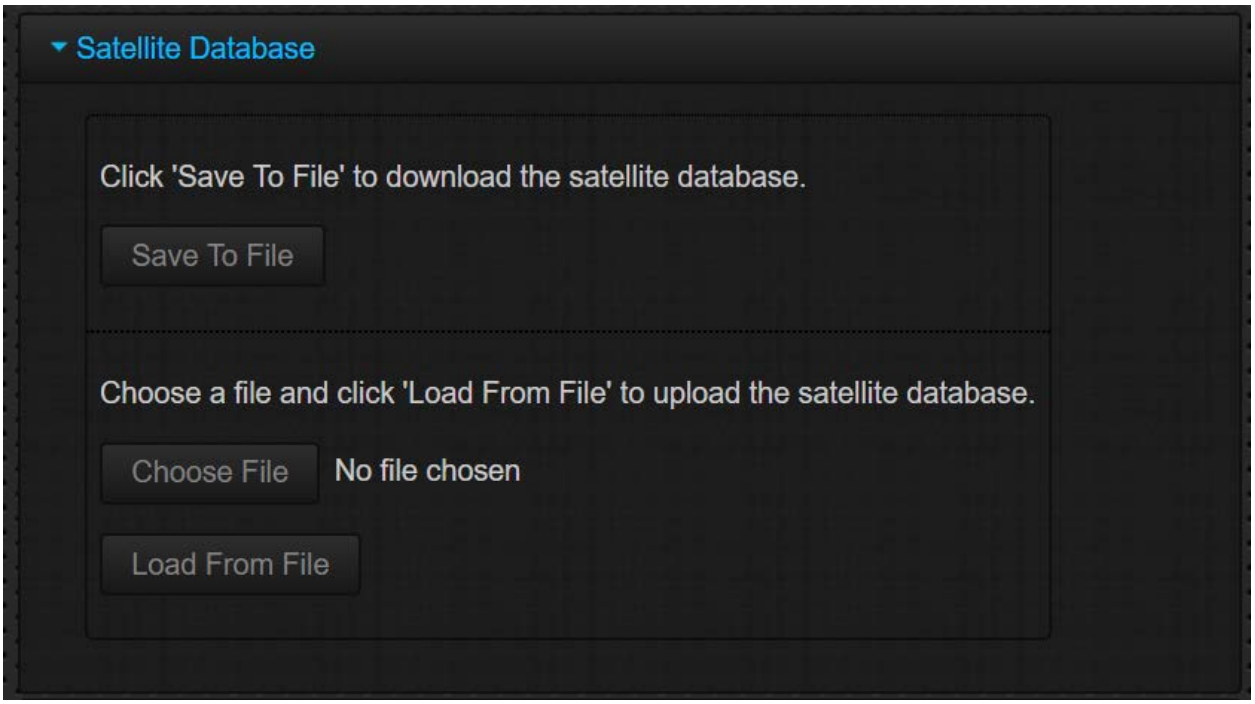
If there are any other IP devices on the system that the ACU needs to communicate with (Spectrum Analyzer, Modem, etc.), an additional window will exist to notify the ACU of the IP parameters of that device. The example below if for an IP based beacon receiver and spectrum analyzer combination.

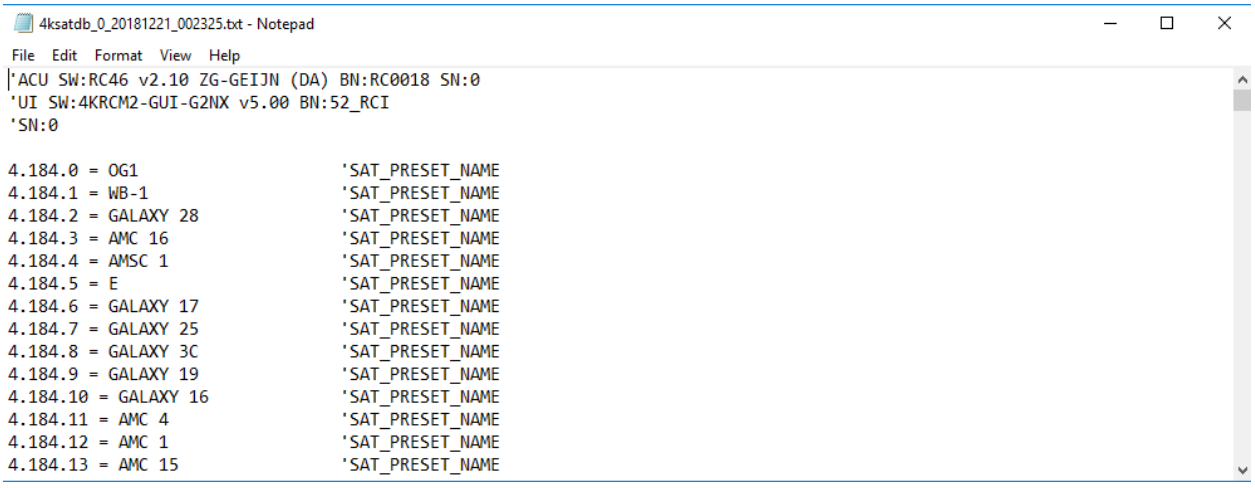
2.1.2.2.3 Advanced

The Advanced tab provides the user with the ability to upload and download configuration data from the RC4600. Additionally, the Advanced tab provides the user with the ability to load new firmware and user interface software onto the RC4600.

