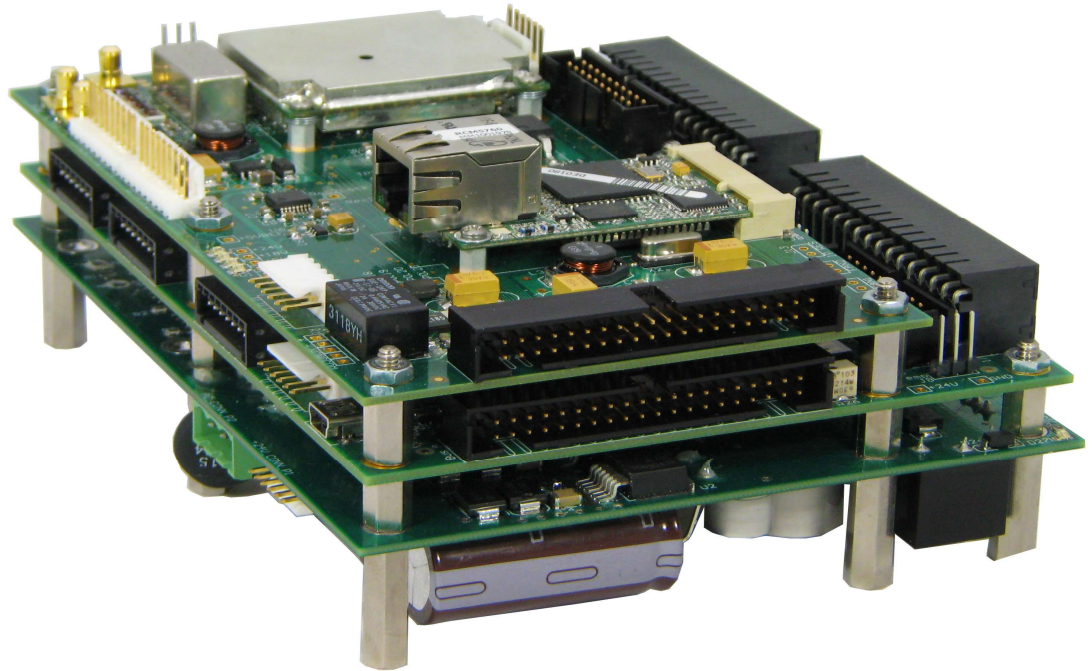# RC4000 ANTENNA CONTROLLER BOARDSET
USER'S MANUAL

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Contents subject to change

Serial No_____

REVISION HISTORY

DATE	MODIFICATION	SW VERSION	INITIALS
07 JAN 2011	Preliminary document	0.00	CJ
15 FEB 2011	Engineering release	0.02	CJ
10 MAR 2011	Initial release	0.03	CJ
26 MAR 2012	System Definition screen	0.05	JFR
12 JUN 2012	Expert Access/Reset Defaults updates	0.05	ECG
10 AUG 2012	Polarization Calibration Multi-Feeds	0.05	JFR
28 NOV 2012	Updated section of fix heading	0.05	ECG
25 NOV 2013	Corrected feed bit significance	0.06	ECG
26 NOV 2013	Corrected Bus A & B tables, change chapter 5 to Appendix A, add Appendix B & C nomenclature	0.06	JDK
05 DEC 2013	Large update to many parts of the manual, references, drawings, descriptions, troubleshooting, etc.	0.06	JDK
26 AUG 2014	Updated appendix list	0.07	BPK
11 NOV 2014	Updated many CONFIG screens & definitions	1.10	JDK
03 DEC 2014	Updated pulse scale factor desc AZ/EL	1.1x	JDK
10 MAR 2015	Updated max inclination spec	1.1x	JFR
18 JUN 2015	Corrected discrepancies in the AZ Jam Slop and Runaway Slop descriptions	1.1x	JDK
10 JUL 2015	Updated Options Board to new design	1.1x	JDK
10 JUL 2015	Updated Magnetic Variation map	1.1x	ECG
23 SEP 2015	Updated Sensors in Specifications	1.1x	JDK
27 SEP 2016	Large update of CONFIG mode with transition to software version 2.0x. Updated CONFIG screens, parameters, etc. Corrected some old references to RC3000 in the trouble-shooting section. Created hyper-links for chapter & section references within the document.	2.03	JDK
10 NOV 2016	Updated warranty	N/A	BPK

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

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

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3. Accidental or intentional damage, including lightning
4. Water / Liquid damage

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APPENDIX A – EXPERT ACCESS CODES

APPENDIX B – MOUNT SPECIFIC DATA

APPENDIX C – ENCLOSURE SPECIFIC DATA

The following appendices describe optional features of the RC4000. These appendices will be included in the manual if the option is present.

APPENDIX BCN : INTEGRATED BEACON RECEIVER

APPENDIX DVB : INTEGRATED DVB-S RECEIVER

APPENDIX DVB-S2 : INTEGRATED DVB-S2 RECEIVER

APPENDIX IP : IP-BASED REMOTE CONTROL

APPENDIX PBO : PUSH BUTTON OPERATION

APPENDIX SAC : SINGLE-AXIS COMPASS

APPENDIX REM : SERIAL-BASED REMOTE CONTROL

APPENDIX TAC : THREE-AXIS COMPASS

APPENDIX TLE : TWO LINE ELEMENT TRACKING

APPENDIX TRK : INCLINED ORBIT TRACKING

1.0 INTRODUCTION

The RC4000 Antenna Control Unit (ACU) boardset consists of stackable set of cards allowing for compact and flexible ACU packaging. The design and function of the RC4000 is derived from Research Concepts Incorporated's previous generation mobile ACU, the RC3000.

PLEASE READ AND UNDERSTAND THE MANUAL. Due to the complexity of the functions performed by the RC4000, time invested in understanding its installation and operation will be well spent.

1.1 Manual Organization

The RC4000 boardset allows for ACU functionality to be packaged in varied configurations. Also many hardware and software options are available for use with the RC4000 architecture. This manual is organized to:

1) describe common hardware and software elements that will apply to all instances of the RC4000 and

2) provide a structure to allow definition of elements unique to a specific use of the RC4000

Chapter 1 summarizes the contents of the manual and highlights the functionality and features of the RC4000.

Chapter 2 describes the RC4000 boardset hardware, interfaces and common external components.

Chapter 3 describes the core software features of the RC4000.

Chapter 4 covers RC4000 common installation and calibration procedures, provides help for system troubleshooting and discusses detailed operational topics referred to in the manual

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

Appendix B, titled "MOUNT SPECIFIC DATA", details unique functions and values unique to a specific antenna mount.

Appendix C, titled "ENCLOSURE SPECIFIC DATA", details mechanical and electrical details on how the RC4000 is packaged. This appendix may not be supplied from RCI if the boardset is not packaged in an RCI provided enclosure.

Separate appendices describe optional features of the RC4000. Example optional appendices that could accompany the manual include:

APPENDIX REM - SERIAL-BASED REMOTE CONTROL

APPENDIX IP - IP-BASED REMOTE CONTROL

APPENDIX TRK - INCLINED ORBIT TRACKING

APPENDIX TLE - TWO LINE ELEMENT TRACKING

APPENDIX DVB - INTEGRATED DVB RECEIVER

APPENDIX BCN - INTEGRATED BEACON RECEIVER

MANUAL CONVENTIONS

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

```
AZIM:   0.0 STOW   SS1: 50         MANUAL
ELEV: -67.5 STOW   SAT:TELSTAR 402
 POL:   0.0        SPD:FAST            CST
<0-9>JOG ANTENNA <MODE>MENU     14:25:47
```

The following table shows typical abbreviations used both on RC4000 screens and in the manual's text.

ITEM	ABREVIATION(S)
Azimuth	AZ AZIM, Azim
Elevation	EL ELEV, Elev
Polarization	PL POL, Pol
Clockwise	CW
Counter-Clockwise (Anti-Clockwise)	CCW
Down	DN
Latitude	LAT
Longitude	LON
Satellite	SAT
Global Positioning System	GPS
Liquid Crystal Display	LCD
Automatic Gain Control	AGC

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 a particular RC4000 mode of operation, that mode's name will be capitalized – ex. LOCATE.

Throughout the RC4000 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.
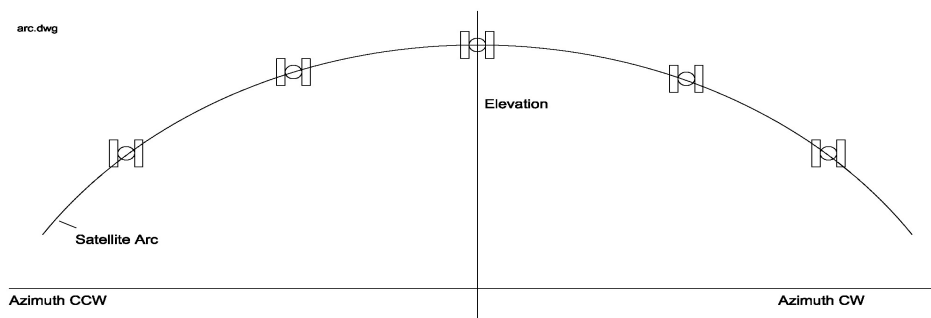
1.2 RC4000 Features

The RC4000 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 RC4000's microcontroller.

The RC4000 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
- Optional 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
        - Single Axis Compass
        - Dual GPS Antenna Module "GPS Compass" (future)
- Multiple User Interface Options
        - Optional Liquid Crystal Display (LCD) and keypad
        - Serial (RS-422/-232) remote control
        - Ethernet (IP-based) remote control
        - Red/Green Button

The following picture shows an example of the RC4000 boardset mounted in a weatherproof enclosure. This picture shows removable connectors on the enclosure but antenna interface wiring could go directly to boardset connectors (via cable glands, etc.) if so desired.
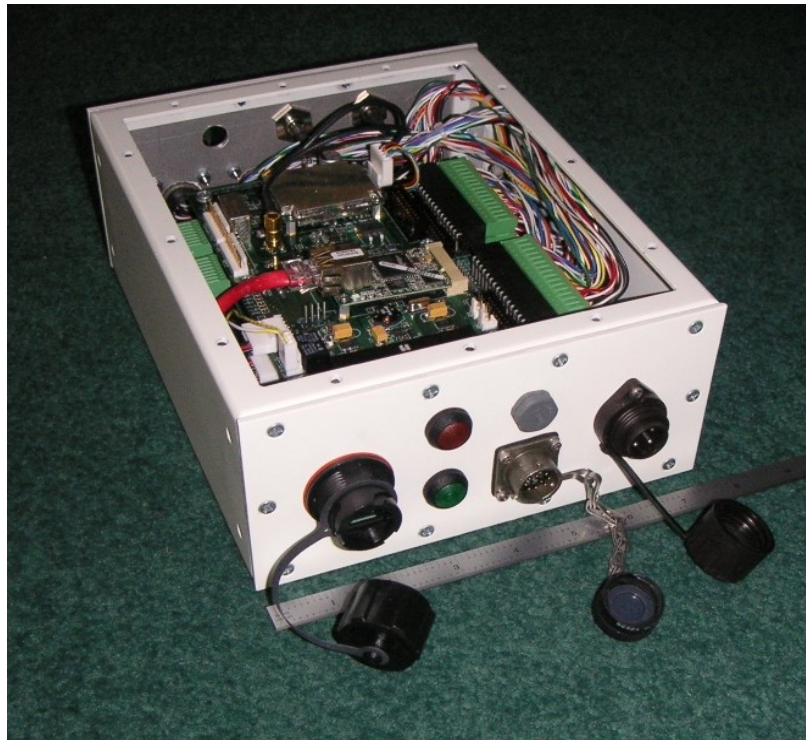
1.3 Hardware Overview

The following figure is a block diagram showing the major components of the RC4000 boardset and how they interface with a typical antenna system.
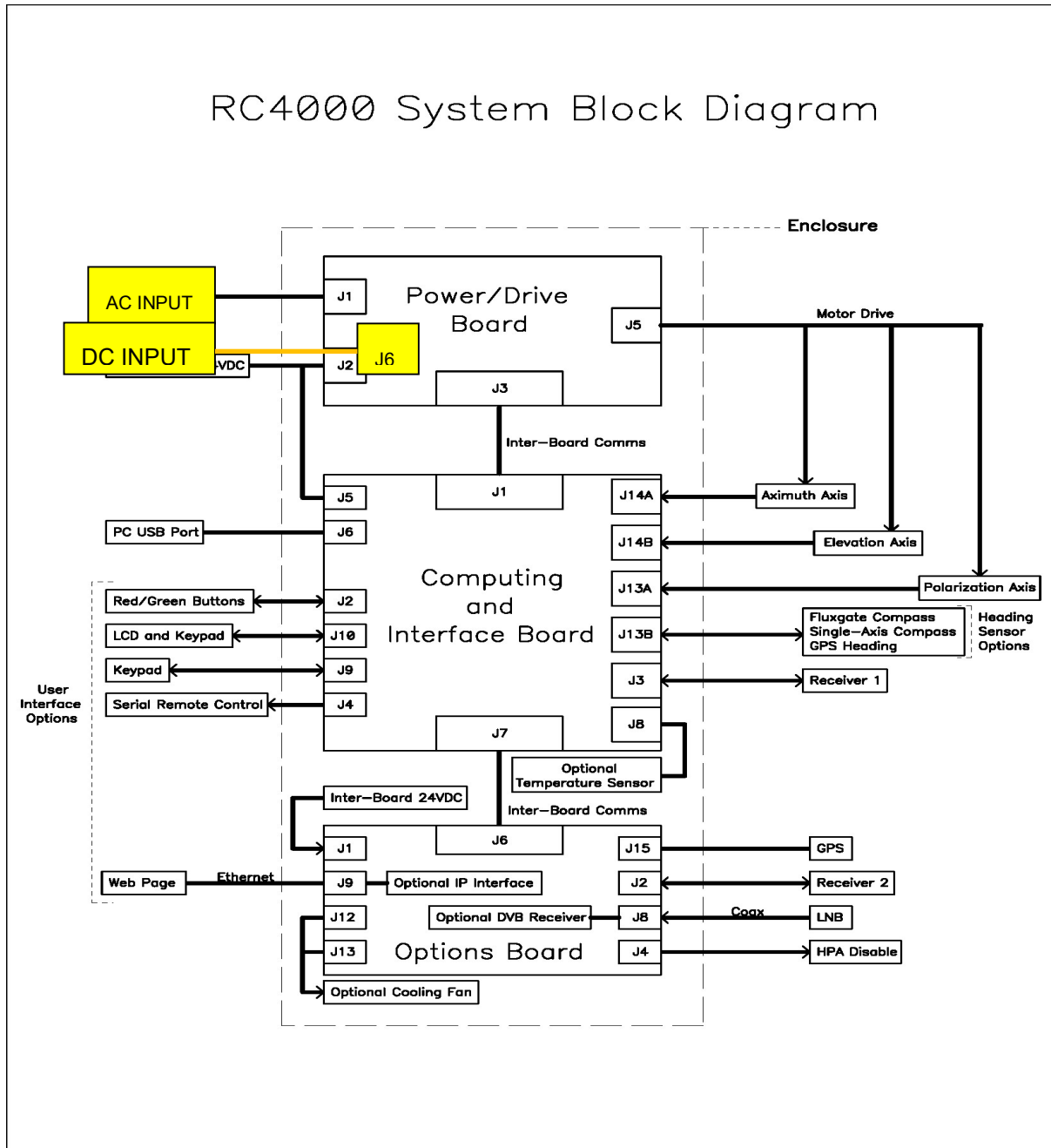
Individual interfaces will be described in detail in chapter 2. NOTE: Appendix C "Enclosure Specific Data" will describe how these interfaces are mechanized for a particular enclosure.

1.4 Software Overview

The RC4000 allows easy antenna control via its mode based operation. Multiple user interface (local and remote control) options exist. This overview highlights the software functions by showing data that would be presented if a user interface utilizes an LCD screen. 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 RC4000.

Operational Group Functions

MANUAL. In MANUAL mode the user may jog the antenna in azimuth, elevation and polarization. Upon power up, the fluxgate compass and GPS receiver initialize and begin providing data.

```
AZIM:   0.0 STOW    SIG: 50         MANUAL
ELEV: -67.5 STOW    SAT:TELSTAR 402
 POL:   0.0          SPD:FAST          CST
<0-9>JOG ANTENNA    <MODE>MENU   14:25:47
```

AUTOMATIC LOCATION OF A SATELLITE. In LOCATE mode, azimuth and elevation pointing angles are automatically calculated based on position (lat/lon), heading and the selected satellite. Position may be obtained automatically from the optional GPS, selected from a preset list of user defined positions or entered manually. Heading may be automatically obtained from the optional fluxgate compass or entered manually. The user selects which satellite to locate from either a preset user defined list of commonly used satellites, a provided extensive list of satellites or by manually entering satellite data. The RC4000 checks that the calculated pointing solution is within the mount's range of movement and prompts the user to automatically position the antenna.

```
POS:    38°56N  94°44W  180.0       LOCATE
SAT:GALAXY 6     74.0W           AZ:-31.1
                                 EL: 40.0
<1>SELECT NEW SAT        READY TO LOCATE
```

STORING SATELLITE LOCATION. After verifying the antenna is precisely on the satellite, the user may STORE the satellite's azimuth and elevation angles along with horizontal and vertical polarization data. If the satellite has been identified as having an inclined orbit, the TRACK mode will be automatically entered as described below.

```
SAT       LON  INCLIN BAND           STORE
BRASIL A1  79.0   2      C
VERIFY  SATELLITE DATA OK FOR STORING
1-CORRECT,  2-INCORRECT
```

RECALLING STORED SATELLITES. The user may quickly and precisely move between previously STOREd satellites via RECALL mode.

```
                                         RECALL
STORED SATELLITE: BRASIL A1


SELECT SAT(SCROLL UP/DOWN) <ENTER>
```

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

```
AZIM: -42.5 (  0.0)                    STOW
ELEV:  23.4 (-67.5)


MOVING TO (TARGET),<STOP> TO HALT MOTION
```

Programming Group Functions

The programming group modes provide for initial configuration of the controller and also provide screens to aid in maintenance and troubleshooting.

Configuration mode screens allow the user to customize and calibrate the operation of the RC4000 for use with a particular mount. Note that most configuration items will be factory set for correct operation with a particular mount.

```
REF_VOLT:2.50 OFF:  0.0      CONFIG-AZIM
     CCW:180    CW:180    SF:76.35


SET REFERENCE VOLTAGE <2.00 - 3.00>
```

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

```
 SYSTEM:11/10/97 22:26:40           TIME
GPS UTC:11/10/97 22:26:40       ZONE:CST
DISPLAY:11/10/97 16:26:40     OFFSET:- 6
1-DATE 2-TIME 3-SYNCH 4-ZONE 5-OFFSET
```

1.5 Specifications

RC4000 BOARDSET	
Physical	
Size	6 1/16" x 7" x 3 3/4" (with RCI plate and RF board)
Weight	2.6 lbs.
Input Power	AC: 85 - 265 VAC, 47 - 63 Hz DC: 20 - 28 VDC
Fusing	3 AMP Slow-Blow
Temperature (Operational)	-40 to +60 deg. C.
Temperature (Storage)	-40 to +70 deg C.
Humidity	10% to 85% Non-Condensing (optional special-environmental kit available)
Antenna Drive	
Azimuth/Elevation/Polarization	24 VDC 10 A. (300 W. power supply), 17 A. (500 W. power supply)
Electromechanical Brakes (optional)	24 VDC, 850 mA
Position Sense	
Azimuth	Potentiometer, 12-bit resolution standard; quadrature pulse sensor standard, optional single phase pulse sensors (Reed, Hall-Effect, Optical); optional resolver, 16-bit resolution
Elevation	Inclinometer, 12-bit resolution standard; quadrature pulse sensor standard, optional single phase pulse sensors (Reed, Hall-Effect, Optical); optional resolver, 16-bit resolution
Polarization	Potentiometer, 12-bit resolution standard; optional single phase pulse sensor, optional resolver, 16-bit resolution
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	
Elevation Accuracy	+/- 0.02 degrees (typical)
Azimuth Accuracy	+/- 0.10 degrees (typical)
Polarization Accuracy	+/- 0.08 degrees (typical)
VSAT Mode	Single key-press-to-locate-operation for untrained operators
Autopeak Input	Full L-Band power detection to find strongest signal.(configurable to AGC voltage or Beacon receiver output -10 VDC to +10 VDC; 2Mohm input impedance, two channels)
Modem Receive-Lock Input	TTL or contact closure, (optional non-invasive modem lock detector available)
Track Mode	
Antenna Size	0.4 – 12.0 meters
Tracking Accuracy	0.1 to 3.0 dB selectable; mount dependent
Maximum Inclination	12 deg., standard
Inclined Orbit Tracking Modes	Step-Track, Memory-Track, Intelli-Search™ , Program Track, optional Ephemeris Track
Signal-Strength Input	-10 VDC to +10 VDC; 2Mohm input impedance, two channels
Non-volatile Memory Backup	Duracell DL2450

1.6 Part Number Scheme

As of January, 2011 the RC4000 part numbering scheme consisted of 20 digits. This scheme is introduced here as a way to highlight many of the options (both hardware and software) associated with customizing an ACU solution using the RC4000. The following table only briefly discusses each item within the PN scheme and provides an initial reference to applicable sections within the manual.

DIGIT	ITEM	DESCRIPTION	REFERENCE
19	Always '4'	common starting digit for RC4000-based products	
18	ACU Version	K - RC4000 "x"- future variations	
16,17	Mount Type	2 digits identifying unique mount/antenna software support	3.1.5
15	Navigation	Specifies optional navigation equipment (GPS, Fluxgate Compass, etc)	3.1.5
14	Tracking	Optional Inclined orbit tracking support	3.1.5
13	Remote Control	Optional remote control (serial, IP-based, etc.)	2.1.2.2.4
12	Receiver 2	Receiver support (DVB, Beacon Receiver, etc.)	2.1.2.3.2
11	Receiver 1	Receiver support (Beacon Receiver, modem,etc.)	2.1.2.2.3
10	Enclosure	Boardset Packaging (boardset only or included in specific enclosure)	2.1
9	User Interface		
8	Antenna Interface		
7	RF Options	Auxiliary RF routing board, etc.	2.1.2.3.8
6	Options Card	DVB Heater, Relay usage, etc.	2.1.2.3
5	Motor Drive Card	Specifies DC or AC power supply, etc.	2.1.2.1
4	Resolver Card	Reserved for future support of resolver interface	
3	Environmental	Optional heaters, fans, conformal coating, etc.	
2	Power Input	Specify which power input option used	
1	Reserved		
0	Options		

NOTE: the part numbering scheme is included in the manual to introduce various ways that the RC4000 boardset may be customized for a particular antenna application. The part numbering scheme is subject to change. Consult RCI before ordering for detailed discussion of options available.

2.0 HARDWARE

This chapter describes both the RC4000 boardset and common external devices that may be used for integrating an antenna system.

2.1 Boardset Devices

This section describes the mechanical and electrical interfaces of the boards that comprise the RC4000 boardset. NOTE: details on how the boardset is packaged in an enclosure and how interfaces are connected to an antenna system would be detailed in Appendix C – Enclosure Specific Data.

2.1.1 Mechanical Mounting

The following picture shows a complete RC4000 boardset attached to a mounting plate.
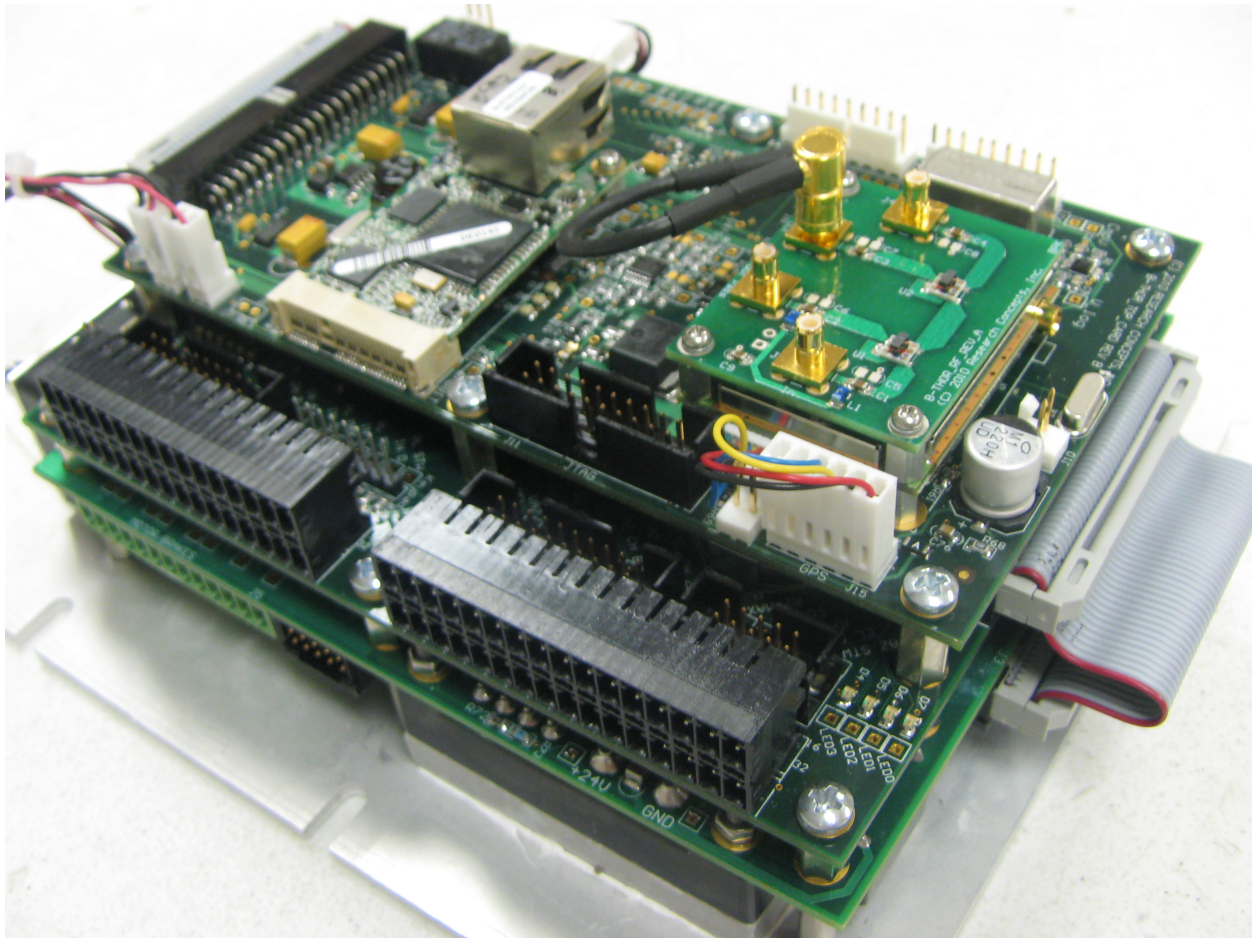
The boardset is designed to occupy the minimum volume by placing the drive board on the bottom, the computing board in the middle and the options board on top. The pictured stack includes an auxiliary RF routing board (see 2.1.2.4.8) with four coaxial connectors on top. In this configuration, the dimensions of the stack (including plate) are 7" x 6 1/16" x 3 3/4". With mating connectors and wiring, a stack of this size fits within an enclosure with internal measurements of 8.9" x 7.4" x 3.4".