2.1.2.2.3.1 Satellite Database

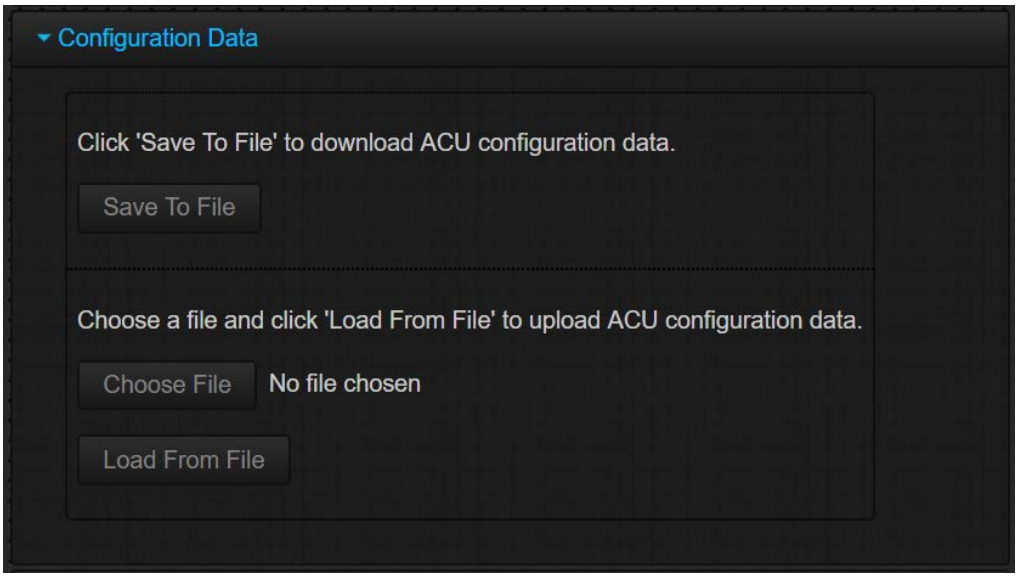
The Satellite Databased window allows the user to download a text file that contains all the information contained in the Satellite Database (2.1.2.2.1). Additionally, by clicking <Choose File>, the user would be able to browse to a previously downloaded Satellite Database text file and load the database into the current RC4600.

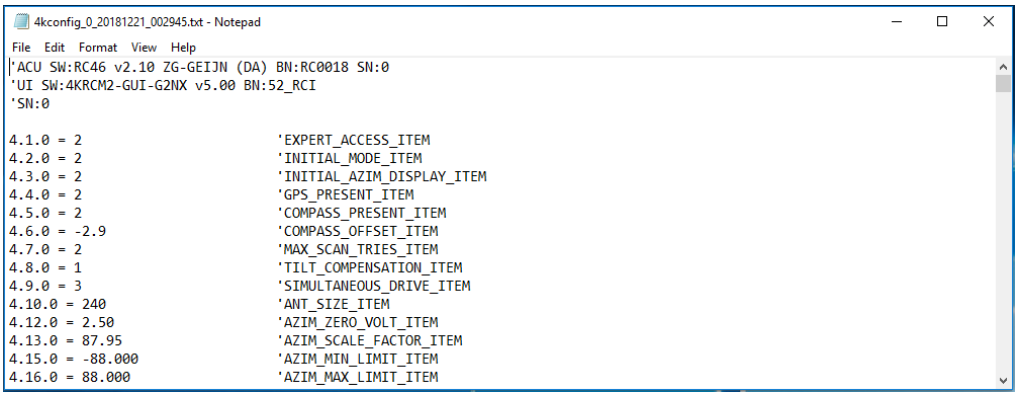


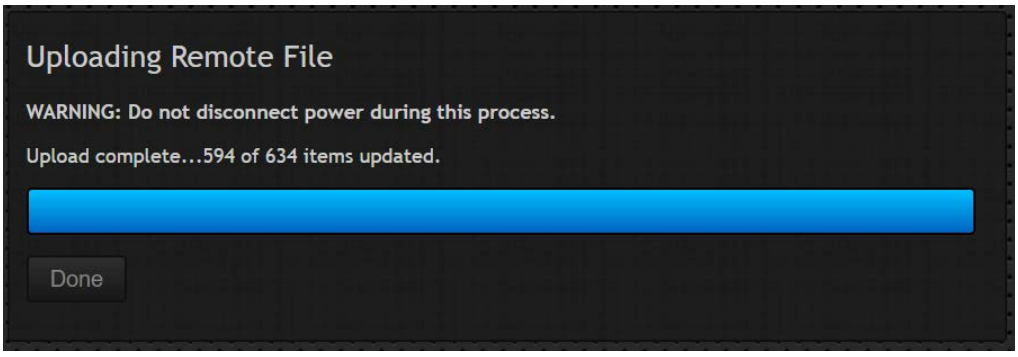


2.1.2.2.3.2 Configuration Data

The Configuration Data window allows the user to download a text file that contains all the configuration items contained in the RC4600. 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 RC4600. 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.