The boardset may be laid out in other configurations in order to accommodate additional components or to minimize height. The following picture shows an alternative configuration. In this example the drive and computing boards are stacked together with the options board to the side.
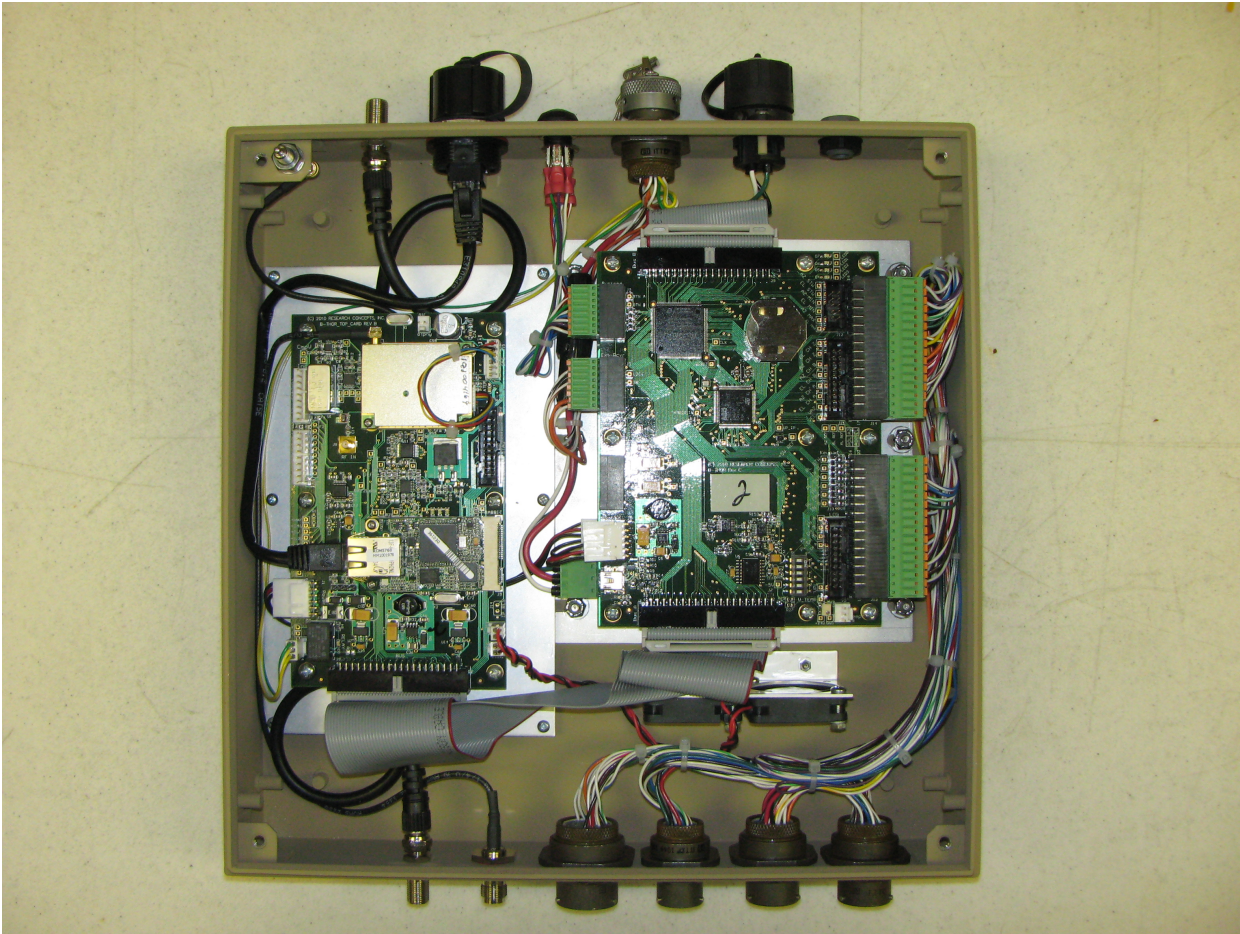
Note that the inclinometer could be mounted inside the enclosure if it rotates with the elevation axis correctly (see section 2.2.1).

The following drawing shows the mounting hole spacing for the RC4000 boards. The Power/Drive board and the Computing/Interface board utilize all nine mounting holes. The Options board (on top in first picture) is narrower and only uses the six inner mounting holes.
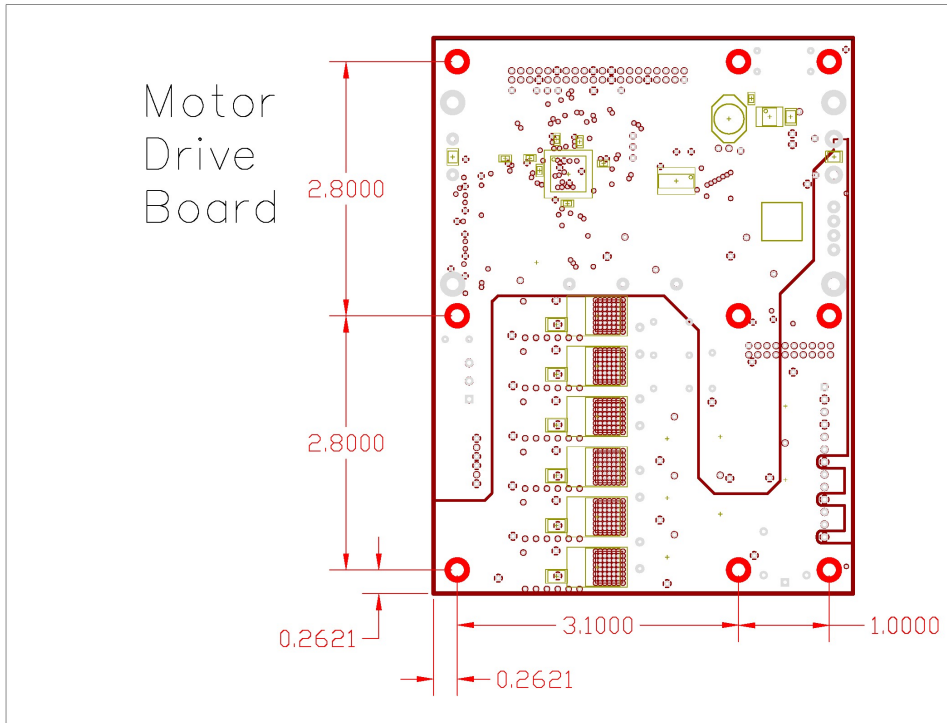
The first picture shows the complete stack attached to a 6.0840" x 6.8667' mounting plate (M-4KPLT1) built by RCI. In addition to board size, room for connectors, wiring harnesses, etc. should be considered. The following diagram shows how a boardset stack could fit inside a chassis with inside dimensions of 7.32" x 8.8191".
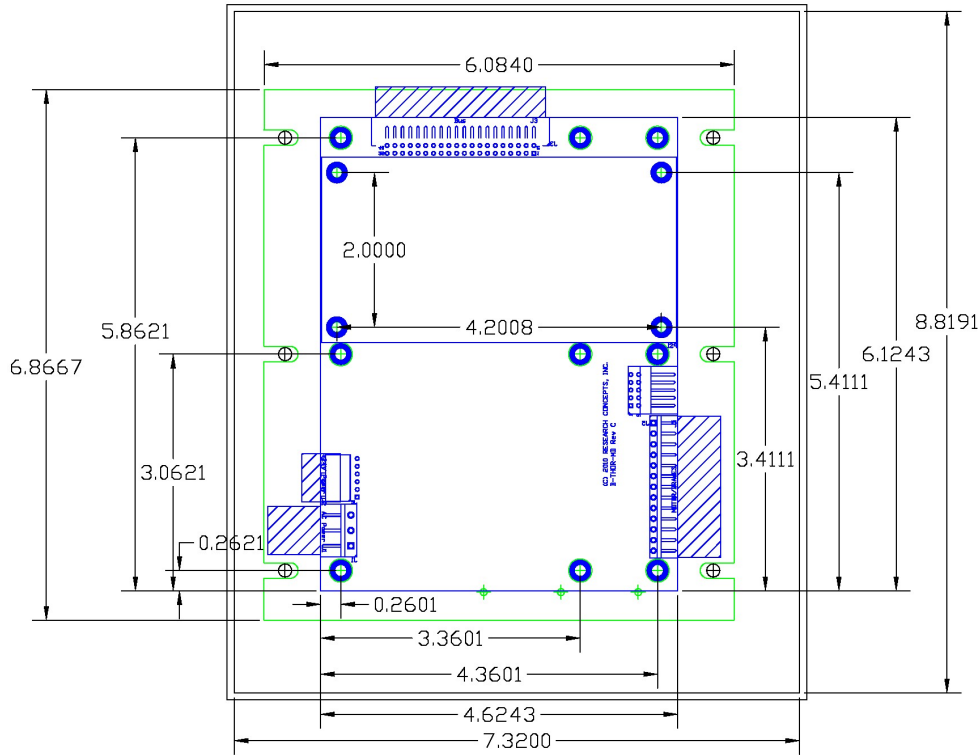
NOTE: the RC4000 boardset may be purchased attached to the M-4KPLT1 plate.

2.1.2 Electrical Interfaces

The interfaces available from each RC4000 board are detailed in this section. For context, typical uses of individual interfaces within an antenna system are described. Differences to these interfaces and how they are accommodated for a particular mount will be described in Appendix B - Mount Specific Data and in Appendix C - Enclosure Specific Data.

Multiple connector types are used by the boardset. The following table assigns each connector type a number and shows which connectors on each board use that type. Section 2.1.2.5.x (x = type) will provide details of the connector types.

Type	Description	Drive Board	Computing Board	Options Board
1	Phoenix Terminal Header	J1, J6		
2	Molex Friction Lock Header	J2	J5, J8	J1, J2, J3, J4, J5, J10, J12, J13, J14, J15, J22, HTR1
3	Right Angle Shrouded Header	J3	J1, J7	J6, J11
4	Right Angle JTAG	J4		
5	Drive Terminal Block	J5		
6	Phoenix Header		J2, J3, J4	
7	USB		J6	
8	Tyco Vertical Header		J9, J11, J12	
9	Unshrouded Header		J10	J7, J23
10	Phoenix Double Header		J13 A&B, J14 A&B	
11	SMB			J8, J16, J17, J18
12	Ethernet			J9

As each interface is defined, its connector designation, PCB board nomenclature, pin count and connector description/type will initially be shown in bold. For example:

Designation	PCB	Pin Count	Connector	Type #
J1	**"AC Power"**	**3**	**Phoenix Terminal Header**	**1**

If there is no nomenclature on the PCB for a particular connector, it will be shown as "unmarked".

2.1.2.1 Power/Drive Board

The power/drive board's main functions are to provide antenna motor control and distribute power to the rest of the RC4000 boardset.

The board may be externally supplied with 24VDC input or convert AC input via optional (300 or 500 W) power supply modules. Note that the picture shows the underside of the card that will typically be faced towards the outside of the enclosure to conduct heat and to provide minimum distance between the card and the computing/interface card.
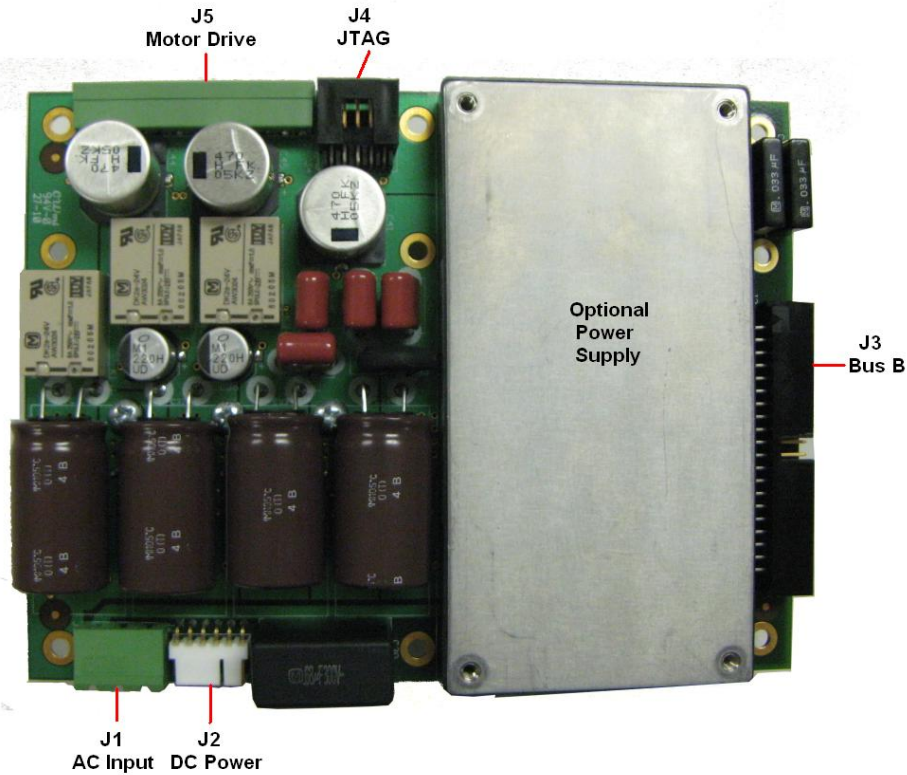
The characteristics of the motor drive (voltage, current limit, IR compensation, etc.) may be programmed for each axis via software configuration items (see 3.3.1.3.4).

Spacers supporting the drive board need to be 0.875" between the mounting surface and the bottom of the card. When an AC power supply is present, a .375" thick block of material must be placed between the power supply and the bottom plate to conduct heat to the enclosure.

2.1.2.1.1 J1 - AC Power Input

Designation	PCB	Pin Count	Connector	Type #
J1	**"AC Power"**	**3**	**Phoenix Terminal Header**	**1**
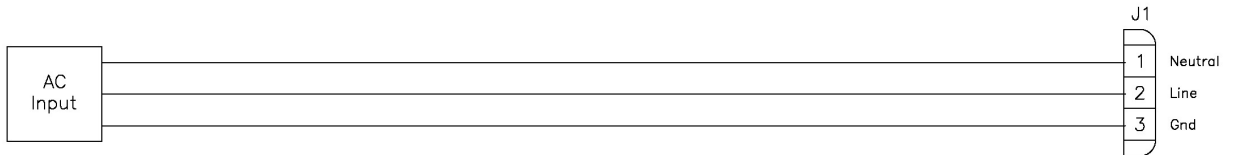
The Power/Drive board may be purchased with optional 300 or 500 Watt power supply cards. If a power supply card is present, AC input power is supplied to connector J1. If external DC power is to be supplied (see section 2.1.2.1.6), leave connector J1 open.

The power supply cards can automatically accommodate AC input between 85 to 265 VAC and between 47 to 63 Hz. The power supply card will convert the AC input into 24 VDC power for use by the drive section and for powering the other boardset cards.

Typical sizing of the power supply card will mainly be a function of motor drive requirements. The following power requirements for the boardset cards and external sensors will also need to be considered:

Component	Power Allocation (Watts)
Computing/Interface Board	1.0
LCD (if present)	1.0
Drive Board (excluding motor drive power)	0.6
Options Board	2.4
GPS Receiver	0.5
IP Interface	0.5

NOTE: All system (boardset components, motors, sensors, etc.) power requirements need to be considered when sizing power supply.

A wire size appropriate for the total system power should be used. It is also recommended that a "slow blow" fuse of appropriate size (typically 3 A.) be placed inline to the AC input.

2.1.2.1.2 J2 - DC power

Designation	PCB	Pin Count	Connector	Type #
J2	**"+24 Power"**	**6**	**Molex Friction Lock Header**	**2**
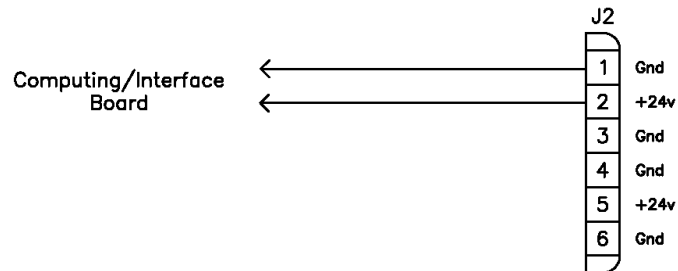
The Power/Drive Board will be used to provide 24 VDC power to other cards in the boardset. Typically pins 1 & 2 will start the DC power distribution "daisy chain" by supplying power to the computing/interface card.

2.1.2.1.3 J3 - Interboard Bus B

Designation	PCB	Pin Count	Connector	Type #
J3	**"Bus"**	**40**	**Right Angle Shrouded Header**	**3**

Drive control signals from the processor card are provided to the Drive board via Bus B.

Signal details for Bus B are provided in section 2.1.2.2.1.

2.1.2.1.4 J4 - JTAG

Designation	PCB	Pin Count	Connector	Type #
J4	**unmarked**	**10**	**Right Angle JTAG**	**4**

J4 provides for factory programming of the Drive Board's microcontroller.

2.1.2.1.5 J5 - Motor Drive

Designation	PCB	Pin Count	Connector	Type #
J5	**" MOTOR/BRAKES"**	**13**	**Drive Terminal Block**	**5**

The RC4000 drive section is designed to drive azimuth, elevation, and polarization motors up to 24 volt DC. The absolute maximum allowed motor current is 10 Amps. The motor drive module supports IR compensation, current limiting, dual speed operation, and dynamic braking. The drive train is also protected with resettable fuses.
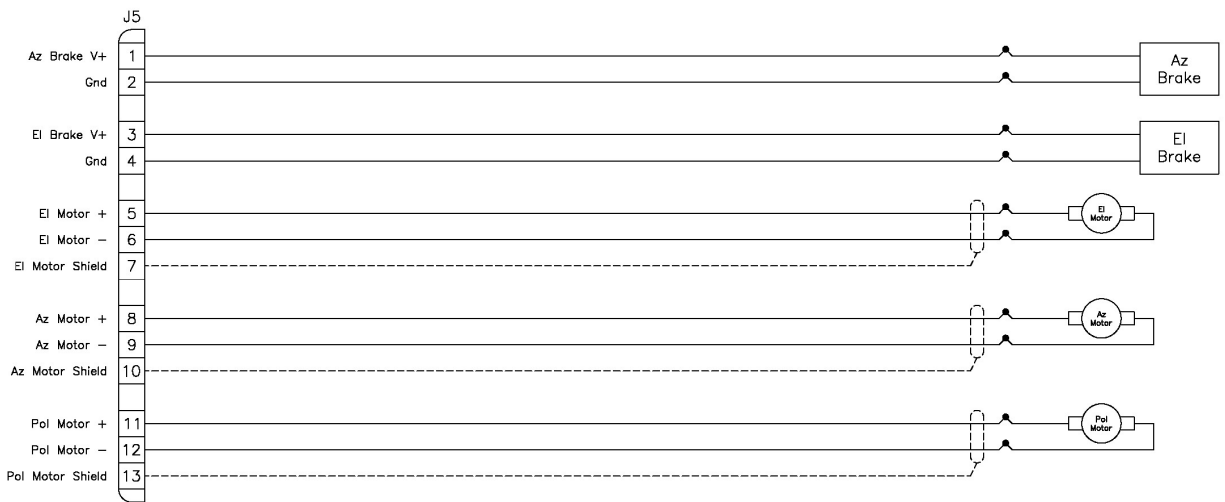
The following table describes the polarity of the RC4000's motor drive output signals.

Axis	J5 Terminals	Polarity
Azimuth	4,5	Azimuth CW – 4 has higher potential
Elevation	7,8	Elevation UP – 7 has higher potential
Polarization	10,11	Polarization CW – 10 has higher potential

The azimuth and elevation brake signals provide 24 VDC to energize brakes if present. Each brake signal has a 1 Amp resettable fuse inline and could be allocated for other functions (fairing drives, etc.)

2.1.2.1.6 J6 - DC Power Input

Designation	PCB	Pin Count	Connector	Type #
J6	**--**	**3**	**Phoenix Terminal Header**	**1**
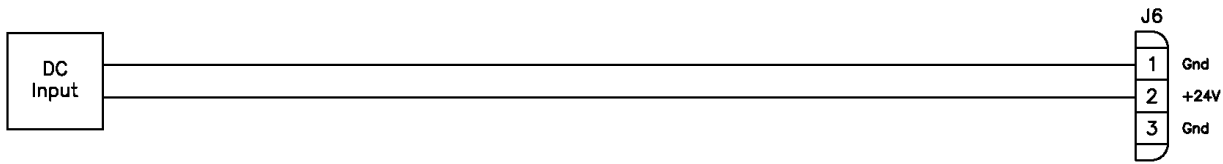
If an optional AC power supply is not present, DC input must be provided to connector J6, pins 1 & 2. If an AC power supply is present, leave pins 1 & 2 open (This connector will not be installed on the circuit board when the AC power supply is used).

Sizing of the DC input should consider all the power requirements discussed in section 2.1.2.1.1.

2.1.2.2 Computing and Interface Board

The Computing/Interface Board's main functions are:

1) Run operational ACU software

2) Detect antenna sensor data via multiple interfaces

3) Control functions on the Drive and Options Boards
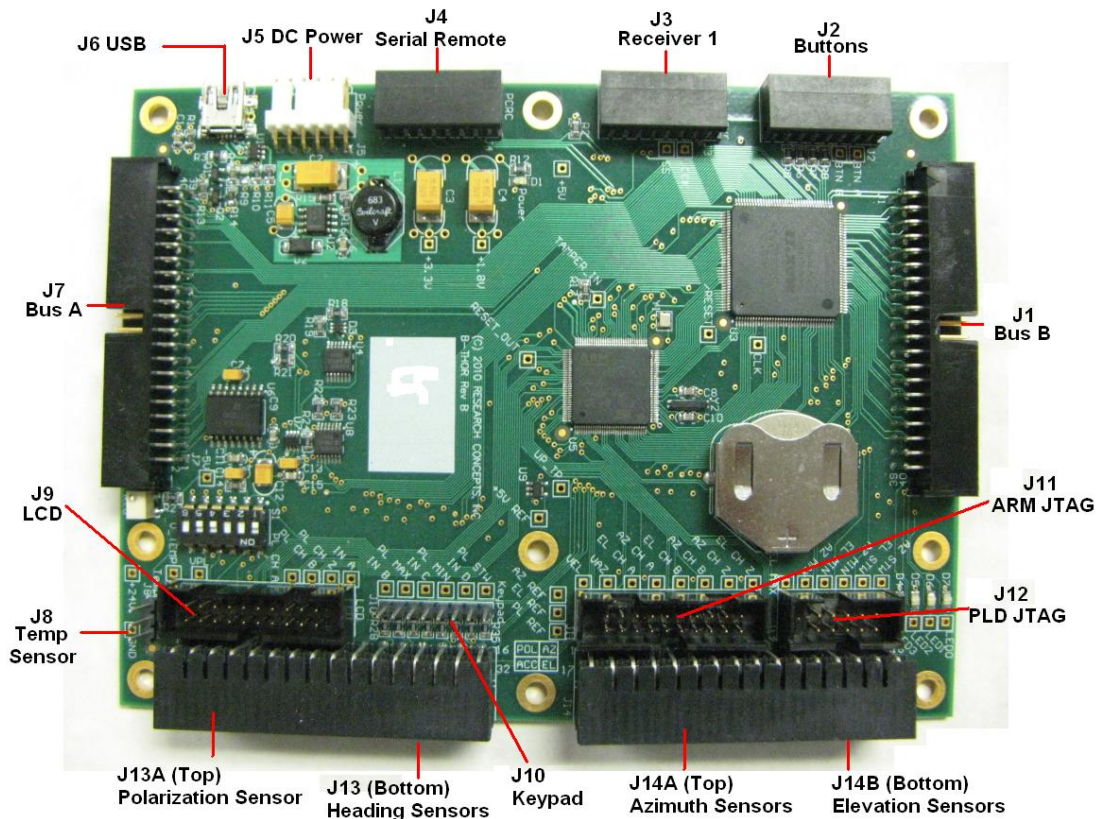
The picture shows the top of the card. Spacers greater than 0.300" in length are required between the bottom of the card and the top of the power/drive board. If the options card is stacked above the card, spacers greater than 0.437" are required.

The Computing/Interface Board uses a 3V, 2450 size coin cell battery.

2.1.2.2.1 J1 - Interboard Bus B

Designation	PCB	Pin Count	Connector	Type #
J1	**"Bus B"**	**40**	**Right Angle Shrouded Header**	**3**

The main function of Bus B is to provide drive control signals from the computing board to the drive board. The following table is provided for reference in case a particular installation of the boardset requires use of some spare interfaces available on Bus B.

Pin	Signal		Pin	Signal	
1	**DRIVE EN**		2	**DRIVE AZ0**	
3	**DRIVE AZ1**		4	**DRIVE AZ2**	
5	**DRIVE AZ3**		6	**EL SPD**	
7	**AZ SPD**		8	GND	
9	**DRV FAULT**		10	**POL SPD**	
11	GND		12	**DRIVE EL0**	
13	**DRIVE EL1**		14	**DRIVE EL1**	
15	**DRIVE EL3**		16	GPIO3	*
17	**DRIVE AZ4**		18	**DRIVE EL4**	
19	GND		20	GPIO4	*
21	I2C1 SCL		22	I2C1 SDA	
23	GND		24	GND	
25	**V_DRIVE**		26	GPIO5	*
27	**DRIVE PL0**		28	**DRIVE PL1**	
29	**DRIVE PL2**		30	**DRIVE PL3**	
31	UP_SPARE1	*	32	UP_SPARE2	*
33	GPIO6	*	34	GPIO7	*
35	GPIO8	*	36	GPIO9	*
37	GND		38	GND	
39	+5 VDC		40	+5 VDC	

-- bold => dedicated drive control signals   * - available for custom I/O

2.1.2.2.2 J2 - Red / Green Buttons

Designation	PCB	Pin Count	Connector	Type #
J2	**"Buttons"**	**8**	**Phoenix Header**	**6**
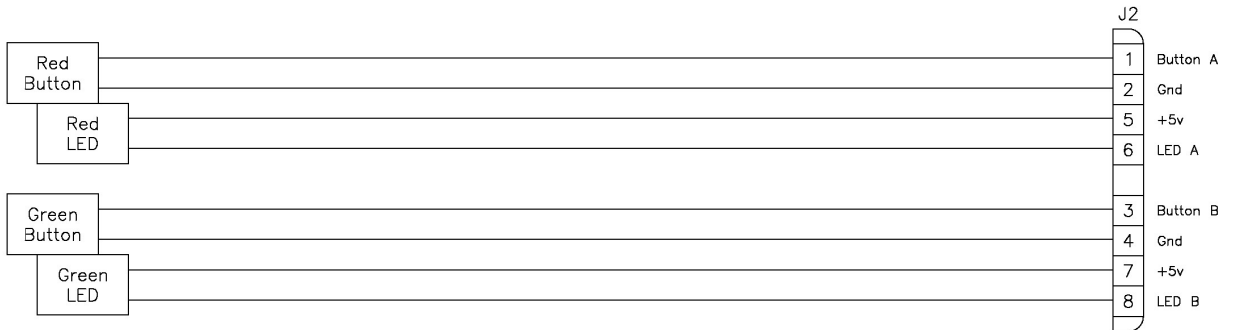
The two inputs and two outputs of J2 are most typically allocated to support the "Red/Green" button user interface option. As an example of this situation, the buttons & LEDs would be positioned on the enclosure itself to allow simple local control of LOCATE & STOW functions (see 3.2.2.10 "VSAT mode").

NOTE: as with most RC4000 I/O pins, if these interfaces are not used for Red/Green button operation, the I/O pins could be re-tasked for some other custom functionality.

2.1.2.2.3 J3 - Receiver 1

Designation	PCB	Pin Count	Connector	Type #
J3	**"Ext Rcvr"**	**8**	**Phoenix Header**	**6**

The J3 connector is allocated to support various types of receivers.

The flexible I/O includes:

1) +5 and +24 VDC for powering a receiver

2) a discrete lock input

3) 12 bit resolution analog to digital input for measuring signal strength over a +/- 10 VDC range

4) an RS-232 serial channel for control and monitoring

5) a "loop out" of GPS data to provide lat/lon/time data

How the J3 I/O is used is determined by which "Receiver 1" software option is present (see 3.1.5).

If there is no integrated receiver support (Receiver 1 option "N"), then the use of the analog signal strength input and the discrete lock input may be programmed from the "SS1 Signal Strength Factors" configuration screen (3.3.1.2.7).

If there is software support for a particular receiver present, then the use of J3 I/O will be unique to that receiver and will be detailed in an appendix describing that software option.

2.1.2.2.4 J4 - Serial Remote Control

Designation	PCB	Pin Count	Connector	Type #
J4	**"PCRC"**	**8**	**Phoenix Header**	**6**

The J4 connector allows for optional serial remote control via either the RS-232 or RS-422 interface
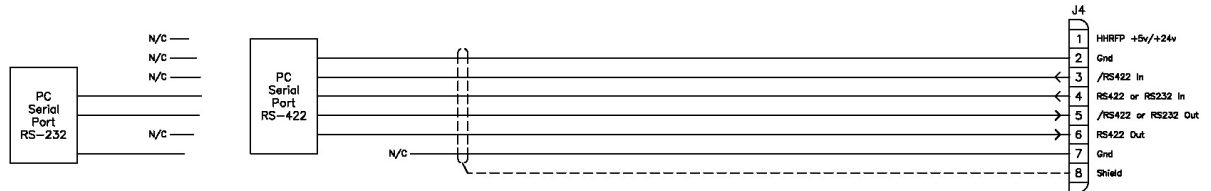
NOTE: the remote control software option (3.1.5) must be present for this interface to be active.

The most common way for this interface to be used is to implement the RC4000's remote control protocol as described in that software option's appendix. How the interface can be switched between the RS-232 and RS-422 standard will be described in that document.

Another way for this interface to be used is with the Handheld Remote Front Panel device described in section 2.2.8.   This device allows the mechanization of the basic keypad/LCD user interface, but at a long distance by using the RS-422 serial interface.
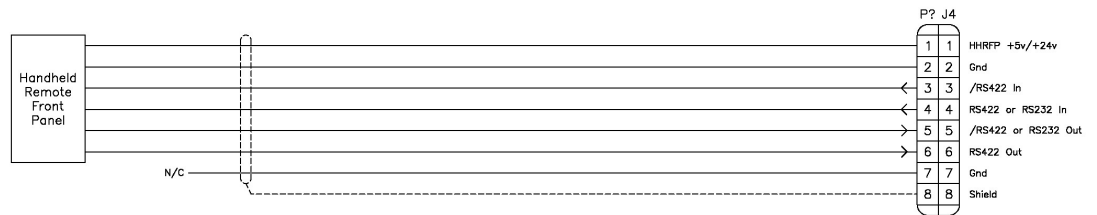
NOTE: Serial & IP remote control are mutually exclusive.

2.1.2.2.5 J5 - Interboard 24 VDC

Designation	PCB	Pin Count	Connector	Type #
J5	**"Power"**	**6**	**Molex Friction Lock Header**	**2**
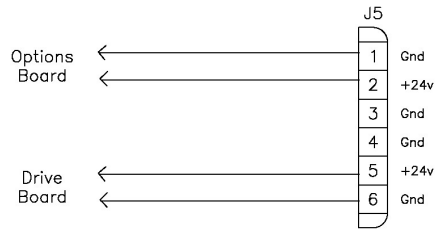
J5 typically receives 24VDC from the Power/Drive Board and daisy chains 24VDC to the Options Board.

2.1.2.2.6 J6 - Software Download

Designation	PCB	Pin Count	Connector	Type #
J6	**unmarked**	**5**	**USB mini-B**	**7**

The J6 USB mini-B female connector allows for factory and in-field programming of the RC4000's operational software via a standard USB cable. At power up, the RC4000's bootloader software checks the presence of a powered USB cable. If a USB cable is detected, the bootloader switches into downloading mode but if no USB is detected the bootloader will jump to the currently stored program for normal operation.

The update procedure is as follows:

1) Power off ACU. Connect USB cable between ACU and PC.
2) Power on ACU, wait for USB drive to be created on PC.
3) Drag hex file (attached) to USB drive. Wait for file to copy over.
4) Power off ACU. Disconnect USB cable between ACU and PC.
5) Power on ACU. New software can be identified by version and build number.

2.1.2.2.7 J7 - Interboard Bus A

Designation	PCB	Pin Count	Connector	Type #
J7	**"Bus A"**	**40**	**Right Angle Shrouded Header**	**3**

The main function of Bus A is to provide control and communication signals between the computing and options boards. The following table is provided for reference in case a particular installation of the boardset requires use of some spare interfaces available on Bus A pins.

Pin	Signal		Pin	Signal	
1	**REC1 SS**		2	REC1 LOCK	
3	**REC1 RX**		4	REC1 TX	
5	**REC2 SS**		6	REC2 LOCK	
7	**REC2 RX**		8	REC2 TX	
9	GND		10	GPS LO	
11	**SER4 RX**		12	SER4 TX	TX/RX ???
13	**SER5 RX**		14	SER4 TX	
15	GND		16	GND	
17	**RF_SS**		18	V_SPARE	*
19	NSS		20	MOSI	?
21	SCLK		22	MISI	?
23	+5 VDC		24	GND	
25	**I2C1 SCL**		26	I2C1 SDA	
27	**I2C2 SCL**		28	I2C2 SDA	
29	CAN RX		30	CAN TX	
31	GND		32	GND	
33	+5 VDC		34	AZ AUX	
35	EL AUX		36	POL AUX	
37	GPIO0	*	38	GPIO1	*
39	GPIO2	*	40	RELAY	???

* available as spare

2.1.2.2.8 J8 - Temperature Sensor

Designation	PCB	Pin Count	Connector	Type #
J8	**"Temp"**	**3**	**Molex Friction Lock Header**	**2**

Pin 1 – 3.3 V   pin 2 – V_Temp pin 3 – Gnd

The Computing and Interface Board can optionally accommodate a temperature sensor interfaced into connector designator J8. The typical temperature sensor used is Texas Instruments p/n LM61. This temperature is rated for a full -30º to +100ºC range. Standard software on the Computing and Interface Board does not implement this input.

2.1.2.2.9 J9 - LCD

Designation	PCB	Pin Count	Connector	Type #
J9	**"LCD"**	**20**	**Tyco Vertical Header**	**8**

The J9 connector allows a 4 row x 40 column character LCD (see 2.2.5) to be utilized as part of the user interface.   Note that the operable length of this connection is limited to 1 foot (30 cm) or less. The pinout details for J9 will not be provided here as the correct cable will be supplied along with the LCD from RCI.

A six position Dip Switch "S1" on the PCB allows the LCD circuitry to be configured for 3 different display sizes.

SWITCH	2x16	2x40	4x40
1	ON	OFF	OFF
2	OFF	OFF	ON
3	OFF	OFF	ON
4	ON	ON	OFF
5	ON	ON	OFF
6	ON	OFF	ON

Also associated with the LCD interface is pot R26 on the PCB for setting contrast.

2.1.2.2.10 J10 - Keypad

Designation	PCB	Pin Count	Connector	Type #
J10	**"Keypad"**	**8**	**Unshrouded Header**	**9**

The J10 connector allows a 4 row x 4 column keypad (see 2.2.6) to be utilized as part of the user interface. Note that the operable length of this connection is limited to 1 foot (30 cm) or less. The pinout details for J10 will not be provided here as the correct cable will be supplied along with the keypad from RCI. The J10 connector would also be used for the optional Local Jog Control Panel (2.2.7).

2.1.2.2.11 J11 - Processor JTAG

Designation	PCB	Pin Count	Connector	Type #
J11	**unmarked**	**20**	**Tyco Vertical Header**	**8**

Factory programming of microcontroller.

2.1.2.2.12 J12 - PLD JTAG

Designation	PCB	Pin Count	Connector	Type #
J12	**unmarked**	**10**	**Tyco Vertical Header**	**8**

Factory programming of PLD.

2.1.2.2.13 J13A - Polarization Sensors

Designation	PCB	Pin Count	Connector	Type #
J13A	**"POL"**	**16**	**Phoenix Double Header**	**10**

J13 provides a double row of pins. The top 16 pins are designated "J13A" and are typically allocated to supporting potentiometer, pulse and limit switch feedback from the polarization axis.
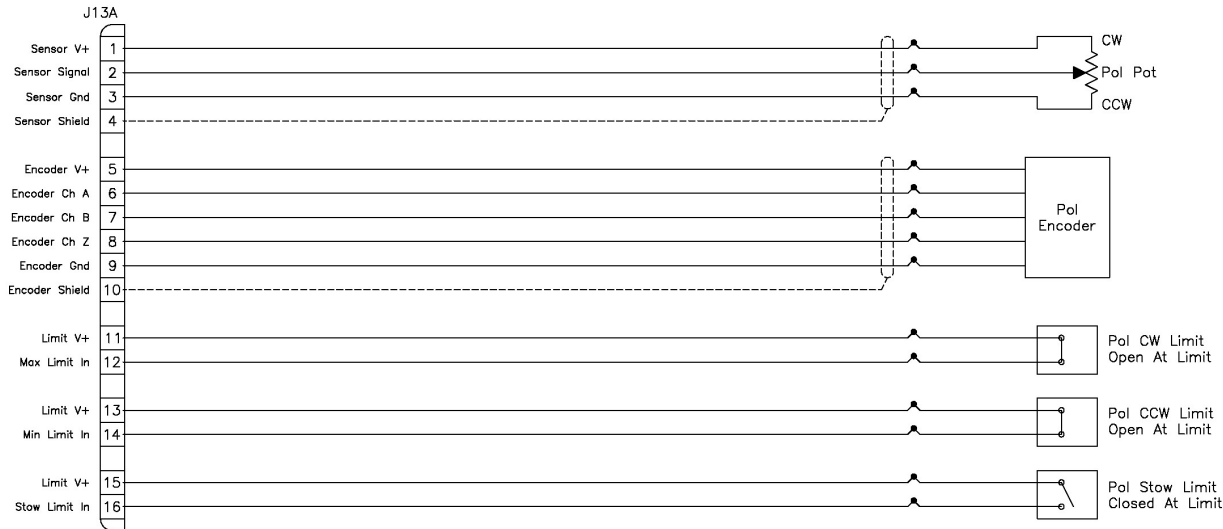
The directional sense of polarization movement is defined as CW or CCW, as seen by an observer standing behind the antenna reflector looking 'through' the reflector at the satellite. **See diagram below.** The reference position for the polarization position angle is vertical polarization for a satellite located at the same longitude as the antenna. In the northern hemisphere, for vertically polarized satellites to the west of the antenna, the polarization deflection is defined as CW relative to the reference position. In the northern hemisphere, the polarization angle increases for satellites farther to the west. In some modes of operation the controller predicts the polarization value required to align the antenna with a given satellite's horizontal or vertical polarization position. For this feature to function properly the antenna's polarization directional sense characteristics (defined by the polarization motor and position sensor) must be consistent with that of the controller. The following diagram shows the polarization axis sign convention used. The diagram depicts looking at the arc of satellites from behind (through) the antenna.
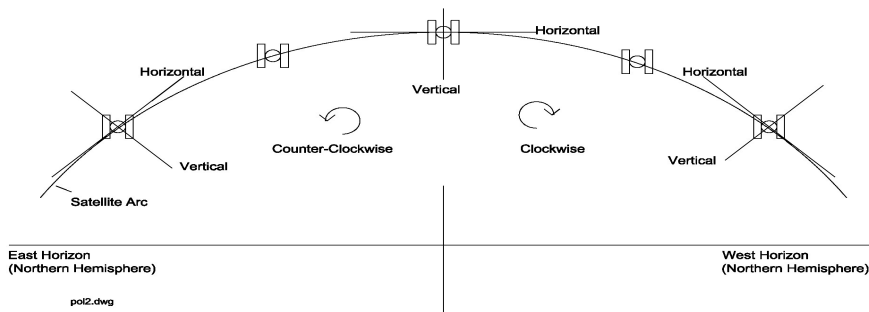
<u>2.1.2.2.14 J13B – ACC/Compass</u>

Designation	PCB	Pin Count	Connector	Type #
J13B	**ACC**	**16**	**Phoenix Double Header**	**10**

J13 provides a double row of pins. The bottom 16 pins are designated "J13B" and are typically allocated for interfacing to various compass options. The flexible I/O scheme provides DC power, serial data and a 10 bit analog to digital input.

Single Axis Compass

This drawing shows how J13B would interface with the Single Axis Compass (see 2.2.4).
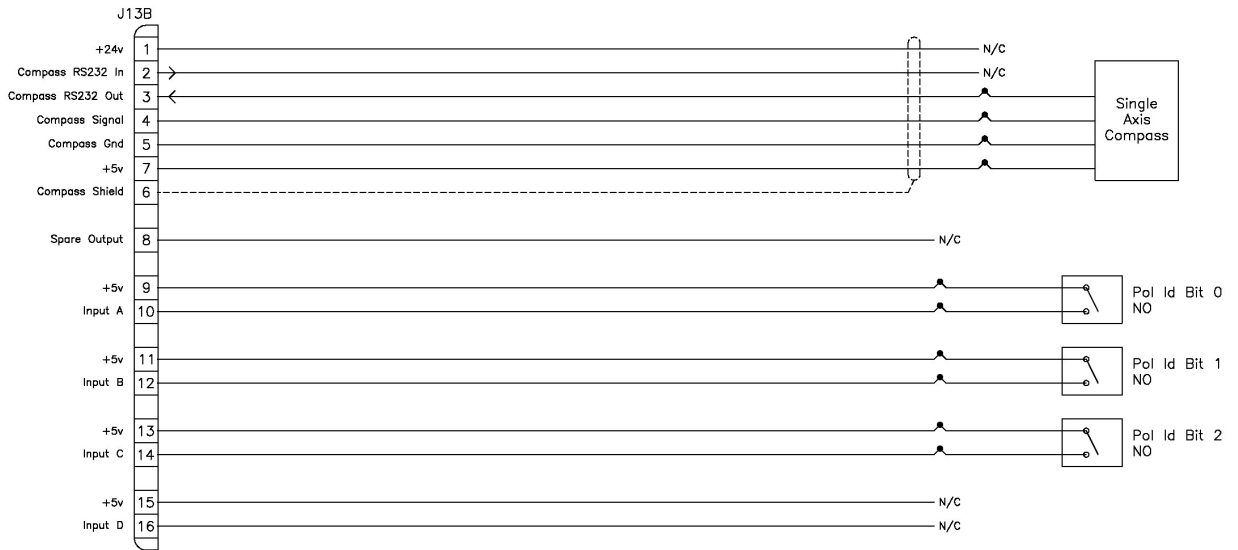
The drawing also shows how three inputs available on J13B are nominally allocated to support "polarization identification" bits in cases where multiple feed types may be automatically sensed. See section 3.3.1.2.4 for discussion of this situation.

 Fluxgate Compass

This drawing shows how J13B would interface to a fluxgate compass (see 2.2.3).
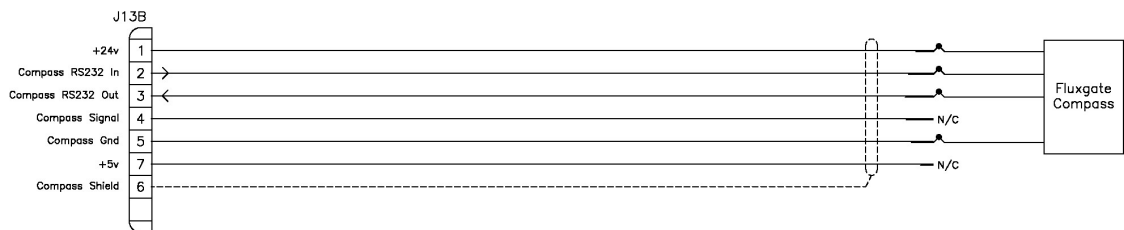
NOTE: the KVH C-100 compass should be wired for 24VDC operation (rather than 5VDC operation).

<u>2.1.2.2.15 J14A - Azimuth Sensors</u>

Designation	PCB	Pin Count	Connector	Type #
J14A	**AZ**	**16**	**Phoenix Double Header**	**10**

J14 provides a double row of pins. The top 16 pins are designated "J14A" and are typically allocated to supporting potentiometer, pulse and limit switch feedback from the azimuth axis.
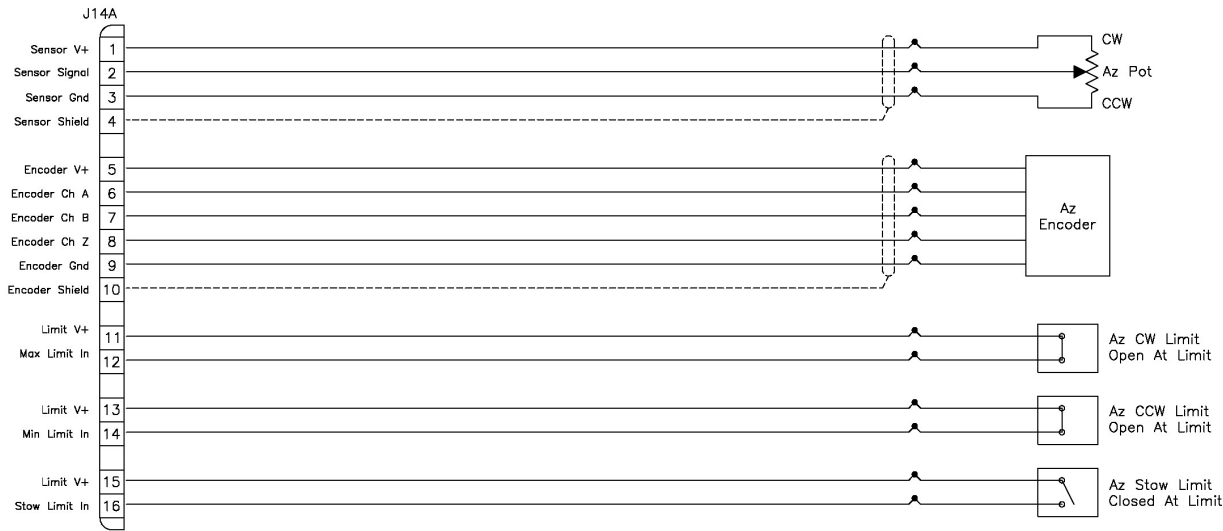
The + side of each limit switch circuit supplies 5VDC. This 5VDC supply is protected by a resettable fuse rated at 250mA.

The azimuth stow switch must be closed when at the azimuth stow position. If the azimuth stow limit switch cable is severed, the RC4000 will think that the azimuth axis is not at the stowed position. Logic within the RC4000 will not allow elevation to move below the elevation down limit switch if an azimuth stowed condition is not recognized.

The directional sense of azimuth movement is defined as clockwise (CW) or counter-clockwise (CCW), as viewed by an observer located above the antenna. On the controller, CW movement results in a greater sensed azimuth position.

2.1.2.2.16 J14B - Elevation Sensors

Designation	PCB	Pin Count	Connector	Type #
J14B	**EL**	**16**	**Phoenix Double Header**	**10**

J14 provides a double row of pins. The bottom 16 pins are designated "J14B" and is typically allocated to supporting an inclinometer, pulse and limit switch feedback from the elevation axis.
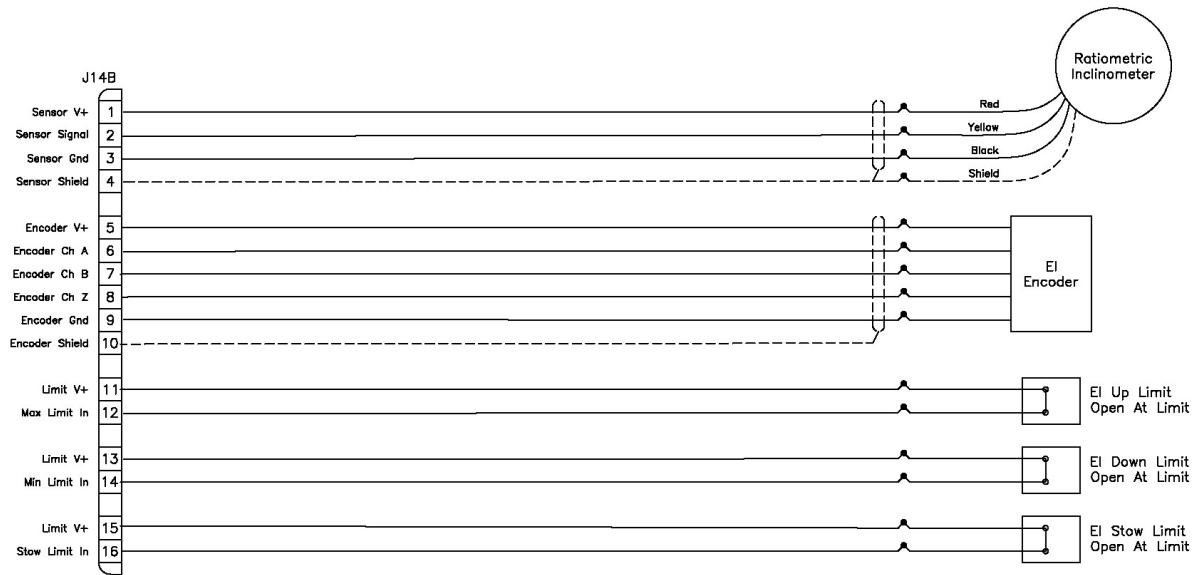
If present, the elevation up switch must be open when the elevation axis has reached the up limit. If the elevation up limit switch cable is severed, the RC4000 will think that the elevation axis is at the up limit. Logic within the RC4000 will not allow the elevation axis to move up if an up limit condition is recognized.

If present, the elevation down switch must open when the elevation axis has reached the down limit. If the elevation down limit switch cable is severed, the RC4000 will think that the elevation axis is below the down limit. Logic within the RC4000 will not allow the azimuth axis to move when the elevation down condition is recognized.

If present, the elevation stow switch must open when the elevation axis has reached the stow position. If the elevation stow limit switch cable is severed, the RC4000 will think that the elevation axis is at the stow position. Logic within the RC4000 will not allow the elevation axis to move down when the elevation stow condition is recognized.

2.1.2.3 Resolver Card

The Resolver Board allows an RC4000-based ACU to be able to sense axis positions via resolvers by utilizing resolver-to-digital converters.

Spacers supporting the Resolver Board need to be greater than or equal to 0.625" long.

J2 Bus A   J1 DC Power

J3 Extra IO   J4 Pol Resolver   J5 El Resolver   J6 Az Resolver
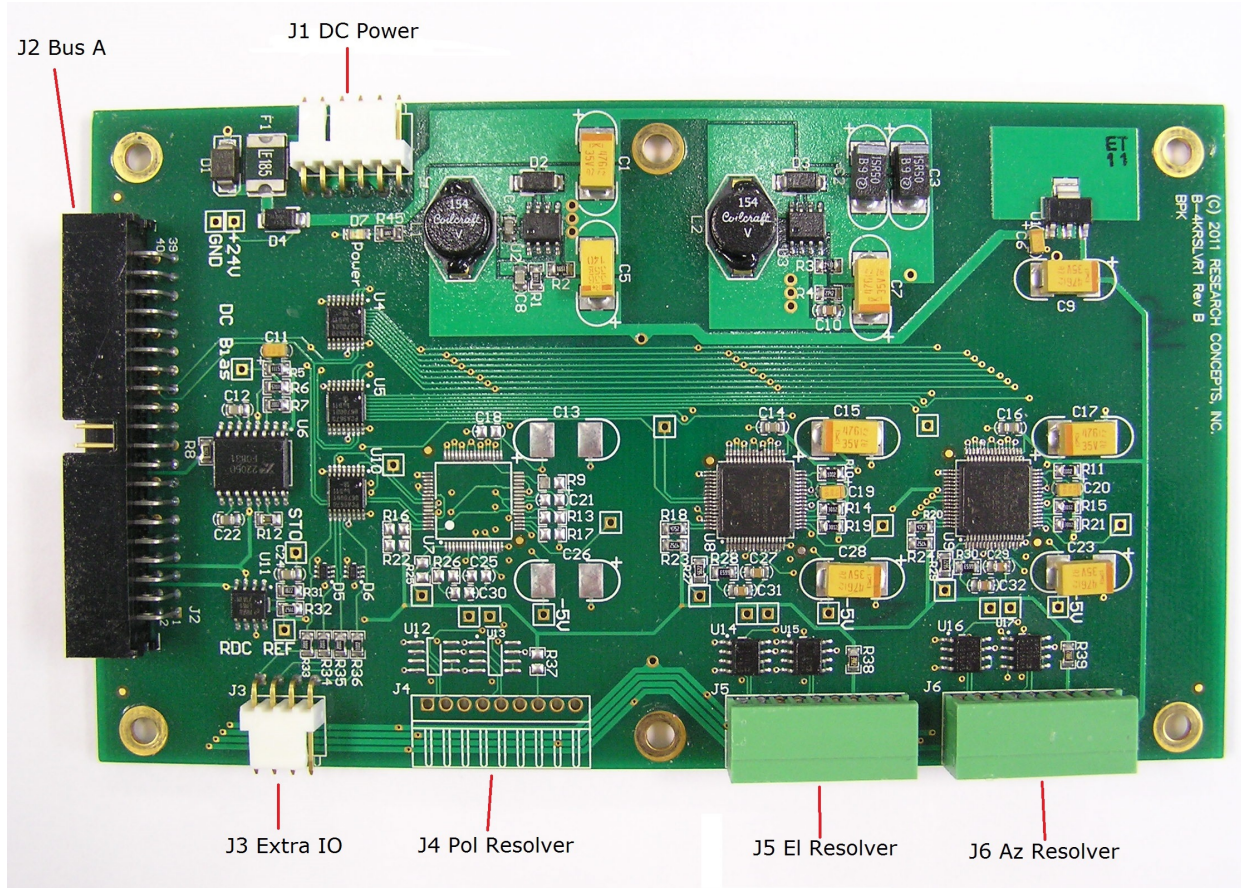
2.1.2.3.1 J1 - Interboard 24 VDC

Designation	PCB	Pin Count	Connector	Type #
J1	**unmarked**	**6**	**Molex Friction Lock Header**	**2**

J1 receives +24 VDC from the computing board and typically daisy chains it on to the Options Board.
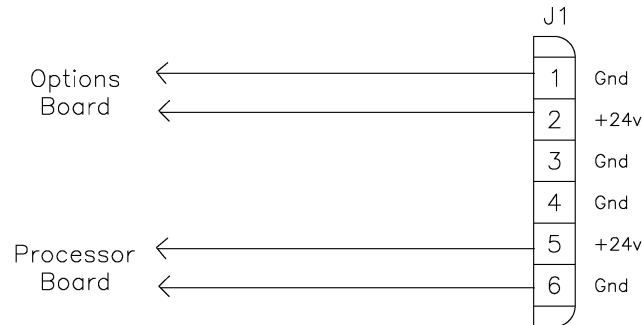
2.1.2.3.2 J2 – Interboard Bus A

Designation	PCB	Pin Count	Connector	Type #
J2	**unmarked**	**40**	**Right Angle Shrouded Header**	**3**

All signal interfacing between the Resolver Board and the Computing and Interface Board are made via Bus A.

Signal details for Bus A are provided in section 2.1.2.2.7.

2.1.2.3.3 J3 – Extra IO

Designation	PCB	Pin Count	Connector	Type #
J3	**unmarked**	**4**	**Molex Friction Lock Header**	**2**

This connector is not utilized for RC4000 applications.