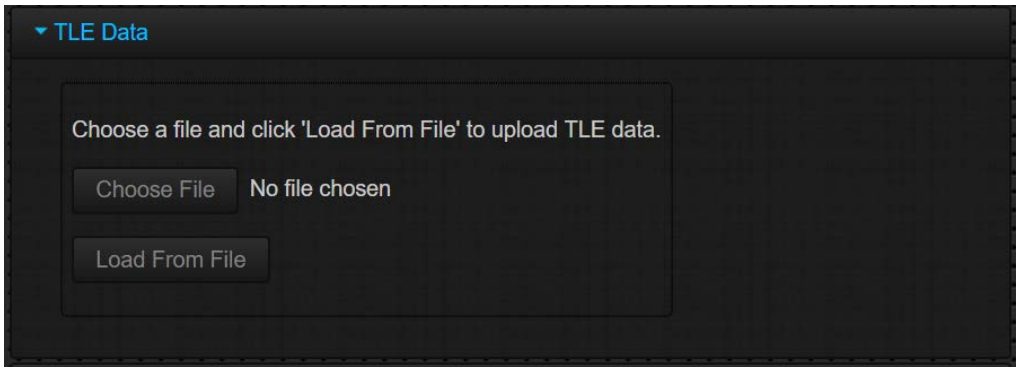


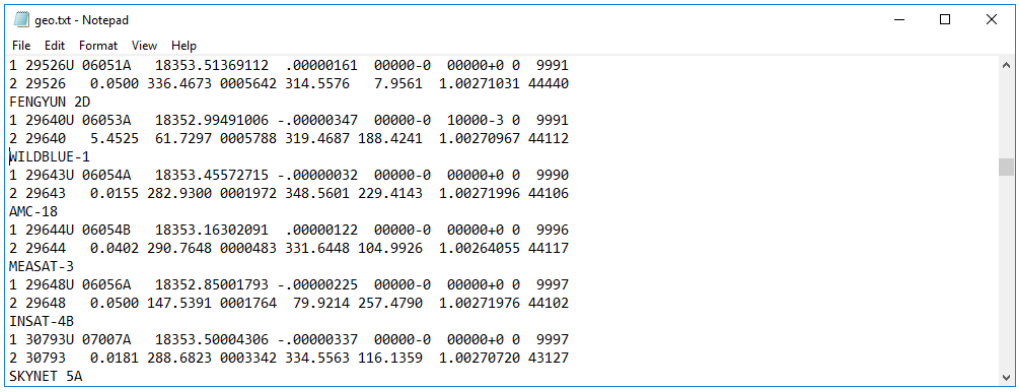


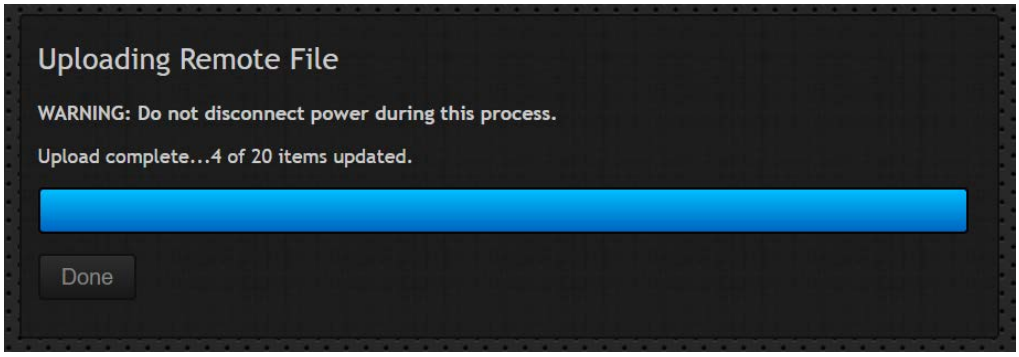


2.1.2.2.3.3 TLE Data

The TLE Data window allows the user to 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 RC4600 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.



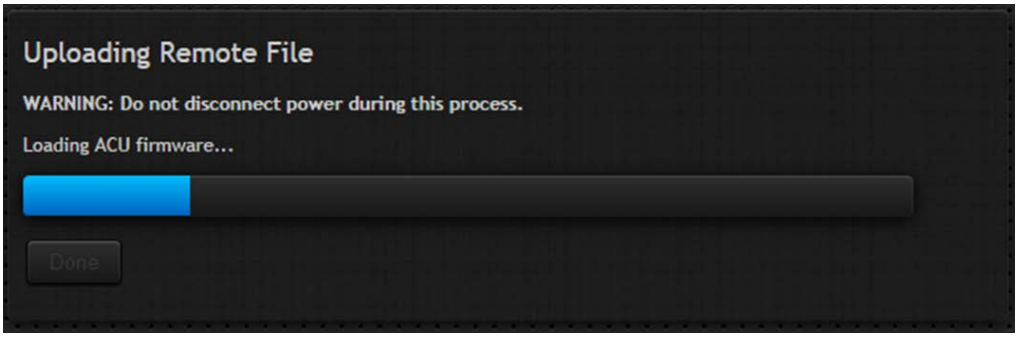




2.1.2.2.3.4 ACU Firmware

The ACU Firmware window allows the user to update the current software on the RC4600. 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.

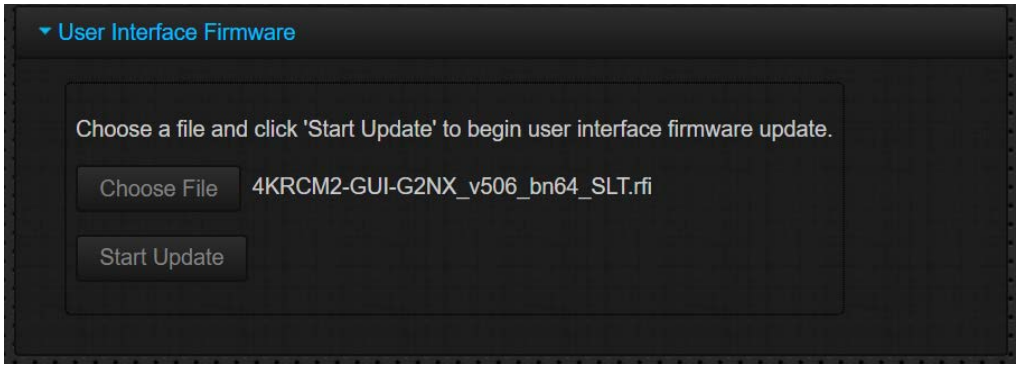


After installing the new software, the user should reset defaults on the RC4600 and load the configuration data file that was downloaded prior to upgrading the software.

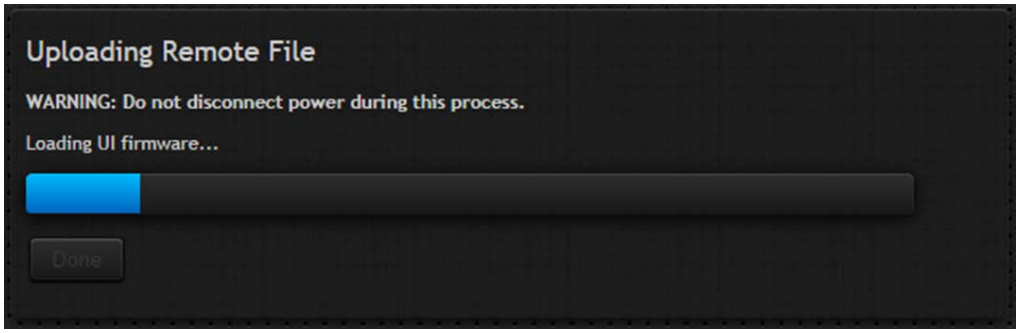
2.1.2.2.3.5 User Interface Firmware

The User Interface Firmware window allows the user to update the current user interface software on the RC4600.

NOTE: Updating the user interface firmware may cause the IP settings of the RC4600 to be reset to factory defaults. The default IP address of the RC4600 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.



3 SUPPORT

3.1 Troubleshooting

3.1.1 Warning Displays

3.1.1.1 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.
Standby	AZ/EL/POL drives are currently disabled. Toggle Standby on and off via the Standby menu mode.

3.1.1.2 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.
STOW, stow	Antenna is at the azimuth hardware limit (STOW) or azimuth software limit (stow), this is part of normal operation.

3.1.1.3 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.
STOW, stow	Antenna is at the elevation hardware limit (STOW) or elevation software limit (stow), this is part of normal operation.

3.1.1.4 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.
STOW, stow	Antenna is at the azimuth hardware limit (STOW) or azimuth software limit (stow), this is part of normal operation.

3.1.1.5 GPS

Warning	**Description/Recommended Action**
No GPS Present	GPS is disabled in the system definition screen
Initializing	RC4600 has sent a message to the GPS to start communication.
GPS Offline	RC4600 is not receiving information from the GPS receiver
Waiting For GPS	RC4600 is waiting for the GPS to report that it has a valid Lat/Lon

3.1.1.6 Compass

Warning	**Description/Recommended Action**
No Compass Present	Compass is disabled in the system definition screen
Compass Offline	RC4600 is not receiving information from the compass
Waiting for Compass	RC4600 is waiting for the compass to report that it has a valid heading

3.1.1.7 Dual Axis Inclinometer

Warning	**Description/Recommended Action**
No Tilt Sensor Detected	RC4600 is unable to communicate with the dual axis inclinometer
Inconsistent Sensor Data	RC4600 is receiving invalid data from the dual axis inclinometer
Waiting for Tilt	RC4600 is waiting for the dual axis inclinometer to provide pitch and roll

3.1.2 Alarm Displays

3.1.2.1 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.

3.1.2.2 Azimuth

Alarm	**Description/Recommended Action**
Drift	Antenna was attempting to hold an azimuth position and the antenna drifted outside of the drift error configuration item range. Verify axis movement working as expected and that the drift error configuration item is set properly.
Follow	Antenna was moving and the difference between the current position and the calculated position was outside of the follow error configuration item range. Verify axis movement working as expected and that the follow error configuration item is set properly.
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.

3.1.2.3 Elevation

Alarm	**Description/Recommended Action**
Drift	Antenna was attempting to hold an elevation position and the antenna drifted outside of the drift error configuration item range. Verify axis movement working as expected and that the drift error configuration item is set properly.
Follow	Antenna was moving and the difference between the current position and the calculated position was outside of the follow error configuration item range. Verify axis movement working as expected and that the follow error configuration item is set properly.
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.