2.1.2.3.4 J4 – Pol Resolver

Designation	PCB	Pin Count	Connector	Type #
J4	**unmarked**	**9**	**Phoenix Header**	**13**

J4 is dedicated to the polarization axis resolver. This part is typically not installed on the board unless the antenna includes a polarization resolver.
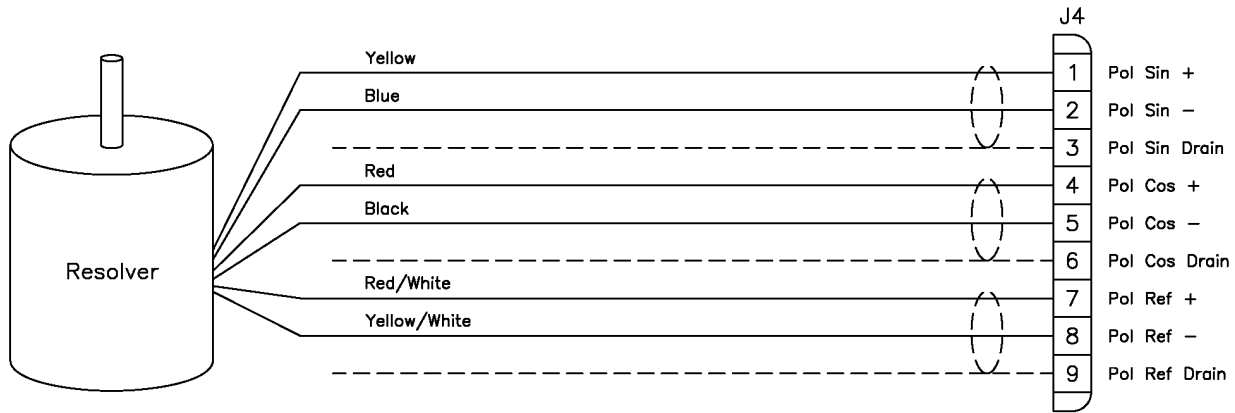
2.1.2.3.5 J5 – El Resolver

Designation	PCB	Pin Count	Connector	Type #
J5	**unmarked**	**9**	**Phoenix Header**	**13**

J5 is dedicated to the elevation axis resolver.
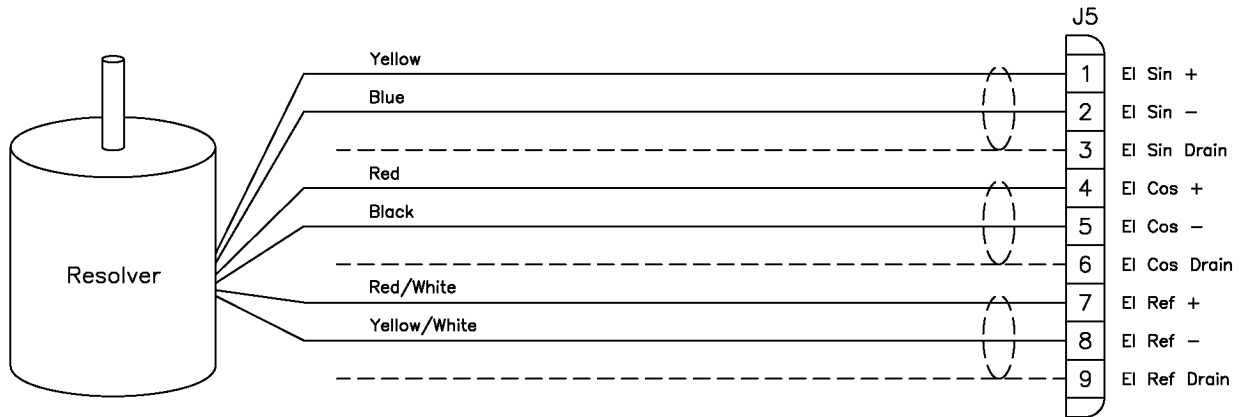
2.1.2.3.6 J6 – Az Resolver

Designation	PCB	Pin Count	Connector	Type #
J6	**unmarked**	**9**	**Phoenix Header**	**13**

J6 is dedicated to the azimuth axis resolver.
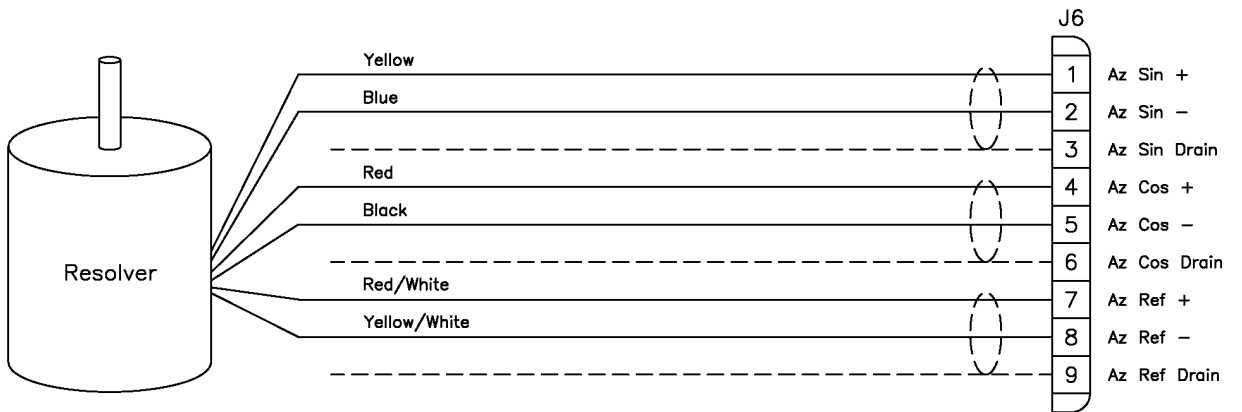
2.1.2.4 Options Board

The Options Board allows an RC4000-based ACU to be customized with the desired set of optional features such as GPS, DVB and Ethernet (IP).
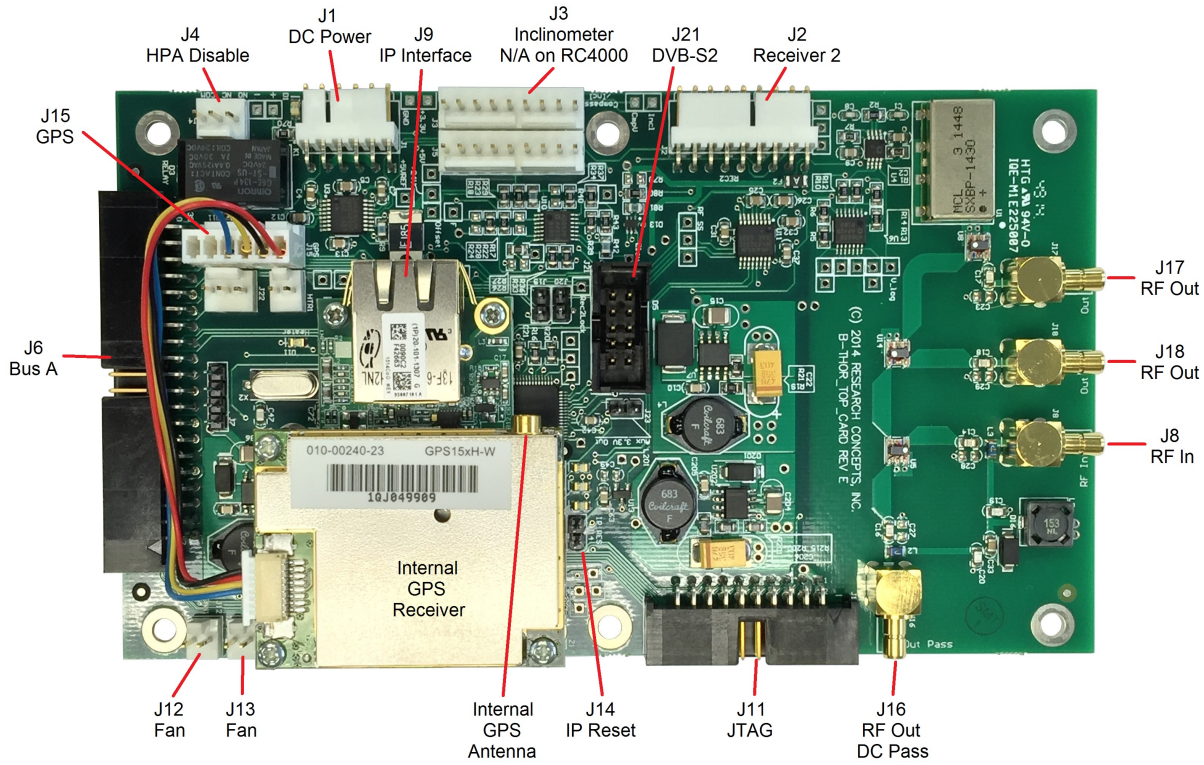
Spacers supporting the options board need to be greater than 0.437".

2.1.2.4.1 J1 - Interboard 24 VDC

Designation	PCB	Pin Count	Connector	Type #
J1	**"Power"**	**6**	**Molex Friction Lock Header**	**2**

J1 receives daisy chained 24 VDC from the computing board.
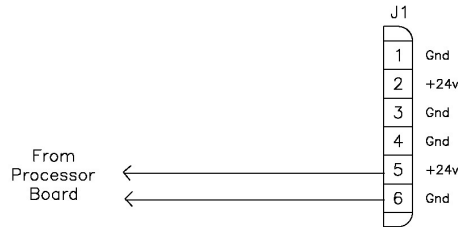
Note that pins 1 & 2 could be used to daisy chain 24 VDC to additional places.

2.1.2.4.2 J2 – Receiver 2

Designation	PCB	Pin Count	Connector	Type #
J2	**"REC2"**	**9**	**Molex Friction Lock Header**	**2**

The J2 connector is allocated to support various types of receivers.
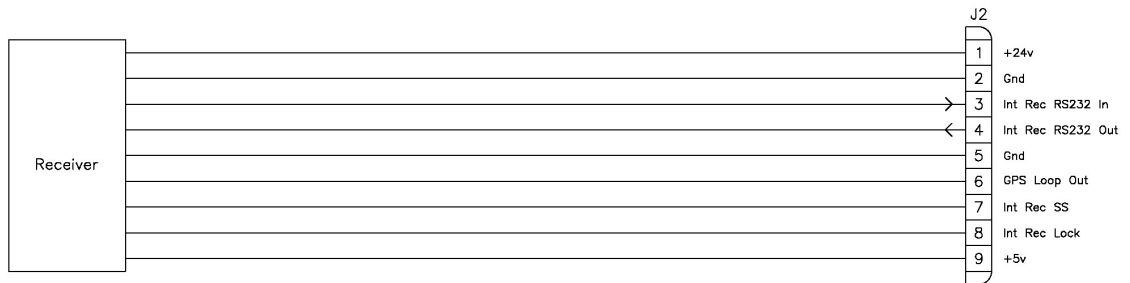
The flexible I/O includes:

1) +5VDC at 125mA and +24VDC at 1.85A for powering a receiver

2) a discrete lock input

3) 10 bit resolution analog to digital input for measuring signal strength over a +/- 10 VDC range

4) an RS-232 serial channel for control and monitoring

5) a "loop out" of GPS data to provide lat/lon/time data

How the J2 I/O is used is determined by which "Receiver 2" software option is present (see 3.1.5).

If there is no integrated receiver support (Receiver 2 option "N"), then the use of the analog signal strength input and the discrete lock input may be programmed from the "REC2 Signal Strength Factors" configuration screen (3.3.1.2.7).

If there is software support for a particular receiver present, then the use of J2 I/O will be unique to that receiver and will be detailed in an appendix describing that software option.

2.1.2.4.3 J3 - Compass/Inclinometer

Designation	PCB	Pin Count	Connector	Type #
J3	**Compass/Incl**	**9**	**Molex Friction Lock Header**	**2**

This connector is used by the RC300 product but not utilized for RC4000 applications.

2.1.2.4.4 J4 - Relay

Designation	PCB	Pin Count	Connector	Type #
J4	**"NO NC COM"**	**3**	**Molex Friction Lock Header**	**2**

HPA Disable, normally-open, 3A @ 30VDC max or 3A @ 250VAC max

HPA Disable, common, 3A @ 30VDC max or 3A @ 250VAC max

HPA Disable, normally-closed, 3A @ 30VDC max or 3A @ 250VAC max

The HPA disable is in a form-C contact arrangement with normally-open, normally-closed and common contacts. While the antenna is below the down elevation limit or while the antenna is performing any large-scale auto-moves, such as deploy, locate, or stow, the normally-closed and common pins will be connected. After the auto-move is complete, the connection will be released.

Some system configurations support a TX MUTE button. The HPA will be disabled when the TX MUTE function is active. In systems with the TX MUTE button this (usually blue) button is lit when the system is un-muted.   In systems with a web-served TX MUTE button, the web-served button and physical button will function as if they are the same button. In short, the HPA disable function can be described by the following Boolean equation.

HPA DISABLE = DOWN_Limit OR   Automated_Slewing_Motion OR   TX_MUTE

The contact arrangement is shown below:
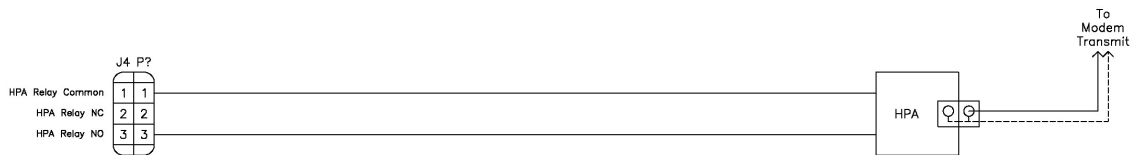
2.1.2.4.5 J5 - Bar LEDs

Designation	PCB	Pin Count	Connector	Type #
J5	**unmarked**	**9**	**Molex Friction Lock Header**	**2**

This connector is used by the RC300 product but not utilized for RC4000 applications.

2.1.2.4.6 J6 - Interboard Bus A

Designation	PCB	Pin Count	Connector	Type #
J6	**Bus**	**40**	**Right Angle Shrouded Header**	**3**

All signal interfacing between the Options Board and the Computing and Interface Board are made via Bus A.

Signal details for Bus A are provided in <u>section 2.1.2.2.7</u>.

2.1.2.4.7 J7 - LEDs

Designation	PCB	Pin Count	Connector	Type #
J7	**Unmarked**	**4**	**Unshrouded Header**	**9**

This connector is used by the RC300 product but not utilized for RC4000 applications.

2.1.2.4.8 J8 - RF Input

Designation	PCB	Pin Count	Connector	Type #
J8	**"RF In"**	**2**	**SMB**	**11**

J8 (50 ohm) accepts the output of an LNB (950-2150MHZ, -50 to –5dBm.).

Internally, this input goes through three splitters (3 dB each.) After the first splitter, it provides an output
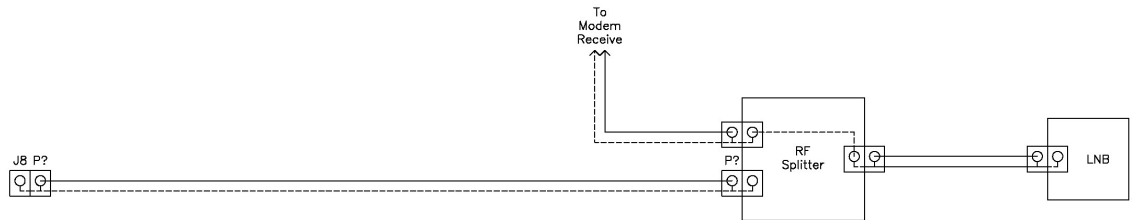
at J16 "Out Pass" that also allows DC pass-through (for applications required to power the LNB) and also allows a 10MHz pass-through. The second splitter provides an output at J18 "Out". This output typically supplies RF to the DVB-S2 carrier board when installed or can optionally route RF to an internal beacon receiver or spectrum analyzer. The third splitter also provides an output at J17 "Out" and routes the RF signal to the on-board L-Band power detector module. The L-Band power detector produces an output proportional to the broadband energy received. When this input is being used, it is indicated on RC4000 screens as the "RF" signal source. See sections 4.1.11.1 and 3.3.1.2.9 regarding use of the L-Band power detector input.

The RF autopeak circuitry includes a "DC block".

Connectors J8, J16, J17 and J18 are SMB connectors.
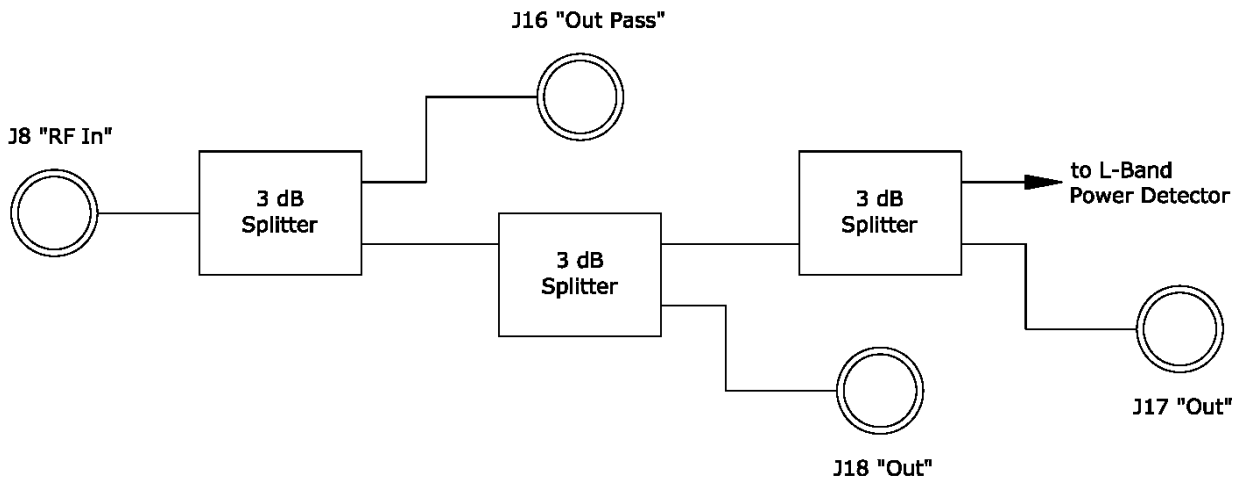
2.1.2.4.9 J9 - Ethernet

Designation	PCB	Pin Count	Connector	Type #
J9	**Unmarked**	**52**	**mini PCI Express socket**	**12**

When the IP remote control interface option is present, J9 holds an IP interface device manufactured by Rabbit. The user's actual interface will be a female RJ45 connector on the Rabbit card.

See the IP Remote Control appendix for further details.

2.1.2.4.10 J10 - Audio

Designation	PCB	Pin Count	Connector	Type #
J10	**"Audio"**	**2**	**Molex Friction Lock Header**	**2**

This connector is used by the RC300 product but not utilized for RC4000 applications.

Note: This connector is included ONLY on Revision B options boards. It is not included in other revisions.

2.1.2.4.11 J11 - JTAG

Designation	PCB	Pin Count	Connector	Type #
J11	**"JTAG"**	**20**	**Right Angle Shrouded Header**	**3**

Factory programming of microcontroller.

2.1.2.4.12 J12 - Fan1

Designation	PCB	Pin Count	Connector	Type #
J12	**"FAN1"**	**2**	**Molex Friction Lock Header**	**2**

2.1.2.4.13 J13 - Fan2

Designation	PCB	Pin Count	Connector	Type #
J13	**"FAN2"**	**2**	**Molex Friction Lock Header**	**2**

2.1.2.4.14 J14 - IP Reset

Designation	PCB	Pin Count	Connector	Type #
J14	**"IP RES"**	**2**	**Molex Friction Lock Header**	**2**

If the IP (Ethernet) remote control option is present, these pins provide a way to manually reset the IP address. Jumpering of these pins for 10 seconds while the boardset is powered on will reset the interface to a known IP address. The default IP address is 192.168.1.1.

Appendix IP should be consulted for further details.

2.1.2.4.15 Heater

Designation	PCB	Pin Count	Connector	Type #
HTR1	**Unmarked**	**2**	**Molex Friction Lock Header**	**2**

This connector location may be used with a heater, either mounted to the boardstack itself or located remotely (within the ACU enclosure

The HEATER connector location is connected to a "switched" 24VDC at 2 Amp supply at pin 1. Pin 2 is connected to GND. There is a temperature sensor installed on the Options Board that controls the 24VDC output to the heater.

Designation	PCB	Pin Count	Connector	Type #
J15	**"GPS"**	**6**	**Molex Friction Lock Header**	**2**

The J15 connector supports either 1) an internally mounted GPS receiver requiring a separate external antenna or 2) an external integrated GPS receiver/antenna.

NOTE: the GPS receiver configuration is transparent to software.

Internal GPS

The internal GPS receiver (Garmin GPS 15xH) will be mounted to the options board and J15 will supply power, ground and serial data. An external GPS antenna will then be attached to the GPS receiver.
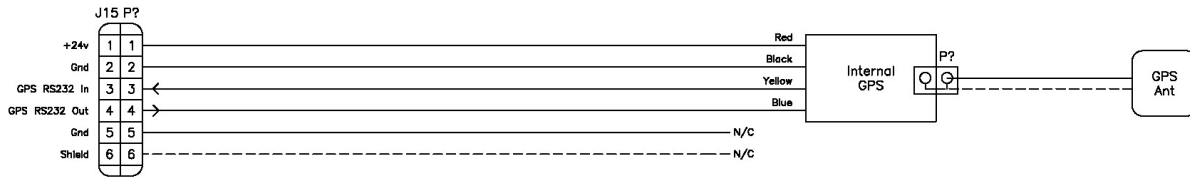
The connection to an active GPS antenna is provided through an MCX RF connector, the antenna should have a male connector installed on the end of its cable. Typically the cable used for the antenna is an RG-174 coaxial cable. The antenna must provide between 10dB to 30dB net gain between the antenna feed point and the connection to the GPS.

An example antenna is the Synergy Systems, LLC part number AR-05 active GPS antenna. This antenna has a center frequency of 1575.42 MHz and has a gain of 28dB.

External GPS

If the external GPS receiver is used, power/ground and serial data will be supplied from J15.

The two most common external GPS units that have been supplied with the RC4000 are the Garmin 17xHVS and the Garmin 19xHVS. The model 17xHVS has been discontinued by Garmin and the 19xHVS is the recommended replacement. A wiring diagram for each GPS unit is shown as connected directly to the Options Board.
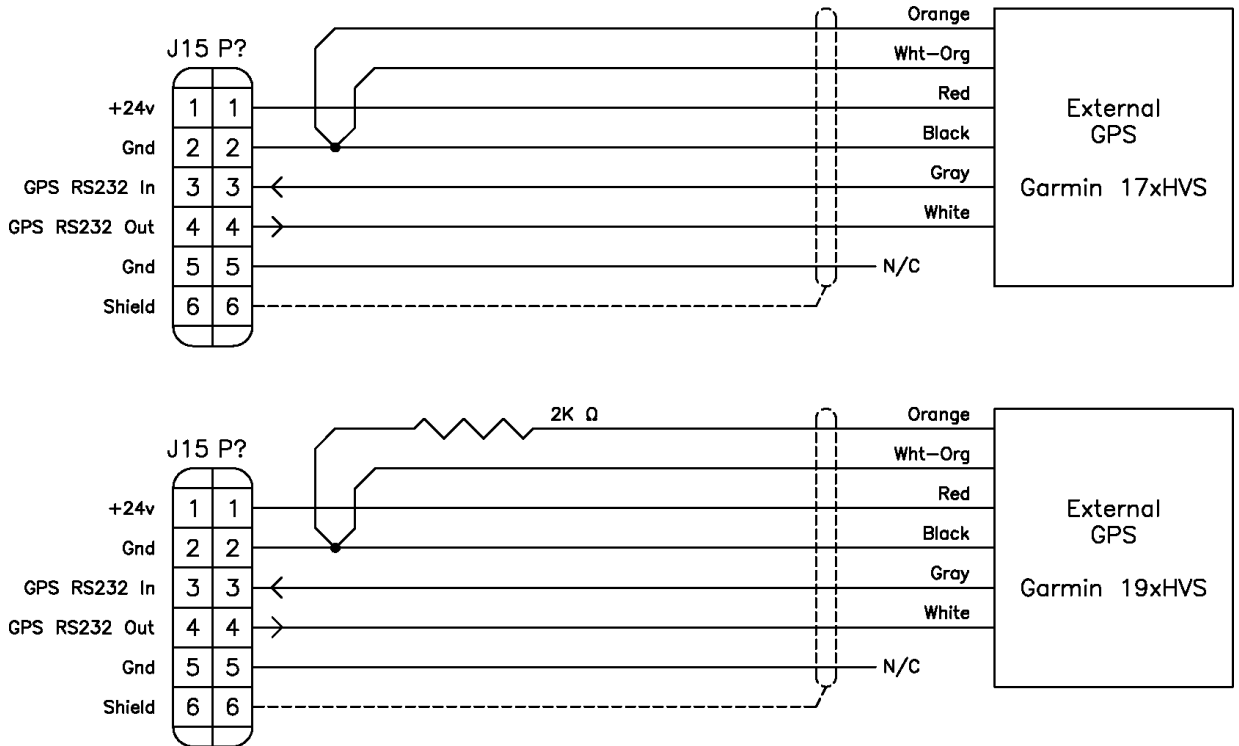
2.1.2.4.16 J22 – GPS PPS

Designation	PCB	Pin Count	Connector	Type #
J22	**Unmarked**	**3**	**Molex Friction Lock Header**	**2**

The J22 connector provides a 1Hz pulse output derived from the GPS receiver. This output is only available when specifically ordered as an option. Contact the factory for timing and electrical specifications of the pulse output.

2.1.2.4.17 J21 – DVB-S2

Designation	PCB	Pin Count	Connector	Type #
J21	**Unmarked**	**10**	**Tyco Vertical Header**	**8**

When the DVB-S2 option is included with the RC4000, the J21 connector provides the connections to the DVB-S2 carrier board, which is typically mounted directly above the options board on 7/8" tall standoffs. The DVB-S2 carrier board has a board-to-board connector that plugs directly into J21 so no external cables are required.

More information about the DVB-S2 option is available in the "INTEGRATED DVB-S2 RECEIVER" appendix.

2.1.2.4.18 J23 – Auxiliary 3.3V Out

Designation	PCB	Pin Count	Connector	Type #
J23	**"Aux 3.3V Out"**	**2**	**Unshrouded Header**	**9**

The J23 is an Auxiliary 3.3V DC, 750mA power source. Pin 1 is 3.3V. Pin 2 is DC common.

2.1.2.5 Connectors

This section provides details of the connectors used on the RC4000 boardstack.

2.1.2.5.1 Phoenix Terminal Header

Phoenix Contact 1757255

Terminal Header; 12 A; 250 V; 5.08 mm; 3; Solder Mount; 1.4 mm; 4 kV; 320 V

2.1.2.5.2 Molex Friction Lock

Molex 22-12-2064 6 pin

PCB .100" Right Angle Friction Lock Header

2.1.2.5.3 Right Angle Shrouded Header

Tyco Electronics 5103310-8

Right Angle Shrouded Header

2.1.2.5.4 JTAG Programming

Tyco Electronics 5-102617-3   right angle (vs. other 3)

2.1.2.5.5 Drive Terminal Block

Phoenix Contact 1844320

Pluggable Mini Terminal Blocks MC 1 5/13-G-3 5

2.1.2.5.6 Phoenix Header

Phoenix 1939303

2.1.2.5.7 USB

USB mini-B upstream receptacle

2.1.2.5.8 Tyco Vertical Header

AMP 5103308-5 20 pin

5103308-1 10 pin

2.1.2.5.9 Unshrouded Header

AMP 4-103321-8.

2.1.2.5.10 Phoenix Double Header

Phoenix 1953855

2.1.2.5.11 SMB COAX

connector, rf coaxial, smb straight pcb jack, 4 legs, mini 75 ohm

2.1.2.5.12 Ethernet

Mini PCI Express Connector, Pinrex 984-63-052202

2.1.2.5.13 Phoenix Header

Phoenix 1881516

2.2 External Equipment

2.2.1 Electronic Clinometer

The electronic clinometer (also referred to as the inclinometer) should be positioned on the mount structure in an orientation that allows the inclinometer's linear range of movement to rotate through the antenna's RF boresight operational range.
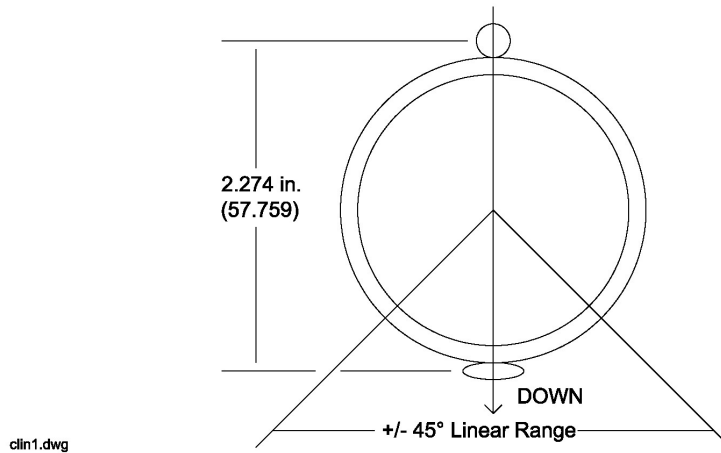
Determining the correct orientation of the inclinometer requires knowledge of the mount's mechanical structure and the antenna's RF offset. Typically the mount manufacturer will place the inclinometer in the correct position on the mount. See Appendix B for the correct orientation for a particular mount.

The elevation position sense circuit of the RC4000 is designed to interface to the Lucas/Schaevitz AccuStar model 0211 1002-000 or 0211 1102-000 inclinometers. The inclinometer's position reference is marked on the body of the inclinometer. The inclinometer should be mounted such that the body of the inclinometer is rotated CW (as viewed by an observer looking at the front of the inclinometer) as the antenna's elevation angle increases. The inclinometer must also be oriented properly on the antenna mount.

To describe the orientation of the inclinometer, the term 'elevation offset angle' needs to be defined. Elevation offset angle is defined as the antenna's RF elevation pointing angle (relative to horizontal) when a straight edge oriented vertically across the face of the antenna reflector (reflector top to bottom) is plumb. The inclinometer should be oriented so that, when the antenna reflector is plumb, the reference mark is deflected CCW (from the vertical position) by an amount equal to the 35 degrees minus the 'elevation offset angle'. If the inclinometer is attached as described the sensor will operate in its most accurate region for elevation look angles up to 80 degrees.