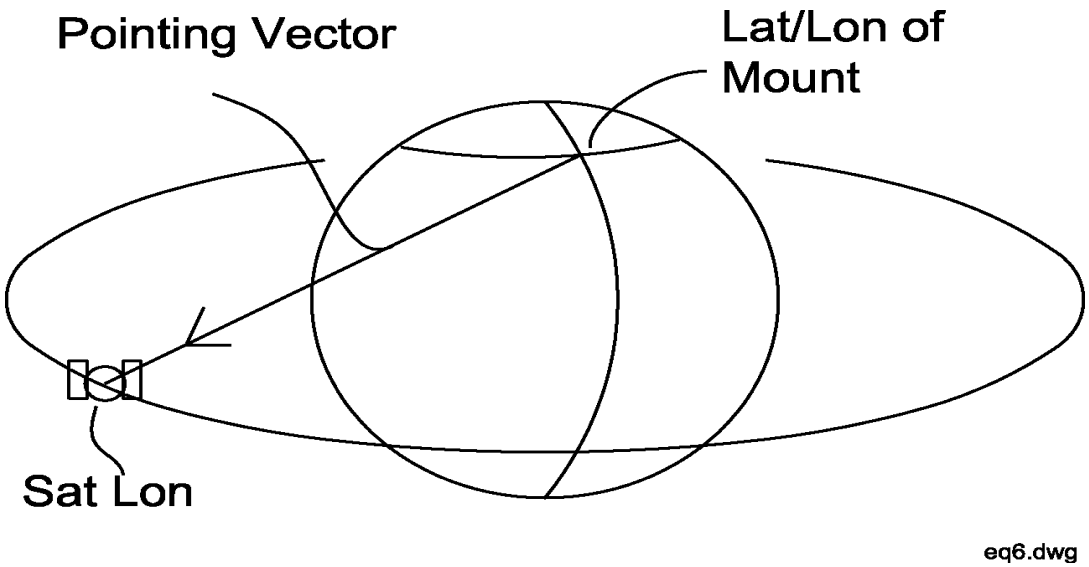
3.1.2.4 Polarization

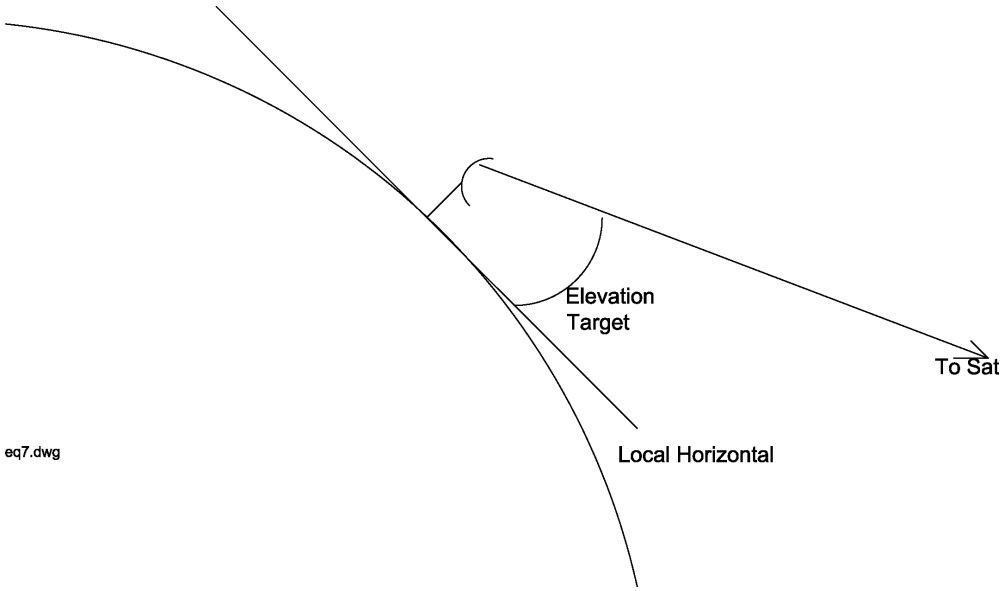
Alarm	**Description/Recommended Action**
Drift	Antenna was attempting to hold an azimuth position and the antenna drifted outside of the drift error configuration item range. Verify axis movement working as expected and that the drift error configuration item is set properly.
Follow	Antenna was moving and the difference between the current position and the calculated position was outside of the follow error configuration item range. Verify axis movement working as expected and that the follow error configuration item is set properly.
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.

3.2 ACU Topics

3.2.1 Antenna Pointing Solution

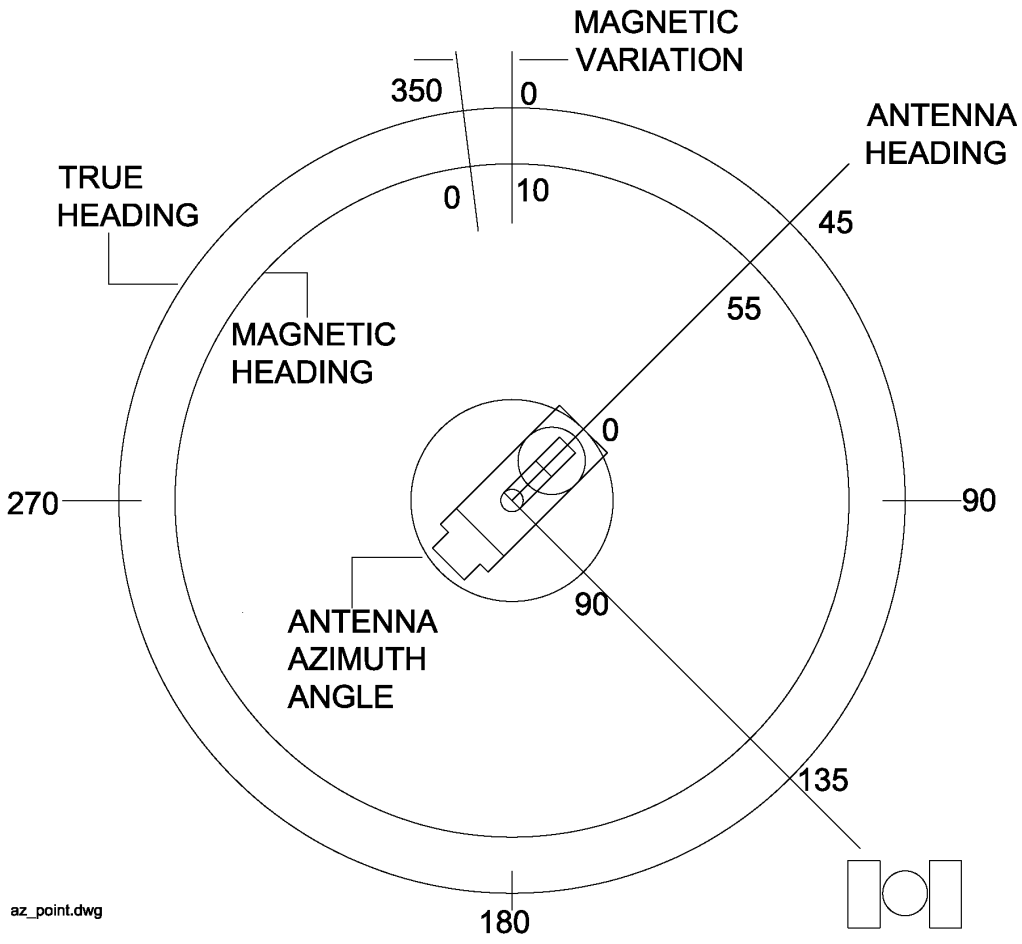
The position (latitude/longitude, heading, pitch/roll) of the antenna and the longitude of a selected satellite are required to calculate a pointing vector from the antenna to the selected satellite.





Given the antenna's latitude and longitude and the pointing vector to the satellite, the RC4600 calculates the elevation (with respect to local horizontal) required. Feedback from the antenna on the elevation axis will be used to move the mount to the required elevation.

The azimuth portion of the pointing vector is calculated with respect to local true North. The compass is used to determine the heading of the centerline of azimuth travel and the required movement in the azimuth axis is calculated.

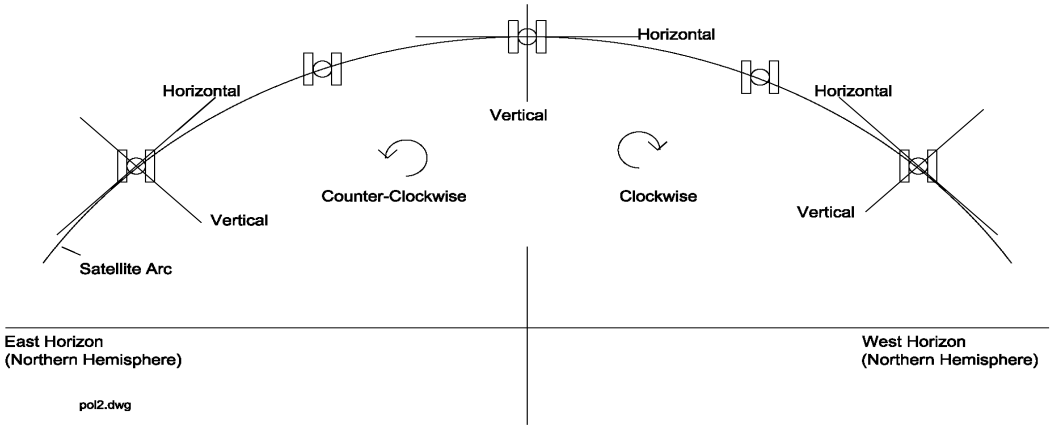


In the above example a true heading of 135 degrees to the satellite has been calculated. Based on the mount's latitude, longitude and date, a local magnetic variation of 10 degrees is calculated. The compass senses a magnetic heading of 55 for the azimuth reference direction. Applying the magnetic variation, this yields an apparent true heading of 45 degrees for the antenna reference direction. An azimuth movement of 90 (135 – 45) degrees clockwise is therefore needed to point at the satellite.

Since a position sensor on the azimuth axis is always active, the RC4600's default displayed azimuth value is that of the antenna angle. Derived estimates of the magnetic and true heading of the mount may be selected in the MANUAL (2.1.1.2.1) and LOCATE (2.1.1.2.2.3) modes.

3.2.2 Polarization Control

The RC4600 calculates the required position and automatically moves the polarization axis as part of the satellite LOCATE 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 RC4600 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. If a linear polarized feed is present, the RC4600 will calculate the theoretical position as a function of the antenna position (latitude/longitude, heading, pitch/roll) and satellite longitude.

3.2.3 Drive System

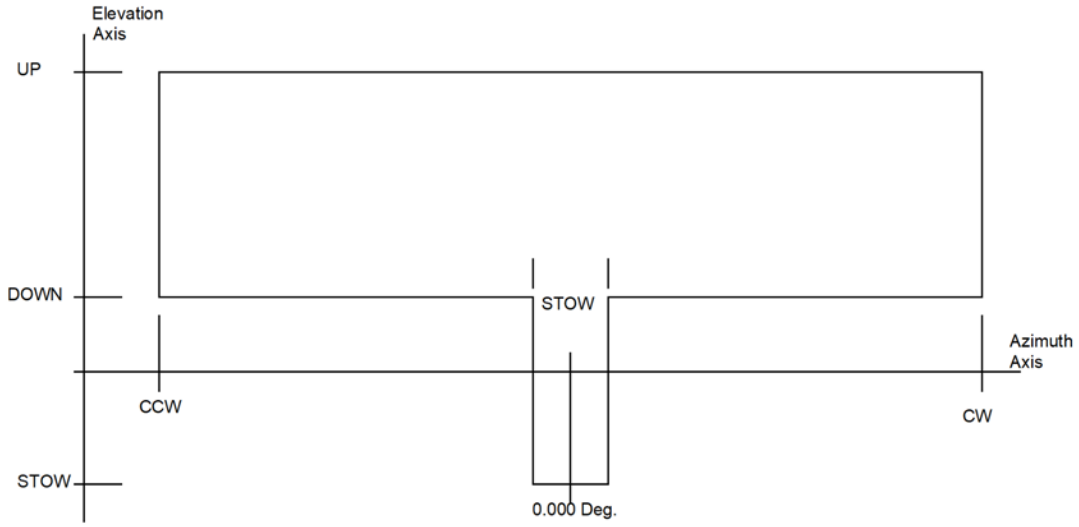
The RC4600 implements several mechanisms for the driving and monitoring of the azimuth, elevation and polarization axis.