The inclinometer mounting flange allows for some adjustment of the device's rotational orientation. The mounting position selected for the inclinometer should allow for adjustment of the inclinometer's orientation. The inclinometer should be mounted in a location such that it is protected somewhat from blowing rain.

If the antenna controller enclosure is mounted to the antenna in such a way that it rotates about the elevation axis, the inclinometer may optionally be installed within the ACU enclosure.

See section 2.1.2.2.16 for wiring of the inclinometer.

VERTICAL REFERENCE

INCLINOMETER REFERENCE

X = 35 DEGREES - ANTENNA OFFSET

X

ELECTRICAL
BORESIGHT

INCLINOMETER

ANTENNA OFFSET

HORIZONTAL
REFERENCE

FEED

REFLECTOR

BACKSTRUCTURE
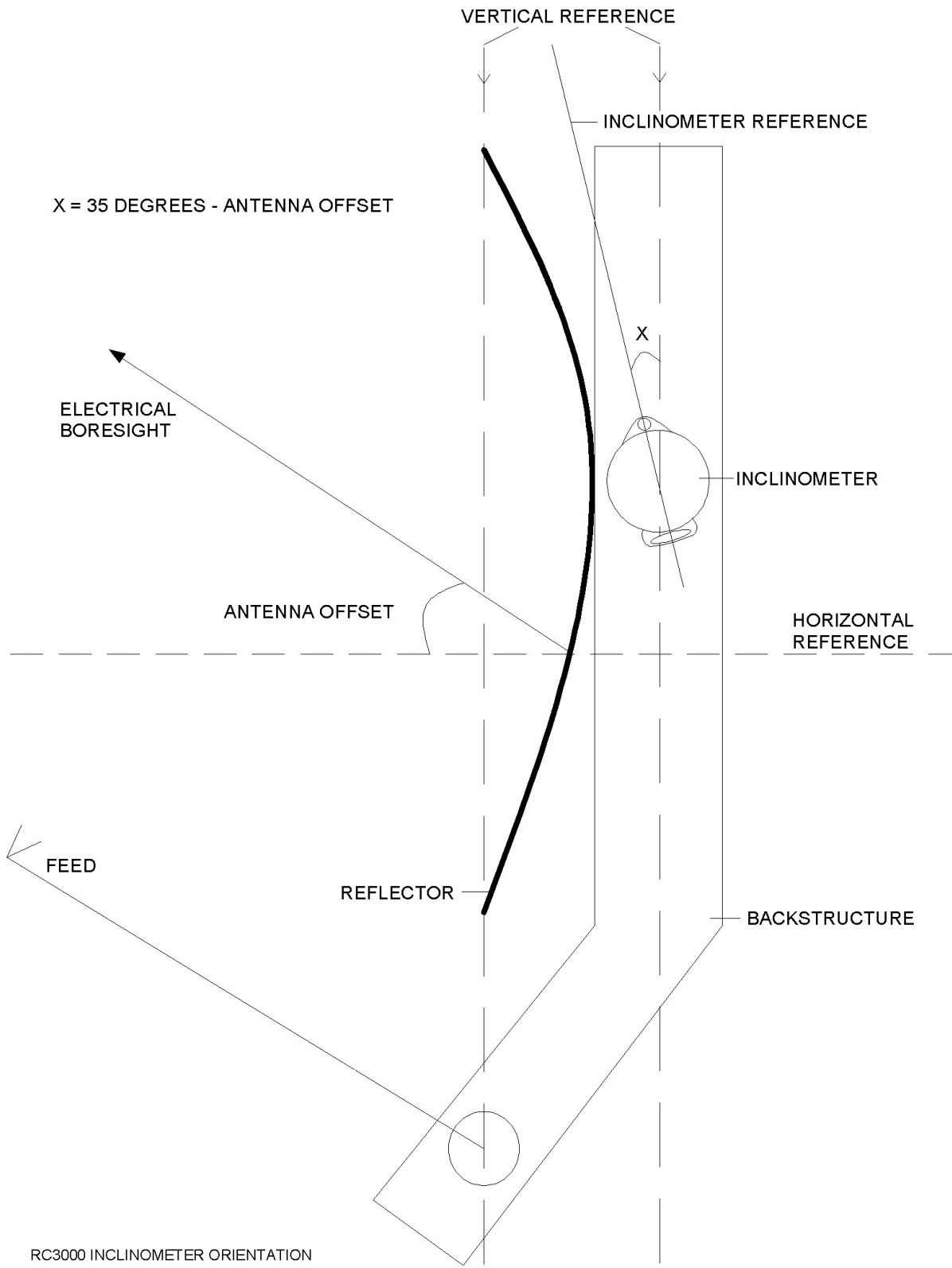
RC3000 INCLINOMETER ORIENTATION

2.2.2 External GPS Receiver

The optional GPS receiver (RC4000GPS) should be mounted in a position (such as the truck's roof) where it has an unobstructed view of the horizon and sky. It should be mounted outside of the reflector when in a stowed position, with the connector (on the underside) towards the cable's entry point into the truck. Care should be taken in the routing of the cable to avoid any problems.

The GPS receiver should be mounted at least three feet from other antennas and electrical generating equipment. Strong RF interference from other sources may disrupt the GPS receiver's signal reception. Wiring of the GPS connector is discussed in section 2.1.2.4.16.

Recent RC4000s have been supplied with the Garmin GPS17 or GPS19 receiver models. The following diagram shows its dimensions.

4.44″
[113 MM]

3.58″
[91 MM]

gps17.dwg

.
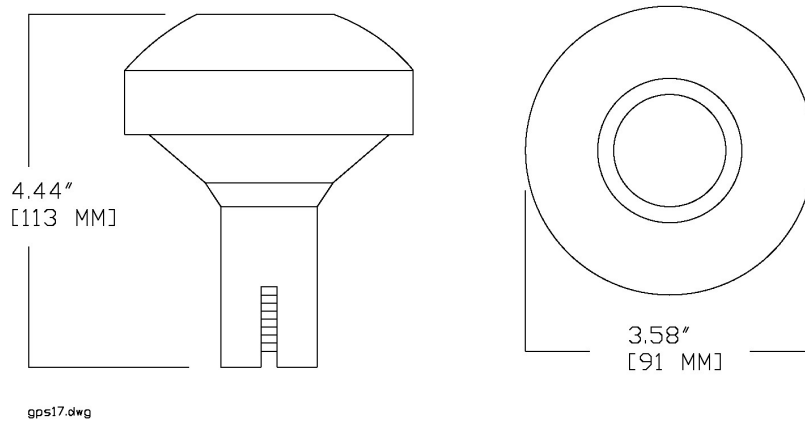
The GPS unit is supplied with 25 feet of cable. The GPS unit is supplied with a flange mounting bracket as shown above. An optional marine mounting bracket is also provided.

2.2.3 Fluxgate Compass

The optional fluxgate compass unit (RC4000FG) should be placed on the roof of the vehicle away from ferrous metals, electric motors, and any equipment that generates magnetic fields such as air conditioners, generators, and traveling wave tube (TWT) amplifiers.   Experience has shown that the fluxgate performs best when mounted as high as possible on the vehicle. The fluxgate compass must be mounted in an upright position.

Some manufacturers position the compass on the mount so that the compass may be lifted well above the top of the vehicle. If the compass is attached to the mount, the compass configuration item (3.3.1.2.1) must be set to the "antenna mounted" value.

The RC4000 uses the fluxgate to determine the true heading of the mount's azimuth centerline (0.0 degrees azimuth). If the compass is not aligned in the direction of the azimuth centerline, that difference must be described in the azimuth offset configuration item (3.3.1.2.3). Some operators prefer to mount the compass pointing forward on the vehicle. If the mount faces rearward, an azimuth offset of 180 degrees would need to be input.
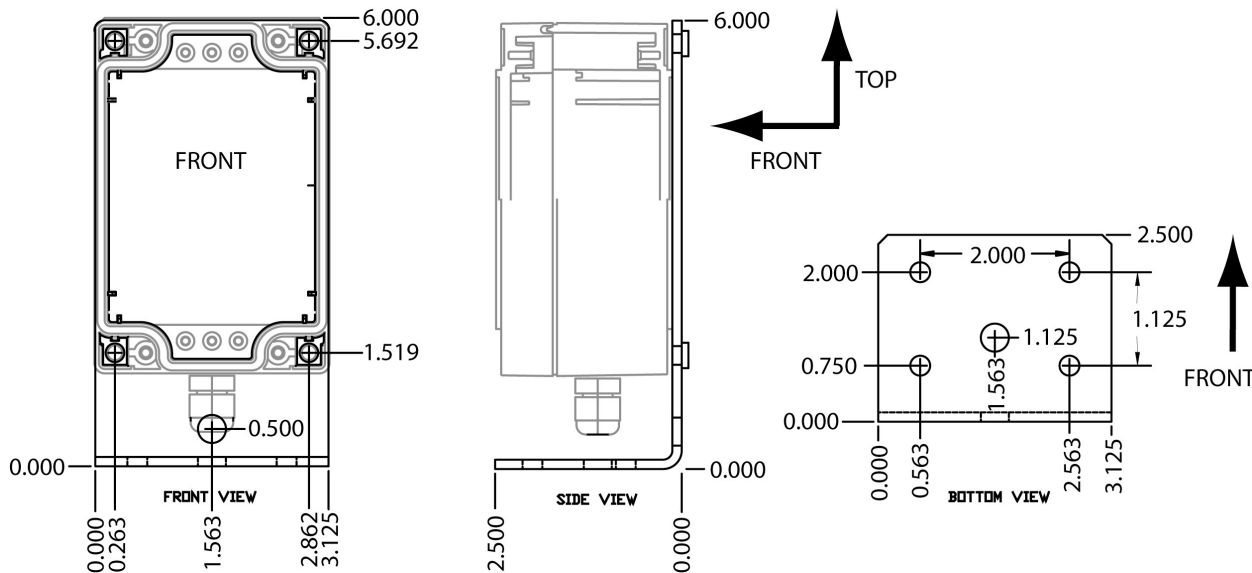
Refer to the drawing of the fluxgate enclosure to verify the proper orientation of the fluxgate. NOTE: An un-housed version of the compass is available for use in a user-designed enclosure.

The Fluxgate Compass box may be either bracket mounted or flush mounted. Without the bracket it may be attached to a flat surface by four 10-32 screws from inside or outside the box through the four corner holes shown in the FRONT view diagram above. When using the bracket mount, it may be mounted with four 1/4 inch bolts using the holes shown in the bottom view of the bracket in the above diagram. The cable may be routed through either hole in the bracket. The circuit board may also be removed from the housing or an un-housed model is available on order for custom installations.

The following method may be used to determine the best location for the compass.

Park the vehicle in a location that is away from large metal objects or sources of magnetic fields. **NOTE: for best results, the vehicle should be parked facing in an easterly or westerly direction.** The vehicle's generator should be running, as well as all electrical equipment on the vehicle that generates magnetic fields.

Stand on the roof of the vehicle with a standard magnetic compass. Slowly lower the compass to the proposed fluxgate mounting location on the vehicle without changing the orientation (or heading) of the

compass body. If the needle of the compass swings as the compass is lowered to the mounting location, it is due to distortion of the earth's magnetic field by ferrous metals on the vehicle, or magnetic fields generated by the vehicle.

The fluxgate should be mounted in the location where the needle of the compass experiences the minimum amount of swing as the compass is lowered to the proposed mounting location.

2.2.4 Single Axis Compass

The Single Axis Compass is a smaller, less expensive, and slightly less accurate heading sensor option compared to the original Fluxgate Compass. The single axis compass module contains a magnetoresistive sensor that converts the magnetic field in one direction to a representative voltage. When positioned perpendicular to the earth's gravitational field (level), the sensor can measure the horizontal component of the earth's magnetic field. By rotating the sensor (via rotating the antenna) and measuring the resulting voltages, the RC4000 can derive an estimate of the antenna's magnetic heading.

-- see appendix SAC for full description of hardware and unique software items

2.2.5 LCD

The RC4000 can be optionally supplied with a 4 row by 40 column character LCD (liquid crystal display). Details regarding the interface of the LCD display to the RC4000 boardstack is outlined in section 2.1.2.2.9. The standard LCD display has a temperature rating of 0º to +50ºC. There is an optional VFD (vacuum fluorescent display) that is rated for -40º to +85ºC.

2.2.6 4x4 Keypad

The RC4000 can optionally be supplied with a 4 row by 4 column keypad. When used in conjunction with the 4x40 LCD (section 2.2.5), the keypad can be used for full user control of the antenna controller. Details regarding the interface of the keypad with the RC4000 boardstack is outlined in section 2.1.2.2.10. The layout and operational use of the keypad is outlined in section 3.1.2.

2.2.7 Local Jog Control Panel

The local jog control panel provides a simple keypad that includes the essential keys necessary for manual jog control and for automatic locate and stow routines. The jog panel is typically used when it is necessary to see the antenna as it is moving (if the remote control is not within eyesight) or when the remote control is not available.

The local jog control panel essentially connects directly to the keypad interface and to the red/green button interface on the Computing and Interface Board. The typical jog control panel includes a 10 ft long cable that uses 8 conductors of 24 AWG stranded wires.

2.2.8 Handheld Remote Front Panel

The optional Handheld Remote Front Panel (HHRFP) implements the traditional 16 button keypad and 4x40 character LCD user interface, but allows a much longer distance than what could be achieved by directly connecting to the LCD and keypad connectors on the computing card.

The HHRFP allows the keypad and display information to be communicated to/from the RC4000 via serial port (RS-422) or Ethernet port. There is an interface card within the HHRFP that handles the serial/Ethernet protocol, as well as driving the LCD and monitoring user key inputs.

NOTE: the HHRFP is pictured above in a weatherproof enclosure supplied by RCI. The HHRFP components (LCD, keypad and interface card) may also be purchased without an enclosure for incorporation into a user defined panel. The LCD may optionally be replaced with a VFD (vacuum fluorescent display) for a wider temperature range (as shown above.)

3.0 SOFTWARE

3.1 Operation Overview

The RC4000 allows multiple options for mechanizing the user interface. This section describes software operations as if the most basic "front panel" interface (keypad and LCD) was present.

3.1.1 Modes

The functionality of the RC4000 is achieved by placing the controller in the desired mode of operation. The figure shows the hierarchy of the RC4000's modes. Each mode has a unique display screen that presents the information applicable to that mode's operation.
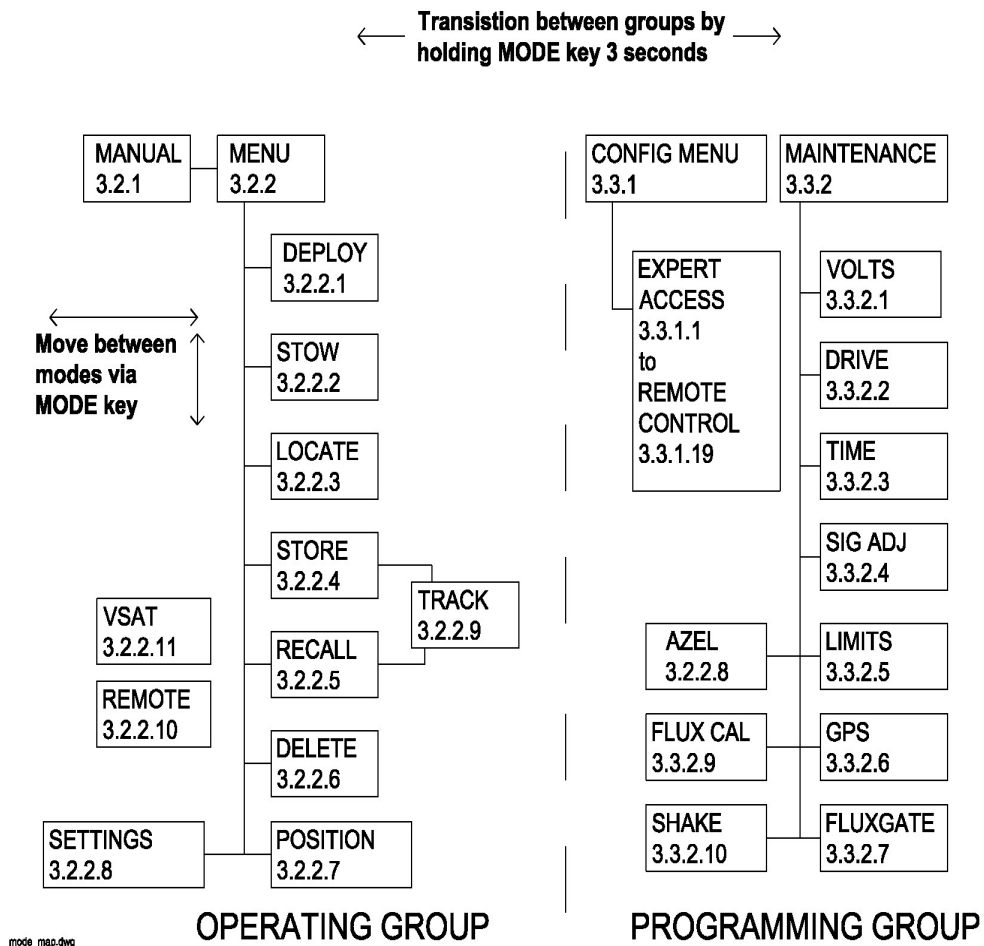
As the figure shows, there are two main groups of modes – operating and programming. Transitions between modes within a group are initiated via a momentary press of the Mode key, while a transition between the two groups requires the Mode key to be held down for three seconds.

After installation, the programming group of modes will typically not be used for day to day operations. Sections 3.2 (operating modes) and 3.3 (programming modes) detail each mode. The rest of section 3.1 introduces common elements of all modes.

3.1.2 Keypad Usage

The keypad provides a flexible method of controlling the functionality of the RC4000. While each RC4000 mode has different requirements for user input, the use of the keypad remains consistent throughout all modes.
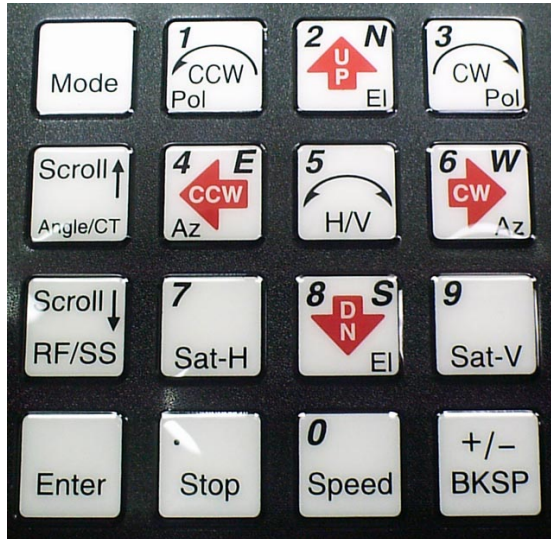
The keypad provides for both specific actions and general data input. As an example, the UP_2_N key initiates an antenna up movement while in MANUAL mode but also allows for the entry of the number 2 when numeric entry is required or the indication of North when entering a latitude value. The required key usage is provided in the detailed description of each mode.

NOTE: keypads on earlier RC4000s may not have included the exact nomenclature depicted above. Keypad usage has remained the same though for all RC4000s.

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

.

	KEY LABEL	SPECIFIC FUNCTION	GENERAL FUNCTION
Mode	Mode	No specific function	Momentary push switches between modes within group. Button held for 3 seconds switches between operational and programming groups. Momentary push also exits sub-mode screens.
Scroll ↑ Angle/CT	Scroll Up Angle/CT	Toggles between angular and pulse az/el position display in Manual Mode	Scrolls forward through lists. Provides "YES" answer to prompts.
Scroll ↓ RF/SS	Scroll Dn RF/SS	Toggles between RF/SS1/SS2 signal strength display in Manual Mode	Scrolls backward through lists. Provides "NO" answer to prompts.
Enter	Enter	Heading Fix in Manual Mode	Complete entry of data. Select entry from list. Access sub-mode in CONFIG mode.
1 CCW Pol	1 Pol CCW	Jogs polarization motor counter-clockwise when pol movement is allowed	Supplies "1" for numeric entry. [1]
2 N UP El	2 N El UP	Jogs elevation axis up when in MANUAL mode	Supplies "2" for numeric entry. [1] Supplies NORTH for latitude entry.
3 CW Pol	3 Pol CW	Jogs polarization motor clockwise when pol is movement allowed	Supplies "3" for numeric entry. [1]
4 E CCW Az	4 E Az CCW	Move azimuth axis counter-clockwise in MANUAL mode	Supplies "4" for numeric entry. [1] Supplies East for longitude entry. (123°45E)
5 H/V	5 H/V	Commands Cross-Polarization movement in MANUAL mode, Store	Supplies "5" for numeric entry. [1]

[1] Numbered keys may also be used to select from a set of choices such as <1>LOCATE <2>STOW.

	KEY LABEL	SPECIFIC FUNCTION	GENERAL FUNCTION
	6 W Az CW	Move azimuth axis clockwise in MANUAL mode	Supplies "6" for numeric entry. [1] Supplies West for longitude entry. (123°45W)
	7 Sat-H	Requests move to predefined Horizontal polarity position	Supplies "7" for numeric entry. [1] Signals current polarization value to be stored as the Horizontal value.
	8 S El DN	Jogs elevation axis down when in MANUAL mode	Supplies "8" for numeric entry. [1] Scrolls down during alphanumeric entries.
	9 Sat-V	Requests move to defined Vertical polarization	Supplies "9" for numeric entry. [1]
	0 Speed	Toggles motor drive speed between FAST and SLOW	Supplies "0" for numeric entry. [1]
	. (decimal point) Stop	Provides way to stop automatic movements	Provides delimiter for various data entries. Decimal point for floating point entry. (3.15) Degree sign for lat/lon entry. (38°56N) Colon for time entry. (12:34:56) Slash for date entry. (10/11/97)
	+/- BKSP	Provides way to exit out of certain conditions - Selects Waveguide Switch in Manual	Toggles sign of numeric data entry when cursor is at beginning of entry field. Backspaces one field to the left during data entry.

<1> Numbered keys may also be used to select from a set of choices such as <1>LOCATE <2>STOW.

3.1.3 Data Entry

Many RC4000 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:SATCOM K2)

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 Enter 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.

After selecting one character, the flashing cursor is placed in the next space awaiting character selection. To complete the entry of the alphanumeric string, press Enter for a second time. The user may backup through the string by using the BKSP 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. When the input has been backed up past the first entry, the current value of the item will again be displayed. 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 (decimal pt.) 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 DD/MM/YY format.

3.1.4 Display Layout

The following screen shows many elements common to RC4000 mode displays.

```
AZIM: 31561        SS1:625(Ku)      TRACK
ELEV: 11060         SAT:BRASIL A1
 POL: -45.0 H      STEP:IDLE         16:03
WAITING FOR NEXT PEAKUP          <0>MENU
```

MODE TITLE: in the upper right corner the title of the current RC4000 mode is displayed – in this example TRACK designates that the RC4000 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, AZIM: is the label for the current azimuth pulse count.

DATA VALUES: the current value of relevant data for the mode is displayed following the appropriate data label. In the example, the current azimuth pulse count (AZIM:) is 31561. Likewise the current satellite being tracked (SAT:) is BRASIL A1.

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 0 key will transition the RC4000 to TRACK MENU mode. There are several types of user data inputs as described in 3.1.3.

USER INFORMATION: when room allows, information about the current state of the RC4000 is displayed. In the above example, "WAITING FOR NEXT PEAKUP" describes the fact that since the RC4000 is currently in the IDLE portion of the STEP track operation the controller is waiting until the appropriate calculated time to perform the next peakup 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 RC4000 is functioning. In the above example, the current system time (16:03) 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 RC4000 has detected. The alarm message will alternate with the text normally on row 4. See section 3.4 for more description of the alarm system.

3.1.5 Software Initialization

Upon powering up the RC4000, an identification screen is displayed for five seconds.

```
   RC4000 MOBILE ANTENNA CONTROLLER
     (c) RESEARCH CONCEPTS INC. 2010
LENEXA, KANSAS USA      (+1)913-422-0210
Please Wait ...
```

```
   RC4000 MOBILE ANTENNA CONTROLLER
     (c) RESEARCH CONCEPTS INC. 2010
LENEXA, KANSAS USA      (+1)913-422-0210
RC4K-AB-VWXYZ                version 1.55
```

Software Configuration. The software configuration (SW:) field is presented in the form RC4K-xy-abcde:

RC4K-(Mount Manufacturer/Model #)-

      (Nav Sensor Option)(Tracking Option)(Remote Option)(Receiver 1 Option)(Receiver 2 option)

Descriptions of the software configuration designations are provided in the following tables:

Mount Manufacturer/Model

The software within the RC4000 is customized to account for specifics of individual mounts. A particular mount is referred to by a two character designation with the first character typically associated with the mount manufacturer and the second character associated with a specific mount/antenna model from that manufacturer.

CATEGORY	DESIGNATION	DESCRIPTION
Mount Manufacturer / Model Number	Letter / #	Example: V1 - Vertex 2.4m. DMK
		S1 - SweDish 1.5m. DA
		A3 - AVL 1.2m. USA
		N1 - Andrew 4.5m. TriFold

The RC4000's predecessor, the RC3000, supported over 200 different mount models from dozens of manufacturers worldwide.

Navigation Sensor Options

The RC4000 may be provided with multiple navigation sensor options. Navigation sensors allow the RC4000 to determine the mount's latitude, longitude and heading. If no navigation sensors are present, estimates of this data may be entered manually.

CATEGORY	DESIGNATOR	DESCRIPTION
Navigation Sensors	A	External GPS and 3-Axis Compass
	B	GPS and 3-Axis Compass
	G	GPS and Fluxgate Compass
	H	Differential GPS Compass
	I	Internal Differential GPS Compass
	L	GPS/3-Axis Compass/Solar Tilt
	M	GPS and HMR3400 Compass
	N	No Navigation Sensors
	O	GPS Only
	P	Locosys GPS and 3-Axis Compass
	S	GPS and 1-Axis Compass
	T	GPS and 1-Axis Compass (GPGGA Only)

Tracking Options

The RC4000 may provide optional support for tracking inclined orbit satellites.

CATEGORY	DESIGNATOR	DESCRIPTION
Inclined Orbit Tracking	N	Tracking not supported
	T	Step/Memory Track
	E	Step/Memory Track + Two-Line Element Tracking
	S	Base Tilt Compensation
	W	Elevation wind stiffening
	U	Option E and Option W
	V	Option T and Option W
	P	Enhanced Predictive Tracking

Remote Control Options

The RC4000 may provide optional support for controlling the mount from a remote (away from the front panel) location.

CATEGORY	DESIGNATOR	DESCRIPTION
Remote Control	N	No Remote Control Supported
	R	Serial Remote Control
	I	Ethernet Remote Control

RECEIVER OPTIONS

The RC4000 may provide optional support for controlling multiple integrated satellite receivers from two different connectors.   The RC4000 can support the integrated DVB receiver along with two additional receivers.

Receiver 1 Options

The Receiver 1 option specifies support for both the RCI DVB receiver (integrated on the options board) along with an additional receiver via the REC1 connector.

CATEGORY	DESIGNATOR	DESCRIPTION
Integrated Receiver	A	ASC Beacon Receiver
	B	Novella Beacon Receiver
	C	Avcom SBS Spectrum Analyzer
	D	Option C and Option R
	E	Option A and Option R
	F	Option B and Option C
	G	Option K and Option R
	H	DVB-S2 Receiver
	I	Option B and Option H
	J	Option H and Option K
	K	Avcom SBS2 Beacon + SpecAn
	L	Avcom SBS2 Beacon Only
	M	Option H and Option L
	N	No Integrated Receiver
	P	Option A and Option H
	Q	Serial Novella Beacon
	R	DVB-S Receiver
	S	Option B and Option R
	T	Option L (Ethernet Only)
	U	Option K (Ethernet Only)
	V	Option H and Option U

Receiver 2 Options

The Receiver 2 option specifies support for an additional receiver via the REC2 connector.

CATEGORY	DESIGNATOR	DESCRIPTION
External Receiver	A	ASC Beacon Receiver
	B	Novella Beacon Receiver
	C	Novella Beacon Receiver (Serial)
	E	Viasat Modem (European)
	I	iDirect X-series modem
	K	SkyWAN modem
	L	Option B and Option K
	O	Generic OpenAMIP
	P	EIRP
	R	UHP Modem
	W	Newtec Modem

NOTE: Descriptions of the optional features are typically provided by separate appendices.

MOUNT POSITION CONFIRMATION

Following the power on screen, the RC4000 transitions to the appropriate screen based on whether or not a mount position (latitude/longitude/true heading) has been "saved".

If the mount's position has been previously saved via the POSITION mode (3.2.2.7) or the STORE (3.2.2.4) mode, the following screen appears at power up requesting that the user confirm that this position is correct (i.e. the mount hasn't moved since the position was saved). The SAVED MOUNT POSITION screen shows the position and the date and time that the position was saved.

```
                    SAVED MOUNT POSITION
38°56N  94°44W 218.1        31DEC99 23:59
<SCROLL UP>USE SAVED POSITION
<BKSP>CLEAR POS (DELETES STORED SATS)
```

If the saved position is still appropriate, pressing the Scroll Up/Yes key will instruct the RC4000 to continue to use that position. The RC4000 will use the saved position rather than attempting to automatically determine position.

Note that using a saved position may be desirable because the position may have been previously "fixed" to account for the local compass inaccuracy, etc. Also the saved position may have been manually determined and inserted due to a possible navigation sensor (GPS receiver or fluxgate compass) malfunction. Using a saved position also allows the LOCATE mode to instantly begin calculating pointing solutions rather than waiting for the GPS receiver to form a navigation solution.

If the user determines that the saved mount position is no longer appropriate (the mount has moved), pressing the BKSP key will invalidate the saved position. The RC4000 will then proceed to MENU mode. The LOCATE mode will automatically attempt to determine latitude/longitude from the GPS receiver and heading from the fluxgate compass. If the unit does not have the GPS and Fluxgate, control will pass to the POSITION mode.

3.2 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 RC4000's automatic movement features. While in either one of these modes, a momentary push of the Mode key will transition the RC4000 to the other mode.

3.2.1 Manual Mode

```
AZIM:   0.0  STOW      RF: 50        MANUAL
ELEV: -42.5  DOWN
 POL:  30.0  V         SPD:FAST         UTC
<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.

AZIM:
MAG:/mag:
TRUE:/true

The azimuth field shows a current position value of the azimuth axis. It also shows the status of azimuth limits (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 antenna angle, antenna pulse count, magnetic heading and true heading values. When first entering MANUAL mode, the field will always be initialized in the display mode selected by the initial_azimuth_display configuration item (3.3.1.2.3).

The magnetic and true heading values are derived by taking the current heading estimate of the mount (see the LOCATE function) and adding the antenna angle. 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 will be annunciated by small letters (mag: or true:) to indicate that the heading value may be inaccurate due to compass error. If the RC4000's heading estimate has been "fixed", the field will be annunciated in capital letters (MAG: or TRUE:) to indicate confidence that the value represents an accurate magnetic or true heading.

ELEV:

The ELEV field shows a current position value of the elevation axis. It also shows the status of elevation limits (STOW, DOWN, UP). The elevation axis may be moved by pressing the El Up or El Dn keys.

NOTE: when the azimuth field shows a pulse count value (due to pressing of the Scroll Up/Angle CT key), the ELEV field will also show the current elevation pulse count. During the other three choices of azimuth display, the field will show the elevation angle derived from the inclinometer.

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.

POL:

This field shows the current angular value of the polarization axis along with its limits (CCW, CW). This field will also show if the polarization axis has been placed at a predefined horizontal (H) or vertical (V) position.   An asterisk (*) placed before the POL label indicates that the proceeding LOCATE function calculated that a waveguide switch "flip" will have to occur.

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. Otherwise H and V depend on whether or not satellites have been STOREd. If MANUAL was entered following a RECALL operation, H and V will be those stored for the RECALLed satellite. If multiple satellites have been STOREd, H and V will correspond to the values for the closest (in terms of azimuth location) STOREd satellite. If no satellites have been STOREd, 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 takes into account 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.

SS1/SS2/RF:

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 signal strength channel 1 (SS1), signal strength channel 2 (SS2) and the RF autopeak input (RF).

The current signal strength will be displayed as a value between 0 and 999. If the selected signal source is saturated (value greater than 999), *** will be displayed.

If a signal lock input has been enabled associated with RF, SS1 or SS2, 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 reference time (4.3.2) and time zone in the lower right hand corner.

AUXILLARY FUNCTIONS

According to the RC4000's configuration and current conditions, several additional functions may be initiated via the MANUAL mode.

3.2.1.1 Heading Fix

From the MANUAL mode 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 of 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.

```
PREDICTED AZIM: -50.9          HEADING FIX
  CURRENT AZIM: -48.7       SAT:galaxy 7
    DIFFERENCE:   2.2
<BKSP>APPLY DIFF. TO HEADING <MODE>EXIT
```

The HEADING FIX screen shows the name of the selected satellite in the SAT: field. The PREDICTED AZIM field shows the target azimuth originally predicted by the LOCATE function based on the mount's current position. The CURRENT AZIM 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 predicted azimuth from the current azimuth. 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. In the above example, if the current true heading of the mount was 195.0 it would be "fixed" to 197.2.

NOTE: to make this "fixed heading" persist through the next powering down of the RC4000, the mount's position would need to be "saved" via the POSITION mode. If the difference is applied, the RC4000 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 RC4000 to the MANUAL mode.

3.2.2 Menu Mode

MENU mode allows the user to select one of listed modes. Pressing the Mode key will move to MANUAL mode. Note: RECALL and DELETE will not be displayed if no satellites are currently STOREd.

```
1-DEPLOY   2-STOW   3-LOCATE        MENU
4-STORE    5-RECALL 6-DELETE
7-POSITION 8-SETTINGS                CST
<0-9>SELECT <MODE>MANUAL        14:37:23
```

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

3.2.2.1 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.

```
<MODE> MENU (DO NOT DEPLOY)       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.

```
AZIM:   0.0 (   0.0)              DEPLOY
ELEV: -42.1 (  22.3)
 POL: -56.7 (   0.0)
MOVING TO (DEPLOY)      <STOP>HALT MOTION
```

As each axis moves, its label (AZIM/ELEV/POL) 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 RC4000 will return to MANUAL mode. The automatic movement may be terminated anytime by pressing the Stop key.

The azimuth, elevation and polarization deploy positions are defined in the Stow/Deploy configuration screen (3.3.1.3.10).

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3.2.2.2 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.

```
<MODE>MENU (DO NOT STOW)              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 (AZIM/ELEV/POL) will flash and the current position will update. The target stow positions will be displayed in parenthesis.

```
AZIM:-123.4 (   0.0)                  STOW
ELEV:  55.1 ( -67.5)
 POL: -56.7 (   0.0)
MOVING TO (STOW)        <STOP>HALT MOTION
```

The following describes a typical sequence of movements:

- the azimuth axis is moved to its predefined stow position (typically AZIM:0.0). After moving to this indicated position, the RC4000 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 stow position. Typically this movement ends when the elevation stow limit is encountered.

Following completion of movement to the stow position, the RC4000 will return to MANUAL mode. The automatic movement may be terminated anytime by pressing the Stop key.

Many mounts have unique stow sequence requirements. Check Appendix B to see if your mount has any unique stow situations. The azimuth, elevation and polarization deploy positions are defined in the Stow/Deploy configuration screen (3.3.1.3.10). Typically the default parameters will be correct for a particular mount.

3.2.2.3 Locate

The LOCATE mode performs a calculation of the pointing angle (4.3.1) to a selected satellite based on the RC4000's estimate of where the antenna is positioned (lat/lon) and oriented (true heading). After the calculation is performed, the user may initiate an automatic antenna movement to locate the selected satellite.

```
┌─────────────────────┐
│ ANTENNA POSITION    │
│ ─────────────────   │
│                     │                  ┌──────────────────┐
│ LAT: 38'56N         │                  │ ANTENNA TARGETS  │
│ LON: 94'44W         │       ╭──────╮   │ ──────────────   │
│ HDG: 180.0          │──────▶│ POINTING │  │ AZ: -31.1        │
└─────────────────────┘       │ SOLUTION │─▶│ EL:  40.0        │
                              │ CALCULATION│  │ H:   66.3        │
┌─────────────────────┐       ╰──────╯   │ V:  -23.7        │
│ SATELLITE DATA      │                  └──────────────────┘
│ ─────────────       │
│                     │                     locate.dwg
│ NAME: GALAXY 6      │
│ LON:  74.0W         │
└─────────────────────┘
```
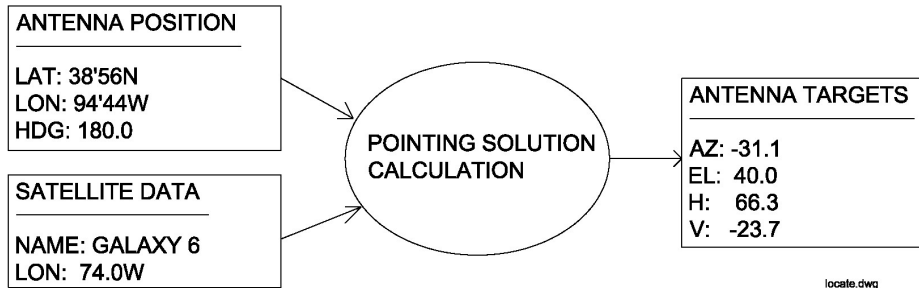
When the LOCATE mode is first entered, the following screen appears.

```
┌──────────────────────────────────────────────┐
│ POS:     38°56N  94°44W  180.0        LOCATE  │
│ SAT:GALAXY 6     74.0W                AZ:-31.1 │
│                                       EL: 40.0 │
│ <1>SELECT NEW SAT          READY  TO  LOCATE  │
└──────────────────────────────────────────────┘
```

POS: 38°56N 94°44W 180.0

The POS: field shows the RC4000's current estimate of antenna position. If no estimate of antenna position is available, the RC4000 will automatically attempt to obtain position information from the navigation sensors (GPS receiver and compass) if present.

Mount Position Initialization. In order to calculate a pointing solution, the RC4000 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 RC4000 believes the antenna is positioned is displayed on the top line. The position data obviously affects the pointing angle that the RC4000 calculates and is displayed as a crosscheck for the user in case the vehicle has been moved and the RC4000's position has not been updated. If the lat/lon or heading data is not considered valid by the RC4000, asterisks will be displayed in the appropriate field and the "parameter needed" message will be triggered in the location readiness field.

The RC4000 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 RC4000 and the GPS receiver would need to be checked. If the RC4000 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 not last for more than a minute. If it does, then investigate whether or not 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 RC4000 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 RC4000 will poll the fluxgate 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 (3.2.2.7).

SAT: GALAXY 6   74.0W
<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 3.2.2.3.1 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: -31.1
EL: 40.0

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.

MAG:/TRU:

If the user wishes to display a magnetic or true heading pointing solution (rather than antenna relative), he may choose how the azimuth data is presented by changing the initial_azimuth_display configuration item via the Azimuth Calibration (3.3.1.2.3) screen.

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) vehicle lat/lon b)vehicle heading and c)satellite information. If lat/lon and/or heading is missing/invalid, the user will need to go to POSITION mode to enter valid data. If satellite information is missing/invalid, the user will need to supply that information via the mechanisms described in 3.2.2.3.1.

2) AZIM/ELEV RANGE ERROR. If the pointing solution calculation yields an azimuth angle that is outside the clockwise or counter-clockwise azimuth limit (3.3.1.2.3) or outside the up or down elevation limit (3.3.1.2.2), one these messages will be displayed to indicate that the RC4000 does not think it can move the antenna to the correct position to acquire the satellite. The user may have to move the vehicle 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 RC4000 considers the calculated pointing solution valid. Pressing the Enter key will initiate automatic movement to find the selected satellite as described in 3.2.2.3.2.

3.2.2.3.1 Satellite Selection

Several pieces of information must be provided to describe a satellite to the RC4000 before the satellite may be automatically located (and subsequently stored, recalled, tracked,etc):

NAME: up to 10 characters (A-Z, 0-9, space)

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 RC4000 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 RC4000, the bands are assigned numbers from the following list: <0-C 1-Ku 2-CK 3-L 4-X 5-Ka 6-S>

POLARIZATION OFFSET: predicted polarization angles (horizontal and vertical) assume that the spacecraft maintains its polarization axis oriented with the equatorial plane. A few satellites don't maintain this orientation. The amount of offset from this standard in degrees must be defined. The sign convention used is that the offset is defined from the perspective of looking from the earth to the satellite (clockwise positive, counterclockwise negative). If no offset exists, the default value of 0 is described.

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-MANUALLY ENTER SAT DATA          LOCATE
2-CHOOSE SAT FROM PRESET LIST
3-SELECT SAT LONGITUDE
<1-3>SELECT SAT DATA SOURCE    <BKSP>EXIT
```

Manual satellite entry

```
  NAME:          LON:            LOCATE
INCLIN:        BAND:
PL_OFF:
ENTER NAME
```

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

Preset satellite list

```
                              LOCATE
#  NAME          LON   INC BAND
 1 BRASIL A1  79.0W    2   C
<SCR>THRU PRESET LIST         <BKSP>EXIT
```

When the user chooses to select a satellite from the user programmed list of satellites, a screen appears allowing the user to scroll through the list and select a satellite by pressing the Enter key. The preset list contains data for 20 satellites programmed by the user via the Preset Satellite configuration mode (3.3.1.1.3). **It is strongly suggested that the user program and use the preset satellite list.**

Satellite Longitude

```
                              LOCATE
LON: 94W            BAND:Ku
(ASSUMES NO INCLINATION & POL OFFSET)
<SCR>LON <7>BAND <ENTER>SELECT   <0>EXIT
```

When the user chooses to select a satellite longitude, a screen appears showing the satellite orbital slot closest to the mount's current longitude. The user may change the orbital slot by one degree at a time by scrolling up or down (down for more Westerly, up for more Easterly). The selected satellite's band may also be changed. The name used by the LOCATE function will reflect the orbital slot selected ("94W" in the above example.)

NOTE: Selected satellite data pertains only to information about a particular satellite. With respect to the RC4000, this is not considered "STOREd" data. See the STORE mode (3.2.2.4) for more information.

3.2.2.3.2 LOCATE Automatic Movement

Before automatic movement to the calculated position is initiated, the RC4000 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 polarization configuration is defined as "circular" or if the polarization automove is disabled via the polarization configuration screen (3.3.1.2.4). In this case the RC4000 will only request that the user press the BKSP key to confirm that the automatic LOCATE movement is to proceed.

```
H-HORIZONTAL:  85.4                  LOCATE
V-  VERTICAL:  -4.6           SAT:GALAXY 7
8-   NEUTRAL:  40.4              <MODE>MENU
<H/V/8> SELECT POLARIZATION    <BKSP>NONE
```

The RC4000 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 autopeak function is using the L-Band detector (RF) input for signal strength observation. If the user does not want a polarization movement to be performed for this LOCATE, pressing the BKSP key will initiate the elevation and azimuth automatic movements but a polarization movement will not be performed.

NOTE: If the polarization calculation determines that the correct orientation is outside the polarization axis' limits, the target position will be achieved by moving the position by 90 degrees. This situation is annotated by placing an "*" next to the calculated horizontal and vertical positions. The user may need to "flip" a waveguide switch in this case.

Immediately following the polarization selection, the RC4000 will begin moving to the calculated position. The progress of the movement is displayed on the following screen.

```
AZIM:   0.0 (  -5.9)                  LOCATE
ELEV: -61.7 (  44.8)         SAT:GALAXY 7
 POL:   0.0 ( -45.0)
MOVING TO (TARGETS) <STOP>HALT MOTION
```

The current angular values for az/el/pol 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.

The first automatic movement will be in the elevation axis to ensure that the mount is brought out of the elevation stow and down regions. The next movement will be in the polarization axis to ready the feed system to detect signal strength. If enabled, tilt compensation (3.2.2.3.6) movements will be performed.

The final movement will be in the azimuth axis. How this movement is accomplished depends on whether the autopeak system (see Autopeak Configuration 3.3.1.2.8) is enabled and whether the selected satellite is described as having an inclined orbit or not.

If the autopeak system is not enabled, 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 the autopeak system is enabled, an azimuth scanning autopeak movement (see 3.2.2.3.3) 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 (see 3.2.2.3.4) will be performed. For both autopeak movements to be successful, the user is required to have the receiving equipment (prior to the movement) configured for the RC4000 to be able to detect signal strength.

3.2.2.3.3 Azimuth Scanning Autopeak

The figure shows the movements made to perform an azimuth scanning (SCAN) operation. This SCAN operation enables the RC4000 to try to compensate for any azimuth inaccuracy caused by truck heading calculation errors.
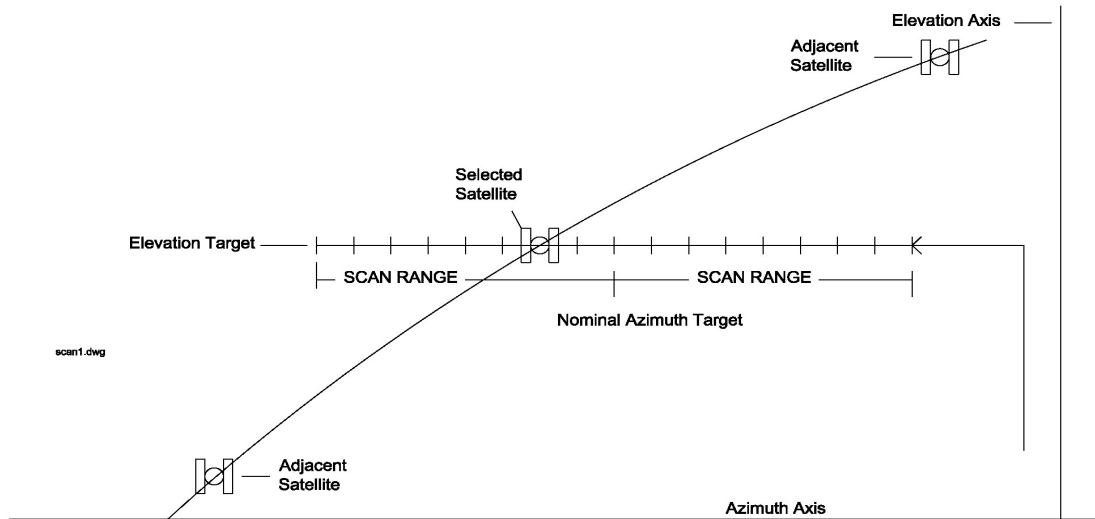
1) as part of the basic LOCATE movement, the mount will be moved to the target elevation position and the polarization axis will be moved to the correct orientation.

2) SCAN moves to the closest azimuth position "scan range" away from the nominal target azimuth. SCAN will begin trying to detect a satellite from this position.

3) SCAN steps and samples signal strength following each step. The signal strength measurements are used to calculate the average background signal noise and to determine if a signal strength peak has been detected indicating the presence of a satellite at a particular position. The size of steps taken is calculated as a function of the antenna diameter and the signal band the receiving equipment is using to ensure that the satellite is not "stepped over". 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 stepping movements may be truncated due to the physical limit of azimuth movement.

4) After completing the total number of step movements, SCAN moves to the position that gave the best indication of a satellite. If no satellite was clearly indicated, SCAN moves back to the original target.

During the SCAN operation, line 4 of the display shows the total number of steps to be made and the current step being performed.

```
AZIM:   0.0 (  -5.9)     SS1:523    LOCATE
ELEV: -61.7 (  44.8)        SAT:GALAXY 7
 POL:   0.0 ( -45.0)
SCAN( 1/17) AZIMUTH FOR PEAK  <STOP>HALT
```

The scan range is a user-defined angular value (see RF Signal Strength Factors 3.3.1.2.9) that determines the range to be searched by the SCAN routine. Since this angular range is user-defineable,

there are several factors to take into consideration. If the range is too narrow, it might not be able to compensate for a heading error. If the range is too wide, it will take the unit slightly longer to lock up, although this is usually not a significant amount of time. There might also be certain situations in which two satellites will be at a given elevation within that specified wider range, and the RC4000 will position the antenna at the point of the strongest signal, even though it is not the desired satellite. This value can be changed at any time. It is recommended that the narrowest scan range that results in consistently locating the desired satellite be used.

Following the completion of the SCAN operation, the RC4000 will move to MANUAL mode. As in the case of the basic LOCATE, the user should peak and confirm the identity of the satellite.

<u>3.2.2.3.4 Spiral Search Autopeak</u>

The spiral search autopeak operation (SEARCH) performs somewhat differently from the SCAN operation. Whereas SCAN counts on the fact that a non-inclined orbit satellite should be at the calculated elevation, 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 SEARCH operation.
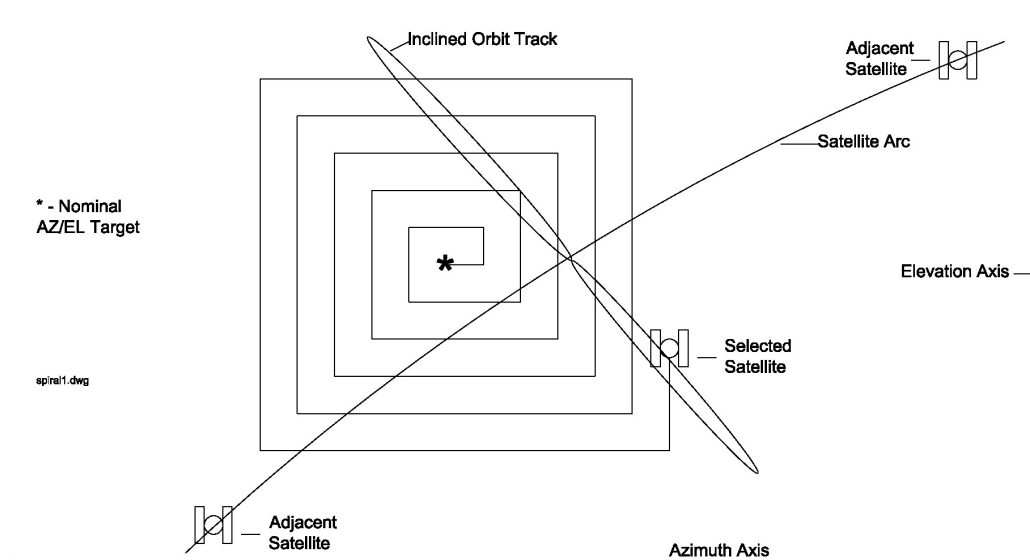
1) as part of the basic LOCATE movement, the mount will be moved to the target elevation position and the polarization axis will be moved to the correct orientation.

2) 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, 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 effect a spiral-like pattern. Unlike SCAN, SEARCH looks for a signal strength above a defined threshold in order to declare an end to the SEARCH operation. Performing the total search pattern could be time consuming so the search is terminated when a hot spot is found.

4) If no satellite was detected, SEARCH moves back to the original target.

During the 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.

```
AZIM:   0.0 (  -5.9)    SS1:523   LOCATE
ELEV: -61.7 (  44.8)       SAT:GALAXY 7
 POL:   0.0 ( -45.0)
SPIRAL SEARCH(CCW 12)          <STOP>HALT
```

Note that when pulse-based position feedback is available, the automatic azimuth and elevation movements are pulse rather than pot based for greater accuracy.

3.2.2.3.5 Terminal Peak Up

NOTE: this option is only functional if the mount has been fitted with high resolution pulse or resolver sensors for both the azimuth and elevation axes. This option will not be available on some mounts where the ability to fit high resolution sensors is not available. The performance of this movement depends on whether or not the correct azimuth and elevation pulse scale factors (3.3.1.3.3 and 3.3.1.3.6) have been characterized for the mount.

The terminal peakup option is selected via the AUTOPEAK TARGET PEAK configuration item (3.3.1.2.6).

If an azimuth scan finds a peak, it will return to the azimuth position where it noted the peak. This position may not be the absolute peak position due to the relatively large steps taken during the azimuth scan. If enabled, the terminal peakup option will next perform a "fine tune" peakup. While executing this peakup, line 4 will display "PERFORMING PEAKUP" and the AZIM and ELEV fields will display pulse or resolver counts rather than angles.

During the peakup, small jogs in azimuth and elevation will be made to find the local peak position. These movements will be similar to the Step Track maneuver described in 3.2.2.9. The step sizes taken will approximate a theoretical signal strength change of 0.3 dB (according to antenna size, operating band, etc).

3.2.2.3.6 Polarization Tilt Compensation

If enabled via the TILT configuration item in the AUTOPEAK screen (3.3.1.2.6), additional movements in azimuth will be made during the LOCATE function in order to characterize the pitch and roll of the antenna platform.

Rather than going directly to the beginning point for a scan operation, azimuth will be moved to points 90 and 45 degrees away. The elevation axis will not be changed during these moves so the effect of platform pitch and roll can be measured via the inclinometer. During these additional azimuth movements a message such as "DETERMINE TILT: MOVE AZIM TO FIRST POINT" will be displayed on line 4 to indicate that the tilt is being characterized.

After the platform tilt has been characterized, the normal LOCATE sequence will be finished. After reaching the target location, an additional step will be performed to move polarization to compensate for any platform tilt. During this step the message "ADJUSTING POL TO COMPENSATE FOR TILT" will be displayed.

3.2.2.4 Store

The STORE mode saves a satellite's name, azimuth and elevation positions, horizontal and vertical polarization positions and RF band in memory for use in later RECALLing the satellite.

When the STORE mode is entered, it is assumed that the user has peaked up on the satellite. The first screen that appears asks the user to confirm the name of the satellite to be stored. The name displayed is that of the last satellite "selected" in LOCATE mode.

```
   SAT      LON INCLIN BAND        STORE
BRASIL A1  79.0  2     C
VERIFY SATELLITE DATA OK FOR STORING
<1>CORRECT <2>INCORRECT      <MODE>EXIT
```

If this is not the correct satellite (<2>), the following message will be displayed on lines 3 & 4 to remind the user to "select" the correct satellite from the LOCATE mode.

```
GO TO LOCATE MODE TO SELECT SATELLITE
<MODE> RETURN TO MENU
```

If the satellite data is correct (<1>), the user will next be asked to store values for horizontal and vertical polarization positions. While this screen is displayed, the Pol CW and Pol CCW keys are active allowing the user to peak up in this axis. The "5" key is also active to initiate a 90 degree "cross polarization" movement. Note that the user will need to tune the receiving equipment to correct frequencies for the different polarizations. To store a polarization position, press the H key for horizontal and V for vertical. When a polarization is stored, the display for that orientation will change from "NOT SET" to SET.

```
HORIZONTAL: NOT SET                STORE
  VERTICAL: NOT SET
POL:   -4.3    SS1:795 L
<5>X-POL <POL CW/CCW>PEAK <H/V>STORE POL
```

Note that if the signal strength source is not correct to peak up on, go to the MANUAL mode to change signal strength source.

If the selected satellite is not inclined, the following screen will appear momentarily and the RC4000 will return to MANUAL mode.

```
*** SATELLITE DATA STORED ***
RETURNING TO MANUAL MODE
RECALL SATELLITE VIA MENU-RECALL
```

If an inclined satellite is selected (and the inclined orbit tracking option is present), control will automatically move to the TRACK (3.2.2.9) mode.

If the STORE function is completed correctly, the mount's position will save (see POSITION 3.2.2.7). If the position is saved, the user will be asked to verify the position upon power up of the RC4000. If the mount has moved, STOREd data will no longer be valid since the azimuth and elevation angles will no longer be correct.

3.2.2.5 Recall

NOTE: RECALL and DELETE modes will not be available from MENU if no satellites are currently "stored".

Satellites which have been stored in the controller's non-volatile memory (via STORE) can be recalled from the RECALL mode. Azimuth, elevation, and horizontal and vertical polarization data for up to 20 satellites may be stored in non-volatile memory.

```
                                          RECALL
STORED SATELLITE: SBS 4


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

Use the Scroll Up and/or Scroll Dn keys to scroll through the list of satellites stored in non-volatile memory. Press the ENTER key to select the desired satellite.

If no satellites are currently stored the following screen will appear.

```
                                          RECALL
** NO SATELLITES STORED **
SETUP SATELLITES VIA STORE MODE
<MODE> TO EXIT
```

If invalid data was somehow stored for a satellite the following screen will appear.

```
                                          RECALL
** INVALID DATA STORED FOR SATELLITE **

<ENTER>SELECT ANOTHER SAT <MODE>EXIT
```

After a satellite has been selected, the controller will prompt the user to specify the desired polarization.

Antenna movement to the stored position will proceed similar to the STOW and DEPLOY automatic movements. Antenna movement can be stopped at any time by pressing the Stop key.

When the automatic move is completed, control will transfer to MANUAL mode if the target is a geostationary satellite. If the target of the automatic move is an inclined orbit satellite, TRACK mode receives control.

3.2.2.6 Delete

The DELETE mode allows a stored satellite to be removed from non-volatile memory.