3.2.4 Position Sensing and Limits

The RC4600 senses absolute axis position using feedback from various sensors (potentiometers, resolvers, encoders, etc). The sensed information is scaled appropriately for the particular 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 is with respect to the centerline of azimuth travel.

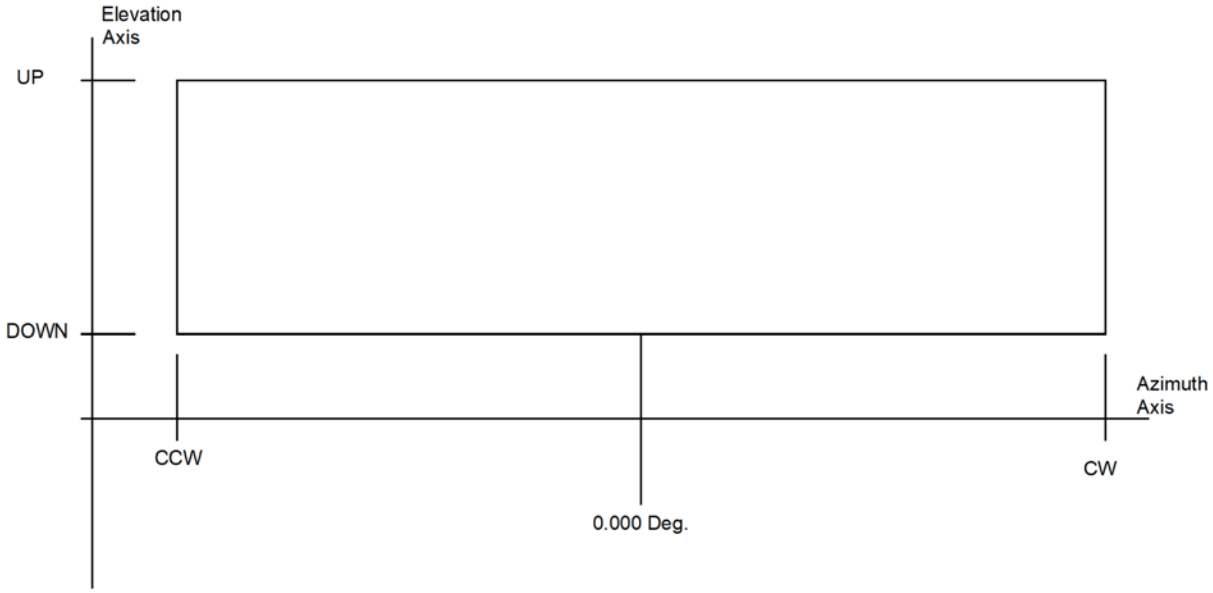
The following diagram shows a typical range of movement for mobile satellite antennas. Note that elevation movement to the stow position is limited about a small range of azimuth movement in order to ensure safe stowing of the antenna.



In the azimuth axis, movement in one direction is disabled when clockwise and counterclockwise limit switches are activated. There is also typically a region in the center of azimuth travel indicating that the azimuth axis is in a position that will allow for moving the elevation axis down to the stow position.

In the elevation axis, there are typically three limit switches. The UP switch prevents further movement up. The “DOWN” switch delimits the elevation the mount may not move further downward unless it has been placed in the azimuth stow region. The STOW switch indicates when the mount has reached its furthest down position which is typically where the dish is stowed for travel.

The following diagram shows a typical range of movement for fly-away satellite antennas. Note that elevation movement below the down limit is prohibited at all points in azimuth.



3.2.4.1 Follow, Drift, and Drive Error Sensing

The RC4600 continuously monitors the axis positions to detect incorrect movement of the antenna. If an axis has been commanded to move and the RC4600 detects that the movement is not "following" the calculated path, the controller will declare a "FOLLOW" condition and not allow further movement until the condition has been reset.

Similarly, if the RC4600 is holding position in an axis and the position "drifts" away from the held position and the controller cannot correct it out, the RC4600 will declare a "DRIFT" condition and not allow further movement until the condition has been reset.

The RC4600 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 RC4600 will declare a "DRIVE" condition and not allow further movement until the condition has been reset.

3.2.5 Timekeeping

There are several versions of time (system, sidereal, display and GPS) discussed within this manual.

System time is maintained by the RC4600's real time clock. The real-time clock is backed up by battery so that system time is available as soon as the RC4600 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 RC4600'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.