```
# OF STORED SATS: 12                    DELETE
DELETE: AMERISTAR


<SCR>THRU LIST <ENTER>DELETE <MODE>EXIT
```

The user may scroll through the list of stored satellites and delete the displayed satellite by pressing the Enter key. Note that at the end of the list is a delete all stored satellites option. If no satellites are stored, the message "RETURNING TO MENU" will momentarily appear and control will return to the MENU mode.

3.2.2.7 Position

The POSITION mode allows the user to set the latitude, longitude and heading of the vehicle for subsequent use in calculating pointing angles to satellites. The first screen that appears shows the current mount position used in the RC4000. Note: Mount "position" consists of the mount's latitude, longitude and true heading of the azimuth centerline.

```
L/L:38°56N  94°44W GPS           POSITION
ANT BEARING:225.0 FLUXGATE      NOT SAVED
                                  <4>SAVE
<1>LAT/LON <2>HEADING          <MODE>EXIT
```

The mount's position will not be retained at power off unless the position is explicitly saved by pressing the "4" key. If the position is saved, the date and time that the position was saved is noted.

3.2.2.7.1 LAT/LON

When the user chooses to modify latitude and longitude, a screen appears showing the current lat/lon and the source of that value. In the example screen, the source shows that the current lat/lon was obtained from the GPS. If the current values had been entered manually, "MANUAL" would show for the source. If the current values had come from the preset vehicle location list (see Preset Locations configuration 3.3.1.1.2), the name (ex. WICHITA) of the preset location would appear. If there is currently no valid lat/lon, "NO POS SOURCE" would be displayed.

```
   38°56N  94°44W GPS              LAT/LON

SELECT LAT/LON SOURCE #
<1>MANUAL <2>PRESET <3>GPS
```

The user is prompted to select what type of source (manual entry, preset location list, gps) to use to modify lat/lon.

Manual Lat/Lon Entry

```
   38°56N  94°44W GPS              LAT/LON
LAT:        LON:

MANUALLY ENTER LAT/LON  <MODE>EXIT
```

The user is provided two fields to manually enter lat and lon. See 3.1.3 (Data Entry) for instructions on how to enter latitude and longitude.

Preset Location List

```
   38°56N  94°44W GPS              LAT/LON
 2 37°36N  97°18W WICHITA

<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 (2) is displayed along with the name and lat/lon.

GPS Lat/Lon

```
37°36N  97°18W WICHITA         LAT/LON
GPS:38°56N  94°44W 17:36:59


<ENTER>USE GPS LAT/LON    <BKSP>EXIT
```

The current lat/lon that the gps has calculated is displayed. The UTC the gps is outputting is also displayed to show that the data is being updated. To select this lat/lon, press the Enter key. Note that if the gps is not reporting a valid position fix, the message "WAITING FOR GPS" will appear.

3.2.2.7.2 HEADING

When the user chooses to modify heading, a screen appears showing the current heading (HDG:) and source (SRC:) of heading. If valid heading data is coming from the fluxgate, this data will appear in the FLUX HDG: field. The MAG VAR: field displays the calculated magnetic variation for the current lat/lon/date. If the RC4000 thinks it needs to recalculate magnetic variation (thinks lat/lon has changed) the MAG VAR: field will flash "CALC". The magnetic variation calculation may take up to 10 seconds.

```
FLUX HDG:214.3     HDG:180.0    HEADING
 MAG VAR: 3.8      SRC:MANUAL
  AZ OFF: 0.0 <1>MAG <2>TRU <3>COMPASS
TRUE HDG:218.1 SELECT SOURCE <MODE>EXIT
```

To modify the heading to the value determined via the fluxgate (flux heading + azimuth offset +mag var) press the 3 key.

If the user wishes to enter a magnetic heading of the vehicle, press 1.

```
MAG HDG=>          HDG:180.0    HEADING
 MAG VAR: 3.8      SRC:MANUAL
  AZ OFF: 0.0 <1>MAG <2>TRU <3>COMPASS
TRUE HDG: **** SELECT SOURCE <MODE>EXIT
```

After the magnetic heading is entered, the RC4000 will apply the magnetic variation and azimuth offset to generate the true heading of the mount's azimuth centerline.

If the user wishes to manually enter true heading, press the 1 key and the prompt to enter heading will appear on line 3 as shown below.

```
FLUX HDG:214.3     HDG:180.0    HEADING
 MAG VAR: 3.8      SRC:MANUAL
  AZ OFF: 0.0      ENTER HDG=>
TRUE HDG:218.1 SELECT SOURCE <MODE>EXIT
```

3.2.2.8 Settings

Note: The SETTINGS mode may not be available on all software versions.

The SETTINGS mode provides a way to change the operational characteristics of the RC4000 without requiring to go to the configuration group of screens. It also provides a way to reset a drive error without going to the DRIVE RESET maintenance screen.

```
1-LOCATE SOURCE:   RF              SETTINGS

                                <0>RESET DRIVE
<1>CHANGE SETTING               <MODE>MENU
```

<0>RESET DRIVE

This selection is only available if an azimuth, elevation or polarization drive error (jam or runaway) is active. Selecting 0 will attempt to clear the error.

1-LOCATE SOURCE:
SOURCE <0-NONE 1-RF 2-BCN 3-RCV2 4-DVB>

Selection 2 allows the user to change the signal source that will be used with the LOCATE function.

3.2.2.9 Track

The optional TRACK mode may be entered via the STORE or RECALL modes if the selected satellite has been described as having an inclined orbit.

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

TRACKING INCLINED ORBIT SATELLITES. The RC4000 tracking algorithm can be divided into three distinct stages - STEP_TRACK, MEMORY_TRACK, and SEARCH.

```
AZIM: 31561        SIG:735(C)      TRACK
ELEV: 11060        SAT:BRASIL A1
 POL:   8.2        STEP:PEAKING      AGC
JOGGING ANTENNA TO FIND MAXIMUM SIGNAL
```

In **STEP_TRACK**, the controller periodically peaks on the receiver's signal strength by jogging the antenna. The time and position are recorded in a track table maintained in the controller's non-volatile memory. The interval between peakups is determined by antenna beamwidth (determined from antenna size and frequency band), satellite inclination and a user specified maximum allowable error (in dB). When a track table entry exists for the current sidereal time, STEP_TRACK switches to 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 peakup operations in STEP_TRACK. 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 receiver's signal strength. If the error exceeds a level set by the user, all entries in the track table are flagged for update.

TRACK_SEARCH is entered when the satellite signal has been lost. The RC4000 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.

3.2.2.10 VSAT Mode

INTRODUCTION This section details operations of the RC4000's "VSAT" mode.

VSAT mode is intended to be used when the following conditions exist:

1) the mobile satellite terminal is to be run by operators with limited or no satellite communication training or experience

2) the same satellite and the same polarization orientation are to be used

3) the RC4000 is equipped with a GPS receiver and Fluxgate compass to allow automatic calculation of the satellite pointing solution

VSAT mode limits the RC4000 functions that the operator may perform to LOCATE and STOW. To perform other functions or to change operating parameters, expert access permission must be established and the RC4000 must be taken out of VSAT mode.

NOTE: VSAT "mode" refers to the overall functioning of the RC4000. VSAT is not a mode in the same sense as MANUAL, LOCATE, TRACK, etc. are modes.

PRIOR TO ENTERING VSAT MODE

VSAT mode should not be entered until the RC4000 has been well calibrated with the antenna and receiving systems. VSAT mode requires that the LOCATE and STOW modes consistently work well.

In order to achieve good performance, ensure that:

1) the azimuth, elevation and polarization axes are well calibrated

2) the Fluxgate calibration procedure as been performed and yields good results

3) the source of signal strength has been well calibrated

Before entering VSAT mode, the satellite to be used and the polarization orientation (Horizontal, Vertical or None) has been selected as part of a completed LOCATE function.

ENTERING VSAT MODE

VSAT mode is selected from the SYSTEM DEFINITION configuration screen (3.3.1.2.1).

```
    GPS: 1                    CONFIG-SYSTEM
COMPASS: 1  ANT_SIZE: 120    WAVEGUIDE:0
   MODE: 2
<1>LOCATE <2>MENU <3>MANUAL <4>VSAT
```

 When the value of 4 is entered for the MODE item, the RC4000 will enter VSAT "mode".

When VSAT mode is entered, expert access permission (3.3.1.1.1) is set to NORMAL. This in itself will prevent the operator from accessing most configuration items and some functions of the RC4000. VSAT mode will further limit operator actions as now described.

After VSAT mode is entered, the RC4000 switches to the MENU screen. The following describes VSAT mode operation by showing a typical sequence of events.

VSAT MODE OPERATION

After powering up the RC4000, the MENU screen will appear.

```
1-LOCATE SATELLITE                 MENU
2-STOW ANTENNA

                                    CST
<1-2>SELECT <MODE>MANUAL        14:37:23
```

In VSAT mode, the MENU screen only gives the operator two automatic functions that may be performed.

LOCATE

Selecting <1> will put the RC4000 into LOCATE mode.

If the antenna system has an antenna mounted compass, the following screen will prompt the operator to confirm that the antenna's platform is in a safe location (not in a garage, not under power lines, etc.) for deployment of the antenna.

```
*   ANTENNA MOVEMENT REQUIRED TO LOCATE *
*    CONFIRM PLATFORM IN SAFE POSITION  *
<ENTER>BEGIN MOVEMENT           <MODE>EXIT
```

After initiating antenna movement, the antenna will be deployed and the LOCATE mode entered.

```
POS:    39°01N  94°49W  180.1      LOCATE
SAT:GALAXY 7     91.0W          AZ:-31.1
                                EL: 40.0
                          READY TO LOCATE
                          PRESS <ENTER>
```

In VSAT mode, the LOCATE screen does not allow the operator to select a satellite. The selected satellite (and polarization) will be the last one chosen prior to entering VSAT mode.

When LOCATE is first entered, the mount's position will be automatically initialized with data from the GPS receiver and the Fluxgate compass. There may be a delay of several minutes while the GPS receiver generates a navigation solution. After the GPS generates lat/lon, the local magnetic variation is calculated and applied to the magnetic heading from the compass to form an estimate of the true heading of the mount.

The latitude, longitude and true heading will be displayed in the POS: field. The pointing solution will be displayed in AZ: and EL: and the messages "READY TO LOCATE" and "PRESS ENTER" will be flashed. When ENTER is selected (or the antenna deployment has previously been confirmed), the RC4000 will automatically begin positioning the antenna to locate the satellite. The previously selected polarization orientation (Horizontal or Vertical) will be automatically calculated.

The autopeak function will be performed according to how it was configured (signal source, lock condition, scan range, etc.) prior to entering VSAT mode. Descriptions of the various operations in the LOCATE sequence will be displayed as the operation progresses.

```
AZIM:   0.0 (  -6.1)              LOCATE
ELEV: -61.7 (  44.7)      SAT:GALAXY 7
 POL:   0.0 (  40.3)
MOVING TO (TARGETS) <STOP>HALT MOTION
```

Following the completion of the LOCATE function, the RC4000 will display the following screen:

```
! 		   LOCATE COMPLETE 		 !
! 	       CONFIRM RECEIVER STATUS 	 !

<MODE>MENU
```

The operator should confirm that the antenna has been placed on the correct satellite. For example, confirmation could be achieved by recognizing if the modem has generated a signal lock.

STOW

By selecting <2> from MENU, the operator may initiate a STOW operation as described in 3.2.2.2. As with the LOCATE operation, the user will be asked to confirm that antenna movement is safe to initiate.

MANUAL

By selecting <MODE> from the MENU, the RC4000 may be placed in MANUAL mode.

```
AZIM:  -6.1(  -6.1)   SS1:695     MANUAL
ELEV:  44.6(  44.7)   SAT:galaxy 7
 POL:  12.3           SPD:SLOW        CST
<0-9>JOG ANTENNA <MODE>MENU     14:25:47
```

In VSAT mode the manual jog speed will be initialized to SLOW to allow fine tuning of the azimuth, elevation and polarization axes if required.

EXITING VSAT MODE

To bring the RC4000 out of VSAT mode, expert access permission must be restored to INSTALL or SUPER USER. Then the initial mode must be set to something other than VSAT in the SYSTEM DEFINITION configuration screen.

RED/GREEN BUTTON OPERATION

A simplified user interface may be mechanized via two lighted buttons, colored red and green. After properly programming the ACU, the two buttons allow the user to initiate LOCATE and STOW operations without using the RC4000 front panel or a remote control interface. (Appendix PBO includes additional information regarding the RED/GREEN Button opteration.)

IMPLEMENTATION

In order for this simplified interface to be active, the RC4000 must be programmed and placed in VSAT mode as defined in section 3.2.2.10 (ENTERING VSAT MODE) of the baseline RC4000 user's manual. VSAT mode limits the RC4000 functions that the operator may initiate to LOCATE and STOW. To perform other functions or to change operating parameters, expert access permission must be established and the RC4000 must be taken out of VSAT mode.

In VSAT mode the following MENU screen would appear after power up.

```
1-LOCATE SATELLITE              MENU
2-STOW ANTENNA

                                CST
<1-2>SELECT <MODE>MANUAL     14:37:23
```

When the RC4000 is in MENU mode, the Red/Green button interface scheme allows the user to initiate a LOCATE by pressing the green button and to initiate a STOW by pressing the red button.   In order for the user to not have to see the front panel, the lights on the two buttons are lit to indicate the status of the ACU. The following table defines the indications.

ACU MODE	LIGHT INDICATION	BUTTON ACTION
POWER UP	Both Red & Green lights flash	No button action during power up
MENU (No errors)	Both Red & Green lights on steady	Green button initiates LOCATE mode Red button initiates STOW mode
LOCATE & STOW	Green light will flash a code indicating current sequence of mode Red light off during normal operation Red light flashes code if error has occurred	Either button will immediately stop mode and return ACU to MENU mode
MENU (Error Detected)	Green light steady on Red light flashes error code from previous mode	Green button initiates LOCATE mode Red button initiates STOW mode

Therefore a typical sequence of operations would be:

1) as the ACU powers up, both green and red buttons flash

2) after power up initialization, both green and red buttons will be lit indicating the ACU is in MENU mode

3) the user presses the green button to initiate an automatic LOCATE. During the LOCATE operation the red button is unlit and the green button flashes indicating normal operation.

4) after successful completion of the LOCATE operation, the ACU will return to MENU mode and both buttons will again be steady on

5) the user presses the red button to initiate an automatic STOW of the antenna. During the STOW operation the red button is unlit and the green button flashes indicating normal operation.

6) after successful completion of the STOW operation, the ACU will return to MENU mode and both buttons will again be steady on

If an operational error was detected during a LOCATE or STOW function:

1) the green button would flash indicating what part of the sequence the mode was in

2) the red button would flash a code indicating the nature of the error. NOTE: typically a detected error would automatically stop antenna movement as a normal function of the LOCATE or STOW mode

3) the user could press either button to return the ACU to MENU mode. In MENU mode the green button would be steady on and the red button would flash the error code previously encountered. The user could press either button to attempt the automatic function again.

NOTES

- if the ACU has not been placed in VSAT mode, neither button will be lit or active

- in general it is hoped that the user will become accustomed to recognizing that when the two buttons are both lit a LOCATE may be initiated by the green button and a STOW initiated by the red button. While

the green flashing codes vary, it is hoped that the user will recognize any green flashing light as an indication of normal operation (as long as there is not a red flashing code.)

The following table provides descriptions of the flashing codes:

CODE	GREEN DESCRIPTION	RED DESCRIPTION
11	Beginning Locate	Azimuth Jammed Alarm
12	Deploying Polarization	Azimuth Runaway Alarm
13	Deploying Elevation	Elevation Jammed Alarm
14	Deploying Azimuth	Elevation Runaway Alarm
15	Waiting For GPS	
16	Synchronizing Time	
17	Getting Heading	
18	Determining Platform Tilt	
21	Moving To Target Elevation	No RF Detected
22	Moving To Target Polarization	DVB Communication Failure
24	Moving To Target Azimuth By Pulses	
25	Moving To Target Azimuth By Angles	
26	Azimuth/Elevation Peak	
27	Elevation-Only Peak	
28	Adjusting Polarization For Tilt	
31	Scanning Azimuth	
32	Flat Spiral Search	
33	Expanding Spiral Search	
41	Determining RF Noise Floor	
42	Moving To Start Of Scan	
43	Initializing Receiver	
44	Moving To Scan Elevation	
45	Moving To Scan Polarization	
46	Scanning Azimuth	
51	Beginning Stow	
53	Continuing Stow	
56	Moving To Azimuth Stow	
57	Searching For Azimuth Stow Switch	
58		Cannot Find Azimuth Stow Switch
59	Moving To Polarization Stow	
61	Searching For Polarization Stow Switch	
62		Cannot Find Polarization Stow Switch
68	Moving To Elevation Stow	
91		Azimuth Range Error
92		Elevation Range Error
93		Outside Pulse Range Error
94		No Signpost Found

Table 1 – SW Version 0.03 Codes

3.3 Programming Group

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

3.3.1 Configuration Mode

The CONFIG mode allows users to view and/or modify various controller parameters and to enable or disable certain features. Many configuration items are used to customize the RC4000 to work with a particular installation.

The CONFIG mode groups configuration items into screens containing between 1 to 10 individual items. The top-level CONFIG-MENU allows the user to scroll through the list of configuration item groups. As the user scrolls through the CONFIG-MENU screens, a group title (line 1) and brief description (line 2) of group items is presented to identify the set of configuration items to view or modify.

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

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


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

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

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

```
REF_V:2.50   OFF:  0.0        CONFIG-AZIM
  CCW:-180.0  CW: 180.0 SF: 65.6
 COMP:   0.0                     DISP:1
ZERO DEG VOLTAGE <1.00 - 4.00>
```

In this example there are nine individual configuration items related to the azimuth axis. To move between the items, use the Scroll Up and Scroll Dn keys. The cursor will flash at the beginning of the data field for the item currently selected. On line 4, a prompt briefly describing the item and showing the valid range of data will appear. Data may be entered for the item as described in section 3.1.3. Momentarily pressing the Mode key will return to the CONFIG-MENU mode.

The following table lists all the configuration item group titles and descriptions as they appear in the CONFIG-MENU mode. Details for each group are provided in the following subparagraphs. The table also shows which configuration item groups are available according to how the expert access permission (3.3.1.1.1) is set.

Additional configuration item screens may appear if they are unique to an optional feature (inclined orbit tracking, remote control, etc). Descriptions of those screens will be provided in their appropriate appendices.

GROUP TITLE	GROUP DESCRIPTION	PARA.
NORMAL ACCESS ITEMS		
EXPERT ACCESS PERMISSION	SETS EXPERT ACCESS PERMISSION	3.3.1.1.1
LOCATION PRESETS	LIST OF PRESET TRUCK LOCATIONS	3.3.1.1.2
SATELLITE PRESETS	LIST OF PRESET SATELLITES	3.3.1.1.3
INSTALLATION ITEMS		
SYSTEM DEFINITON	DEFINE SYSTEM OPTIONS	3.3.1.2.1
ELEVATION CALIBRATION	EL REFERENCE VOLTAGE/LIMITS/SCALE FACTOR	3.3.1.2.2
AZIMUTH CALIBRATION	AZ REFERENCE VOLTAGE/LIMITS/SCALE FACTOR	3.3.1.2.3
POLARIZATION CALIBRATION	POL REFERENCE VOLTAGE/LIMITS/SCALE FACTOR	3.3.1.2.4
FEED DEFINITION	SPECIFY FEED TYPE/BAND/ID	3.3.1.2.5
AUTOPEAK	GLOBAL SCAN/SEARCH PARAMETERS	3.3.1.2.6
SS1 SIG FACTORS	SIGNAL STRENGTH PARAMETERS	3.3.1.2.7
SS2 FACTORS	SIGNAL STRENGTH PARAMETERS	3.3.1.2.8
RF SIG FACTORS	SIGNAL STRENGTH PARAMETERS	3.3.1.2.9
SUPER-USER ITEMS		
RESET DEFAULTS	RESTORES PROGRAMMING TO FACTORY DEFAULTS	3.3.1.3.1
AZIMUTH ANGLE MOVEMENT	AZIMUTH ANGLE-BASED MOVE PARAMETERS	3.3.1.3.2
AZIMUTH COUNT MOVEMENT	AZIMUTH COUNT-BASED MOVE PARAMETERS	3.3.1.3.3
AZIMUTH DRIVE PARAMETERS	AZIM VOLTAGE/CURRENT/IR/JAM/DEADBANDS	3.3.1.3.4
ELEVATION ANGLE MOVEMENT	ELEVATION ANGLE-BASED MOVE PARAMETERS	3.3.1.3.5
ELEVATION COUNT MOVEMENT	ELEVATION COUNT-BASED MOVE PARAMETERS	3.3.1.3.6
ELEVATION DRIVE PARAMETERS	ELEV VOLTAGE/CURRENT/IR/JAM/DEADBANDS	3.3.1.3.7
POL ANGLE MOVEMENT	POL ANGLE-BASED MOVE PARAMETERS	3.3.1.3.8
POL DRIVE PARAMETERS	POL VOLTAGE/CURRENT/IR/JAM/DEADBANDS	3.3.1.3.9
STOW & DEPLOY	AZ/EL/POL STOW & DEPLOY POSITIONS	3.3.1.3.10
SHAKE	SETUP SHAKE MOVES/CYCLES/DELAY	3.3.1.3.11

NOTE: Software options (such as Inclined Orbit Tracking, Integrated DVB Receiver, etc.) may introduce additional configuration screens that will be described in the option's documentation.

3.3.1.1 NORMAL ACCESS ITEMS

The three configuration groups contained in the "Normal" access allows the user to change items that would typically be required to be changed following system configuration.

3.3.1.1.1 Expert Access Level

```
EXPERT ACCESS:     0      CONFIG-EXPERT



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

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

The available expert access levels are: SUPER-USER, INSTALL, and NORMAL. The user has access to all modes and all configuration items when Expert Access is set to SUPER-USER (level 2). The user has access to all controller modes and general configuration items when Expert Access is set to INSTALL (level 1). The user is restricted to basic operational modes and preset item lists when Expert Access is set to NORMAL (level 0).

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

3.3.1.1.2 Preset Locations

This group allows the user to customize a list of 20 commonly used mount locations. This list may be used for selecting mount lat/lon in the POSITION mode.

```
LOC#: 1                         CONFIG-LOCS
NAME:RCI
 LAT:39°01N    LON: 94°49W
<SCR> THRU LIST, <ENTER> TO MODIFY DATA
```

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

This field identifies the list number (1-20) that is currently being displayed. When in this field, using the Scroll Up or Scroll Dn keys will move through the list.

To modify the data press the Enter key. The cursor will move to the NAME field.

NAME: ENTER <ALPHANUMERIC> LOC NAME

This field allows a user to enter a name (up to 10 characters). See section 3.1.3 for instructions on how to enter alphanumeric data. After the name is entered, the cursor will move to the LAT field.

If you do not wish to change the current name, pressing the Scroll Up key will move to the LAT field. Scroll Dn will move back to the LOC# field.

LAT: ENTER LAT IN <DD.MM> FORMAT

This field allows a user to enter a location's latitude in degrees/minutes format. See section 3.1.3 for instructions on how to enter a latitude. After the latiitude is entered, the cursor will move to the LON field.

If you do not wish to change the current latitude, pressing the Scroll Up key will move to the LON field. Scroll Dn will move back to the NAME field.

LON: ENTER LON IN <DDD.MM> FORMAT

This field allows a user to enter a location's longitude in degrees/minutes format. See section 3.1.3 for instructions on how to enter a longitude. After the longitude is entered, the cursor will move to the LOC# field.

If you do not wish to change the current longitude, pressing the Scroll Up key will move to the LOC# field. Scroll Dn will move back to the LAT field.

3.3.1.1.3 Preset Satellites

This group allows the user to customize a list of 20 commonly used satellites. The LOCATE mode allows
the user to select a satellite ([3.2.2.3.1](#)) from this "preset" list.