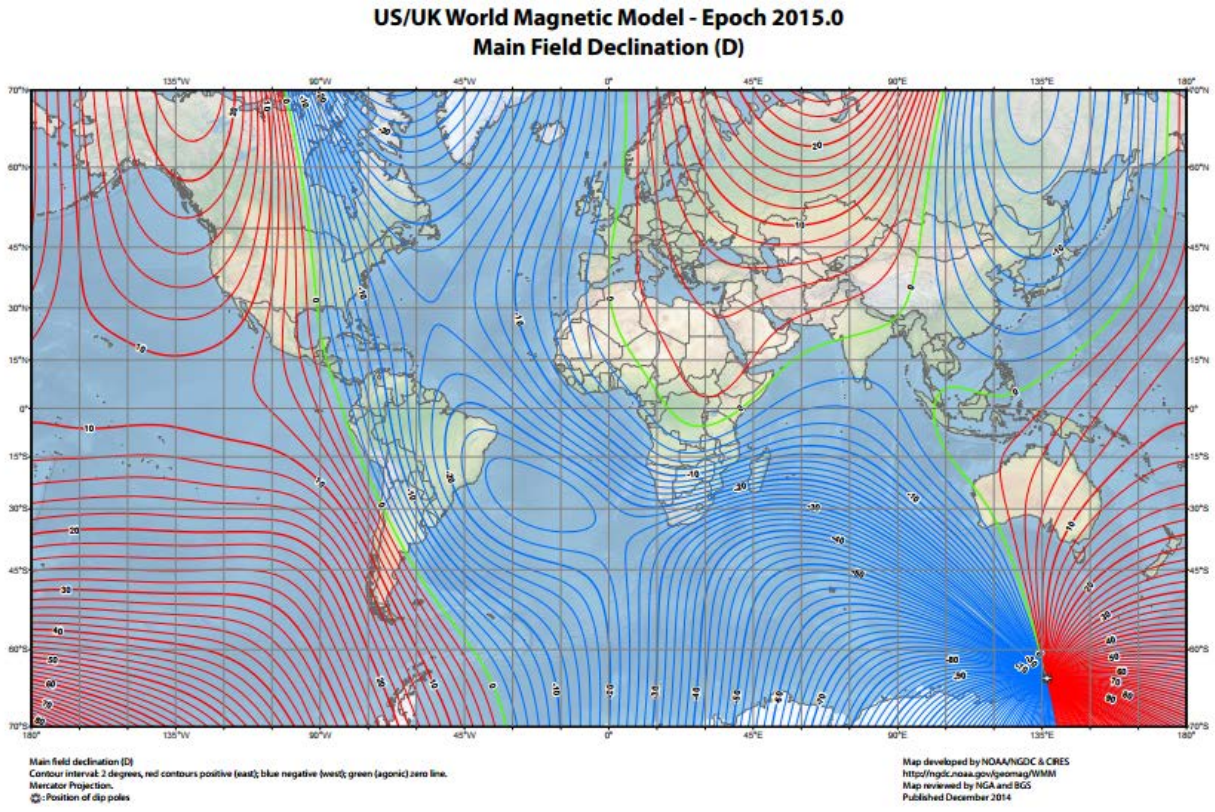
If the optional GPS receiver is installed, the RC4600 parses UTC from the data sent by the GPS receiver. This data is only available when the GPS receiver is sufficiently locked on to GPS satellites to determine UTC. The RC4600 allows the user to synchronize system time to the UTC reported by the GPS receiver.

The period of a satellite's motion is one sidereal day (approximately 23 hours 56 minutes 4 seconds). Entries in the track table for an inclined orbit satellite are stored at intervals of 1/48th of a sidereal day. The RC4600 determines at what point in a sidereal day (with respect to the RC4600 reference) it is by calculating how many sidereal days have passed from January 1, 1992 until the present system time.

In several screens the RC4600 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.

3.2.6 Magnetic Variation

In order to calculate satellite pointing solutions, the antenna's orientation with respect to True North must be known. The RC4600 uses a compass to measure the local horizontal component of the earth's magnetic field. The earth's magnetic field is very irregular as shown in the following map.



The magnetic field also changes slowly over time. The following table shows how the magnetic variation for Washington D.C. has changed over the last 250 years.

Year	Magnetic Variation
1750	-3.3
1800	-1.0
1850	-2.5
1900	-5.5
1950	-7.5
2000	-10.6

The RC4600 uses the International Geomagnetic Reference Field (IGRF) model to determine the local magnetic variation (difference between Magnetic North and True North). This model demonstrates how the earth's magnetic field and how it is changing. The IGRF is based on world-wide observations and is updated every five years. The IGRF model cannot account for short term effects such as magnetic storms, etc.

Local magnetic variation is calculated given the antenna's latitude, longitude and the current date. The magnetic variation calculation cannot account for isolated local anomalies or external effects (power lines, train tracks, etc). The azimuth scanning functions (2.1.1.2.2.3.3 and 2.1.1.2.2.3.6) are used to compensate for these heading calculation errors.

3.2.7 System Performance

The performance achieved by the RC4600 in locating and tracking satellites is dependent on the mechanical tolerances of the antenna, the correctness of the installation and the accuracy of the various sensors.

The largest source of error for the system is due to errors in determining the antenna's magnetic heading. Errors in heading primarily affect the accuracy of the antenna's calculated azimuth position. The compass determines the magnetic heading by measuring the direction of the magnetic field at the sensor. Problems arise because the earth's magnetic field can be distorted by ferrous metals (such as steel and iron; aluminum is a non-ferrous metal) and man-made magnetic fields. These man-made fields can be generated by electric motors, generators, and transformers.

For the compass sensor, there are two unique categories of objects that distort the magnetic field in the vicinity of the truck. Some of the distortion is due to objects and electrical devices on the antenna itself. This component of the distortion can be largely compensated for during system calibration.

The other component of the distortion is due to large metal objects and man-made magnetic fields around the site where the antenna is being operated. This component of the distortion varies as the antenna moves from one location to another, and it affects the accuracy of the calculated azimuth position. Environments which typically produce the largest errors include railroad yards, areas around electrical substations, and sites near structures containing large amounts of steel or iron, such as bridges or large buildings.

To help alleviate this azimuth error, the azimuth scan feature scans an azimuth range about the target azimuth and seeks the strongest signal. This feature is explained in full in section 2.1.1.2.2.3.3.

The RC4600 uses 16-bit resolvers, or 25- bit optical encoders to sense azimuth and elevation position. The 16-bit sensors offer a resolution of 0.0055°, where the 25-bit optical encoders offer a resolution of 0.00001°. It is important to make sure that the proper sensor is used for the application.