```
SAT#: 1   NAME:INTEL 1R      CONFIG-SATS
 LON: 50.0W PO:  0.0
INCL: 0 BAND:1 POL:0
<SCR> THRU LIST, <ENTER> TO MODIFY DATA
```

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

This field identifies the list number (1-20) that is currently being displayed. When in this field, using the
Scroll Up or Scroll Dn keys will move through the list.

To modify the data press the Enter key. The cursor will move to the NAME field.

NAME: **ENTER <ALPHANUMERIC> SAT NAME**

This field allows a user to enter a name (up to 10 characters). See [section 3.1.3](#) for instructions on how
to enter alphanumeric data. After the name is entered, the cursor will move to the LON field.

If you do not wish to change the current name, pressing the Scroll Up key will move to the LON field.
Scroll Dn will move back to the SAT# field.

LON: **ENTER LON IN <DDD.TT> FORMAT**

This field allows a user to enter a satellite's longitude in decimal format. See [section 3.1.3](#) for instructions
on how to enter satellite longitude. After the longitude is entered, the cursor will move to the INCLIN field.

If you do not wish to change the current longitude, pressing the Scroll Up key will move to the INCLIN
field. Scroll Dn will move back to the NAME field.

PO: **POL OFFSET <-90.0 - 90.0> (UNKNOWN->0.0)**

This field describes if the satellite's polarization axis is oriented non-orthogonal to the earth's equatorial
plane. The sign convention is that described in [4.3.4](#).

INCL: **INCLINATION <1-12 DEG> <0>NON-INCLINED**

This field allows the user to define whether or not the satellite is in inclined orbit and if so the number of
degrees the orbit is inclined.

A number greater than zero implies that the satellite has an inclined orbit. A satellite identified as having
an inclined orbit will enter TRACK mode following being STOREd.Entering an inclination of 0 implies that
the satellite does not have an inclined orbit in which case the controller will not enter TRACK following
STORE.

BAND: **BAND <0-C 1-Ku 2-CK 3-L 4-X 5-Ka 6-S>**

This field allows the user to specify the RF band associated with this satellite. This data is used by the
tracking and autopeak algorithms to determine the effective bandwidth of the mount thus affecting size of
movements made.

POL: **DEFAULT POL <0-NONE 1-H 2-V 3-R 4-L 5-N>**

This field allows the user to specify the default polarization type associated with this satellite. The options are:

0) None – The ACU will not perform any automatic movements for Polarization, will not display a Pol position or allow manual jog operations for polarizatiton
1) H – Horizontal linear polarization
2) V – Vertical linear polarization
3) R – Right-hand circular polarization
4) L – Left-hand circular polarization
5) N – Neutral linear polarization (typically halfway between Horizontal and Vertical)

NOTE: the preset list only contains data about a satellite. With respect to the RC4000 there is sometimes confusion between the preset list and the list of STOREd satellite data (3.2.2.4). STOREd data contains both satellite and mount (azimuth, elevation, polarization) position data.

3.3.1.2 INSTALLATION ACCESS ITEMS

This set of configuration groups allows the user to modify parameters that are most typically changed for a particular installation.

<u>3.3.1.2.1 System Definition</u>

```
MODE:2  ANT SIZE: 200      CONFIG-SYSTEM
 GPS:3  ANT LOOK:1            DRIVE:3
COMP:2  COMP OFF:   0.0   AZ DISP:1
<1-LOCATE 2-MENU 3-MANUAL 4-VSAT 5-POS>
```

The CONFIG-SYSTEM screen allows the user to indicate the existence of optional equipment. Indicating that the item is not present will keep the controller from waiting for a valid response from the item in various modes. For example, if the GPS receiver is not present, the RC4000 will simply report "NO GPS PRESENT" vs. waiting for a period of time to decide that it is not receiving data from the GPS.

MODE: **INITIAL MODE <1-LOCATE 2-MENU 3-MANUAL 4-VSAT 5-POS>**

This item specifies to which of the modes listed the RC4000 will go to upon power up.

Selections 1, 2, 3 or 5 will direct the RC4000 to go to LOCATE, MENU, MANUAL or POSITION mode upon power up. For example, if the controller does not have the GPS and compass options, the user may want to power on to the POSITION mode.

Selection 4 puts the controller in "VSAT" mode described in <u>section 3.2.2.10</u>. This section should be thoroughly reviewed prior to placing the controller into "VSAT" mode.

ANT_SIZE: **ANTENNA SIZE <1-9999 CM>**

This item specifies the size of the reflector in centimeters. For example, a 5.9 ft. diameter reflector (1.8m) would require a value of 180 (cm.) be specified.

The antenna_size_cm is used by inclined orbit tracking algorithms to characterize the antenna's beamwidth thus affecting timing of various tracking movements. The value is also used by autopeak algorithms to determine the size of autopeak step movements.

GPS :   **<0>NONE <1>TRUCK <2>TOP <3>BACK**

This item specifies whether or not the optional GPS receiver is present and how the GPS is mounted if it is present. If specified as not present (0), the "NO GPS PRESENT" message will be displayed in various RC4000 screens. If the GPS option was not purchased, this field will always remain at 0. If the GPS is specified as "TOP" or "BACK" (referring to an antenna mounted GPS), the RC4000 will require that the dish be moved to the DEPLOY position to obtain GPS location information.

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

The elevation_lat_configuration item is used for mount types that have different feed boom configurations to achieve different elevation pointing angles. The reported elevation angle will be offset by different values according to whether the high or low elevation configuration is specified. Other elevation related items such as stow and deploy positions will also be affected. **NOTE: for mounts that have only one feed boom configuration, this configuration item may be set to either value with no consequence.**

DRIVE: **DRIVE OPTION <0-SINGLE 1-AE 2-AP 3-AEP>**

This item determines the status of multi-axis motion. For example, setting this item to 1 will have both the Azimuth and Elevation axes operating simultaneously. Some systems with particularly heavy current requirements may only operate successfully one axis at a time.

COMP: **<0>NONE <1>TRUCK <2>TOP <3>BACK <4>BASE**

This item specifies whether or not the optional fluxgate compass is present and how the compass is mounted if it is present. If the compass is specified as "TOP" or "BACK" (referring to an antenna mounted compass), the RC4000 will require that the dish be moved to the DEPLOY position to obtain magnetic heading information. If the compass option was not purchased, this field will always remain at 0.

COMP OFF: **COMPASS OFFSET <+/-180.0 DEGREES>**

The azim_cal_offset item specifies the number of degrees to offset the heading reading with respect to the heading of the centerline of the azimuth axis. The default value for this reading is 0. A value other than 0 may need to be entered to correct for some mechanical misalignment in the system (see Azimuth and Elevation Alignment 4.1.10).

This value will also need to be set if there is an intentional difference between the alignment of the compass and the centerline of azimuth movement.

AZ DISP: **INIT AZIM DISPLAY <1-ANT 3-MAG 4-TRUE>**

This value allows the user to select what format (antenna angle, magnetic heading or true heading) the azimuth position is initially displayed in the MANUAL and LOCATE modes. Traditionally, the antenna angle derived from the mount position sensor is the format displayed by the RC4000.

3.3.1.2.2 Elevation Calibration

```
VREF:1.30    OFF:  0.0         CONFIG-ELEV
DOWN:   5.0   UP:  90.0   SF:50.00
 PSF:10431            ROFF:   0.00  DIR:0
ZERO DEG VOLTAGE <1.00-4.00 VOLTS>
```

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

The elev_zero_voltage defines the voltage present when the elevation axis is at its reference position. See Elevation Calibration in section 4.1.2.

OFF:　　　　　**ANGLE OFFSET <+/-90.0 DEGREES>**

The elev_squint_factor configuration item corrects for discrepancies between the antenna's electrical and mechanical bore sight alignment. The squint factor also compensates for errors in the attachment of the elevation position sensor. The elevation squint factor is the difference between the antenna's theoretical and actual elevation pointing angle. The value for this constant is determined during the elevation alignment calibration procedure (4.1.10). The VALUE OF THIS CONSTANT MUST BE SET TO 0.0 BEFORE THE ELEVATION CALIBRATION OCCURS. The nominal value of this constant is 0.0.

DOWN:　　　　**DOWN LIMIT <-20.0-120.0 DEGREES>**
UP:　　　　　**UP LIMIT <-20.0-120.0 DEGREES>**

The down_elev_limit and up_elev_limit configuration items specify the valid elevation operating range in degrees. If the LOCATE mode calculates a target elevation outside of this range, an elevation range error will be triggered.

The spiral search algorithm (when based on pot-based movements) also uses these values to limit the area that may be searched.

SF:　　　　　**SCALE FACTOR <10.00 – 90.00 mV/DEG>**

The elev_scale_factor_mv_deg configuration item specifies the observed output of the elevation inclinometer.

PSF:　　　　　**PULSE SCALE FACTOR <1-32767 PULSES/RAD>**

This item specifies the approximate number of pulses measured per radian of elevation travel. See installation section 4.1.12 for calculation of the elevation pulse scale factor. The pulse scale factor is used by inclined orbit tracking and autopeak algorithms for determining amount of movement (in pulses.)

ROFF:　　　　**RESOLVER OFFSET <+/-300.0 DEGREES>**

The elev_resolver_offset_item defines the offset to be applied to the angle read directly from the elevation resolver for the purpose of displaying elevation angle. Example: If when at the elevation reference (deploy) position the raw elevation resolver angle reads 180.0, a elev_resolver_offset_item of -157.7 will result in a resolver based elevation angle of 22.3.

NOTE: the resolver-based angle is displayed in MANUAL mode when the elevation DOWN limit is active.

DIR:　　　　　**COUNT DIRECTION <0-NORMAL 1-REVERSED>**

The elev_pulse_count_reversed_item defines whether the polarity of the Elevation resolver matches that of the RC4000 resolver circuitry. If the raw Elevation resolver angle decreases as the mount moves UP, the DIR item must be described as reversed.

3.3.1.2.3 Azimuth Calibration

```
VREF:2.50    OFF:  0.0         CONFIG-AZIM
 CCW:-200.0   CW: 200.0   SF: 86.93
 PSF:10431            ROFF:   0.00  DIR:1
ZERO DEG VOLTAGE <1.00-4.00 VOLTS>
```

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

The azim_zero_voltage defines the voltage present when the azimuth axis is in its center of motion. See Azimuth Calibration in section 4.1.3.

OFF: **ANGLE OFFSET <+/-90.0 DEGREES>**

The azim_cal_offset item specifies the number of degrees to offset the heading reading with respect to the heading of the centerline of the azimuth axis. The default value for this reading is 0. A value other than 0 may need to be entered to correct for some mechanical misalignment in the system (see Azimuth and Elevation Alignment 4.1.10).

CCW: **CCW LIMIT <+/-300.0 DEGREES>**
CW: **CW LIMIT <+/-300.0 DEGREES>**

These items specify the antenna's azimuth range of travel relative to the antenna's center azimuth (0.0) position. These positions are used to trigger the display of the Reposition Truck message. When the RC4000 calculates an antenna pointing solution in LOCATE mode, it checks these values to see if the dish can be physically moved to that position. Thus the Reposition Truck message is displayed when the antenna is incapable of moving to the azimuth position required to intercept the desired satellite. These values are also used by autopeak algorithms to limit the area the autopeak movements will search.

Note that these values may also be used to actually limit the motion of the antenna.   The CW Range should be set to the azimuth position which is displayed when the antenna is at the CW limit. In a similar manner, the CCW Range should be set to the azimuth position which corresponds to the controller's azimuth counter-clockwise limit.

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

This value specifies the azimuth scale factor applicable to the potentiometer-based azimuth feedback. NOTE: The default value for this item will typically be correct.

PSF: **PULSE SCALE FACTOR <1-32767 PULSES/RAD>**

This item specifies the approximate number of pulses measured per radian of azimuth travel. See installation section 4.1.12 for calculation of the azimuth pulse scale factor. The azimuth pulse scale factor is used by inclined orbit tracking and autopeak algorithms for determining amount of movement (in pulses.)

ROFF: **RESOLVER OFFSET <+/-300.0 DEGREES>**

The azim_resolver_offset_item defines the offset to be applied to the angle read directly from the azimuth resolver for the purpose of displaying azimuth angle. Example: If when at the azimuth stow position the raw azimuth resolver angle reads 181.3, a azim_resolver_offset_item of -181.3 will result in a resolver based azimuth angle of 0.0.

DIR: **COUNT DIRECTION <0-NORMAL 1-REVERSED>**

The azim_pulse_count_reversed_item defines whether the polarity of the Azimuth resolver matches that of the RC4000 resolver circuitry. If the raw Azimuth resolver angle decreases as the mount moves CW, the DIR item must be described as reversed.

3.3.1.2.4 Polarization Calibration

```
         VREF:2.50  OFF:  0.0  CONFIG-POL
  CCW: -90.0  CW:  90.0  SF: 48.45  REF:0


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

VREF: ZERO DEG VOLTAGE <1.00-4.00 VOLTS>

The pol_reference_voltage defines the voltage present when the polarization axis is in its center of motion. See Polarization Calibration in section 4.1.4.

OFF: ANGLE OFFSET <+/-90.0 DEGREES>

The pol_offset item corrects for discrepancies between the polarization axis' electrical and mechanical alignment.

CCW: CCW LIMIT<+/-180.0 DEGREES>
CW: CW LIMIT<+/-180.0 DEGREES>

The ccw_pol_limit and cw_pol_limit configuration items specify the range of polarization axis movement. Both values are entered as positive values but the controller assigns the correct sign internally.

The values are used to check validity of stored satellite data and for calculating horizontal and vertical polarization positions. Actual polarization limits are set by potentiometers as described in the installation section.

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

This value specifies the scale factor applicable to the potentiometer-based polarization feedback. NOTE: The default value for this item will typically be correct.

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

The orientation achieved by placing the polarization axis in the reference position.

OPTIONAL MULTI-FEED OPERATION

When multiple, swappable feeds exist in a system, the multi-feed capability allows the ACU to detect and configure itself according to the currently attached feed. The multi-feed ("pol-id") scheme allows for unique properties, polarization movement, position indication, and even locate signal source. A maximum of 8 different configurations are possible. Some systems may be restricted to less than 8.

The multi-feed system is very flexible. All configuration screens that are related to polarization are expanded to allow for scrolling through each available feed index. This operation is similar to the location presets and satellite presets screens. The polarization configuration screen is modified as follows:

```
POL#:0  VREF:2.50  OFF:  0.0  CONFIG-POL
 CCW: -90.0  CW:  90.0  SF: 48.45  REF:0


<SCR> THRU LIST, <ENTER> TO MODIFY DATA
```

POL#:   Feed index Number

This is the zero-based feed index number. It is tied to the data on the screen. You may SCROLL through all available feed indexes using the SCROLL keys. Press ENTER to move the cursor to other data fields.

The feed index is sensed via Inputs A, B, and C from connector J13B -- pins 10, 12, and 14 respectively. The current state of these inputs can be viewed in the LIMITS maintenance screen.

```
AZIM CW:0  CCW:1  STOW:0 (0-OFF)   LIMITS
ELEV UP:1   DN:1  STOW:1 (1- ON)   ACTIVE
 POL CW:0  CCW:1  STOW:* A:1 B:1 C:0 D:0
<BKSP>MAKE LIMITS INACTIVE    <MODE>EXIT
```

The inputs are combined as bits to create a feed index. The MSB is Bit C (Input C) and the LSB is Bit A (Input A). For example, in the condition indicated above with the A=1, B=1, and C=0 the sensed feed index is 3.

The feed index, C|B|A bit pattern, and default feed identifier are shown in the following table:

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

3.3.1.2.5 Feed Definition

```
                                            CONFIG-FEED
TYPE:1    LO:10750
BAND:1
<0>CIRCULAR <1>SINGLE <2>DUAL
```

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

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

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

Single type specifies that the installation has a feed in just one orientation and therefore separate movements must be made to achieve horizontal and vertical polarization positions.

Dual type specifies that separate feeds exist 90 degrees apart. For this configuration just one movement to achieve both horizontal and vertical positions is required. If this is not the case the system should be described as a single feed type so that separate movements will be made.

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

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

LO: FEED LNB FREQ <0-30000 MHZ>

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

OPTIONAL MULTI-FEED OPERATION

Refer to section 3.3.1.2.4 Polarization Calibration. This following description is related to systems which implement a multi-feed scheme.

```
POL#:0                          CONFIG-FEED
TYPE:1   LO:10750
BAND:1   ID:KULP
<SCR> THRU LIST, <ENTER> TO MODIFY DATA
```

POL#:   **Feed index Number**

This is the zero-based feed index number. It is tied to the data on the screen. You may SCROLL through all available feed indexes using the SCROLL keys. Press ENTER to move the cursor to other data fields.

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

This is a 4-character alpha-numeric string that indentifies the feed in-use to the operator. When the multi-feed option is present these characters replace the "POL" that would otherwise be displayed in-front of the polarization angle while in MANUAL mode.

<u>3.3.1.2.6 Autopeak</u>

This screen defines how the autopeak functions of the LOCATE mode are configured.

```
                              CONFIG-AUTOPEAK
LOCATE SOURCE:8                         SCAN:2
  TARGET PEAK:2   POL AUTOMOVE:1    TILT:2
<0-NONE 1,2-RECx 5-RF 6-DVB 8-AUTO>
```

LOCATE SOURCE: **<0-NONE 1,2-RECx 5-RF 6-DVB 8-AUTO>**

The locate_source item defines if which source of input will be used for autopeak operations.

TARGET PEAK: **<0-NONE 1-EL 2-AZEL 3-AZELPL>**

The target_peak item defines if an additional peakup will be performed on the satellite after the standard azimuth autopeak has been completed. Refer to section 3.2.2.3.5 for discussion of this feature.

SCAN   **SCAN TRIES <1-3>**

This item specifies modified scan ranges that will be used if the original autopeak scan does not result in a successful auto-locate.

SCAN TRIES = 1 >> The controller will attempt only a single scan during LOCATE. The scan range is defined in the SS1/SS2/RF SIGNAL FACTORS screens.

SCAN TRIES = 2 >> The controller will attempt a single scan during LOCATE using the range defined in the SS1/SS2/RF SIGNAL FACTORS screens. If the first scan is unsuccessful, then the RC4000 will attempt a second scan that doubles the scan range.

SCAN TRIES = 3 >> The controller will attempt a single scan during LOCATE using the range defined in the /SS2/RF SIGNAL FACTORS screens. If the first scan is unsuccessful, then the RC4000 will attempt a second scan that doubles the scan range. If the second scan in unsuccessful, then the RC4000 will attempt a third scan that will move limit to limit in the Azimuth axis.

POL AUTOMOVE   **LOCATE AUTOMOVE <0>DISABLE <1>ENABLE**

This item lets the user specify whether or not the LOCATE mode should attempt to automatically orient the polarization axis.

TILT: **<0>OFF <1>INCLIN <2>3-AXIS COMPASS**

This item specifies if additional movements are to be made during the LOCATE function in order to characterize the pitch and roll of the platform.   Refer to section 3.2.2.3.6 for discussion of this feature.

OPTIONAL MULTI-FEED OPERATION

Refer to <u>section 3.3.1.2.4</u> Polarization Calibration. This following description is related to systems which implement a multi-feed scheme.

```
┌────────────────────────────────────────┐
│ POL#:0                   CONFIG-AUTOPEAK│
│ LOCATE SOURCE:8                   SCAN:2│
│   TARGET PEAK:2  POL AUTOMOVE:1   TILT:2│
│ <SCR> THRU LIST,  <ENTER> TO MODIFY DATA│
└────────────────────────────────────────┘
```

POL#:   **Feed index Number**

This is the zero-based feed index number. It is tied to the data on the screen. You may SCROLL through all available feed indexes using the SCROLL keys. Press ENTER to move the cursor to other data fields.

3.3.1.2.7 SS1 Signal Strength Factors

This screen defines how the signal strength inputs are used. See sections 2.1.2.2.3 and 2.1.2.4.2 for references to the use of signal strength inputs and section 4.1.11 for information regarding calibration.

```
    LOCK:1          TIME:1.0      CONFIG-SS1
   THRES:  10      SENSE:1
  SCAN RG:10      SRCH AZ: 5    SRCH EL: 5
  LOCK TYPE <0>NONE <1>HI <2>LO
```

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

When the autopeak source is the SS1 input, this item defines whether a discrete signal lock input is required to indicate a satellite has been found. The signal lock input may help in distinguishing the correct satellite while doing a LOCATE.

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

TIME: LOCK TIME <0.0-10.0> SECONDS

This item defines how long the RC4000 will wait after each step before sampling signal strength. Increasing this value may be required to allow equipment such as a modem to generate an AGC output.

THRES: SCAN SLOW THRESHOLD <0-1000>

The threshold item defines what the minimum signal strength indication for the channel is required for the tracking system to "recognize" that a satellite is present. **NOTE: these items are only applicable to TRACK mode.** When the signal strength reaches this threshold level, the scan movement will transition from fast to slow speed.

If different bands are received that exhibit different "off satellite" signal strengths, the highest "off satellite" value should be used to avoid the possibility of recognizing noise as a satellite.

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

The polarity flag tell the controller what the sense is on the signal strength input voltage used for tracking and autopeak operations. A positive sense is defined as one that increases in magnitude as the RF signal strength increases. If the signal strength voltage decreases as the RF signal increases, its polarity is considered negative.

SCAN RG: SCAN RANGE <1-90 DEGREES>

The scan_range item defines how many degrees to either side of the nominal azimuth target the scan autopeak operation will search.

SRCH AZ: SPIRAL SEARCH AZIM LIMIT <1 – 20 DEGREES>
SRCH EL: SPIRAL SEARCH ELEV LIMIT <1 – 15 DEGREES>

The search_azim/elev_limit items define the area that the spiral search pattern is allowed to search to recognize a satellite. If a satellite is not recognized after searching the area defined by these limits, the spiral search will return to the normal target position. The larger the limits, the longer time a search might take. If the limits are too small to account for azimuth target inaccuracy due to heading error or to account for the amount of elevation movement an inclined orbit satellite may exhibit, the spiral search may quit before moving over the satellite.

3.3.1.2.8 SS2 Signal Strength Factors

This screen defines how the signal strength inputs are used. See sections 2.1.2.2.3 and 2.1.2.4.2 for references to the use of signal strength inputs and section 4.1.11 for information regarding calibration.

```
    LOCK:0          TIME:1.0        CONFIG-SS2
   THRES:2800        POL:0
  SCAN RG: 8     SRCH AZ: 3    SRCH EL: 3
  LOCK TYPE <0>NONE <1>HI <2>LO
```

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

When the autopeak source is the SS1 input, this item defines whether a discrete signal lock input is required to indicate a satellite has been found. The signal lock input may help in distinguishing the correct satellite while doing a LOCATE.

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

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

This item defines how long the RC4000 will wait after each step before sampling signal strength. Increasing this value may be required to allow equipment such as a modem to generate an AGC output.

THRES: **SCAN SLOW THRESHOLD <0-1000>**

The threshold item defines what the minimum signal strength indication for the channel is required for the tracking system to "recognize" that a satellite is present. **NOTE: these items are only applicable to TRACK mode.** When the signal strength reaches this threshold level, the scan movement will transition from fast to slow speed.

If different bands are received that exhibit different "off satellite" signal strengths, the highest "off satellite" value should be used to avoid the possibility of recognizing noise as a satellite.

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

The polarity flag tell the controller what the sense is on the signal strength input voltage used for tracking and autopeak operations. A positive sense is defined as one that increases in magnitude as the RF signal strength increases. If the signal strength voltage decreases as the RF signal increases, its polarity is considered negative.

SCAN RG: **SCAN RANGE <1-90 DEGREES>**

The scan_range item defines how many degrees to either side of the nominal azimuth target the scan autopeak operation will search.

SRCH AZ: **SPIRAL SEARCH AZIM LIMIT <1 – 20 DEGREES>**
SRCH EL: **SPIRAL SEARCH ELEV LIMIT <1 – 15 DEGREES>**

The search_azim/elev_limit items define the area that the spiral search pattern is allowed to search to recognize a satellite. If a satellite is not recognized after searching the area defined by these limits, the spiral search will return to the normal target position. The larger the limits, the longer time a search might take. If the limits are too small to account for azimuth target inaccuracy due to heading error or to account for the amount of elevation movement an inclined orbit satellite may exhibit, the spiral search may quit before moving over the satellite.

3.3.1.2.9 RF Signal Strength Factors

This screen defines how the L-Band power detector (RF) input is used. See section 2.1.2.4.8 for references to the use of signal strength inputs and section 4.1.11 for information regarding calibration.

```
                                    CONFIG-RF
     LOCK:0        THRES: 200
 SCAN RG:10     SRCH AZ: 5     SRCH EL: 5
 LOCK SOURCE <0-NONE 1-SS1 2-SS2>
```

LOCK: LOCK SOURCE <0-NONE 1-SS1 2-SS2>

When the autopeak source is the RF input, this item defines whether a discrete signal lock input is required to indicate a satellite has been found. The signal lock input may help in distinguishing the correct satellite while doing a LOCATE.

If a signal lock input is used, it must be defined in the SS1 or SS2 SIG FACTORS.

THRES: SCAN SLOW THRESHOLD <0-500>

This item defines the amount of displayed value (of RF signal strength) above the average noise floor reading that indicates the antenna is passing across a satellite. When the RF signal strength reaches this threshold level, the scan movement will transition from fast to slow speed.

SCAN RG: SCAN RANGE <1 – 90 DEGREES>

The scan_range item defines how many degrees to either side of the nominal azimuth target the scan autopeak operation will search.

SRCH AZ: SPIRAL SEARCH AZIM LIMIT <1 – 20 DEGREES>
SRCH EL: SPIRAL SEARCH ELEV LIMIT <1 – 15 DEGREES>

The search_azim/elev_limit items define the area that the spiral search pattern is allowed to search to recognize a satellite. If a satellite is not recognized after searching the area defined by these limits, the spiral search will return to the normal target position. The larger the limits, the longer time a search might take. If the limits are too small to account for azimuth target inaccuracy due to heading error or to account for the amount of elevation movement an inclined orbit satellite may exhibit, the spiral search may quit before moving over the satellite.

3.3.1.3 Super-User Access Items

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

3.3.1.3.1 Reset Defaults

```
RESET CODE:      0        CONFIG-DEFAULTS



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

The CONFIG-DEFAULTS screen is used to reset the controller's memory. Access to this item is allowed only when the Expert Access level is set to SUPER-USER. To reset the system memory, the user must key in a 5 digit code followed by the ENTER key.

There are two levels of resets that are possible. A first level reset clears NVRAM values including the current selected satellite, the saved position, stored satellite data, and track table data. A full reset clears the NVRAM data and resets all FLASH configuration values to default values.

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

3.3.1.3.2 Azimuth Angle Movement

The CONFIG-AZ ANG screen contains configuration items for calibrating large automatic azimuth movements based on angle (potentiometer or resolver-based) position feedback. See the Drive System theory [section 4.3.3](#).

```
                               CONFIG-AZ ANG
FAST/SLOW: 2.5        COAST:0.2
MAX ERROR:0.20       TRIES:  3
FAST/SLOW THRESHOLD <0.0-10.0 DEGREES>
```

FAST/SLOW: **FAST/SLOW THRESHOLD <0.0-10.0 DEGREES>**

During an automatic move, the azim_fast_slow_threshold configuration item is used to set the number of degrees before a target position is reached when the controller switches the speed of the drive from fast to slow.

MAX ERROR: **MAX ERROR <0.01 - 1.00 DEGREES>**

The azim_max_position_error configuration item sets the maximum acceptable error between the final resting position and a target position during an automatic move.

COAST: **COAST RANGE <0.0 - 2.0 DEGREES>**

During an automatic move, the azim_coast_threshold configuration item sets the number of degrees before the target position is reached where the drive will be deactivated. The idea is to deactivate the drive and let the antenna coast into position. If prior to the initiation of the move operation, the total number of degrees that the actuator has to move to reach the target position is less than the *'Coast Threshold'*, the drive will be deactivated when its position is within *'Max Position Error'* of the target position.

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

The azim_auto_move_max_retry_cnt configuration item sets the maximum number of attempts which will be made to hit a target position (within **Max Error** - described above) during an automatic move based on angle feedback.

3.3.1.3.3 Azimuth Count Movement

The CONFIG-AZ PULSE screen contains items for configuring automatic movements based on sensor count (resolver or pulse) azimuth position feedback.

```
                              CONFIG_AZ COUNT
FAST/SLOW: 50        COAST:  2
MAX ERROR: 2         TRIES: 3
FAST/SLOW THRESHOLD <0 - 999 PULSES)
```

FAST/SLOW: FAST/SLOW THRESHOLD <0 - 999 PULSES>

During an automatic move, the azim_fast_slow_pulse_threshold configuration item is used to set the number of pulses before a target position is reached when the controller switches the speed of the drive from fast to slow.

COAST: COAST RANGE <0 - 999 PULSES>

During an automatic move, the azim_coast_pulse_threshold configuration item sets the number of pulses before the target position is reached where the drive will be deactivated. The idea is to deactivate the drive and let the antenna coast into position. If prior to the initiation of the move operation, the total number of degrees that the actuator has to move to reach the target position is less than the *'Coast Threshold'*, the drive will be deactivated when its position is within *'Max Error'* of the target position.

MAX ERROR: MAXIMUM ERROR <0 - 10 PULSES>

The azim_max_position_pulse_error configuration item sets the maximum acceptable error between the final resting position and a target position during an automatic move.

TRIES: MAX NUMBER OF TRIES <0 - 10>

The azim_auto_move_max_retry_pulse_cnt configuration item sets the maximum number of attempts which will be made to hit a target position (within **Max Error** - described above) during an automatic move based on pulse count feedback.

3.3.1.3.4 Azimuth Drive Parameters

The CONFIG-AZ DRV screen contains configuration items for customizing the characteristics of the motor drive for the Azimuth axis.

```
      FAST:100  ACC:250    CONFIG-AZ DRV
      SLOW: 20  DEC:250 JAM: 0.2 FDB: 750
       CL: 70   IR:  5 RUN: 2.0 SDB: 500
FAST VOLTAGE <0-100 % OF MAX>
```

FAST: **FAST VOLTAGE <0-100 % OF MAX>**
SLOW: **SLOW VOLTAGE <0-100 % OF MAX>**

The FAST/SLOW setting represents the percentage of maximum voltage that the motor drive will output to the motor for the azimuth axis based upon the current speed (FAST or SLOW). The motor drive of the RC4000 will supply 24VDC by default. The output voltage is decreased by way of pulse width modulation.

CL: **CURRENT LIMIT <0-10 AMPSx10, 0=OFF >**

The RC4000 motor drive can supply up to 10 Amps. The current limit setting is a value between 0 to 100 and the unit of measure is tenths of an Amp. For example, if the desired current limit for the Azimuth axis is 7.5 Amps, then enter a value of 75 (7.5 x 10 = 75.) Or the desired current limit is 10 Amps, then enter a value of 100 (10 x 10 = 100.)

ACC: **ACCELERATION <0-999 MSEC>**
DEC: **DECELERATION <0-999 MSEC>**

The ACC and DEC settings represent the acceleration and deceleration times respectively. This represents the time it takes (in milliseconds) to ramp from 0 to 24VDC during acceleration or to ramp from 24 to 0VDC in deceleration. If the Fast or Slow motor speeds are less than 24VDC, the ramp time is a percentage of the maximum based upon the percentage of maximum voltage at the set speed. The ACC and DEC values should be set before a COAST RANGE is set (refer to section 3.3.1.3.2 and 3.3.1.3.3.)

IR: **IR COMPENSATION <0-100 UNITS, 0=OFF)**

The IR setting adjusts the IR Compensation of the motor drive system. The default value of IR Compensation is 0 and can be adjusted higher as needed. This value adjusts gain in the motor drive that counteracts the impedance of the system.

JAM :   **JAM SLOP <0.0-10.0 DEG, 0.0=OFF>**

The azim_jam_slop_item specifies the amount of sensed movement the controller wants to see before declaring a jam condition. See the Drive System theory section 4.3.3.

The unit of measure of the entered value is in hundredths of a degree (0.01 deg).

The value should be set to avoid nuisance jams but allow a jam to be declared within a reasonable amount of time to avoid damage to the system. Too high of a value will trigger false jam conditions since the mount may sometimes not be able to move that far in the required interval. Too low of a value may allow mechanical slop in the system to appear as valid movement thus never triggering a jam.

Setting the value to 0.0 will disable the jam sensing since no movement will be required to be sensed to make the jam system think the mount has moved when it should. This may be a useful thing to do in emergency situations to alleviate unwanted jam declarations but should only be done temporarily vs. having an active jam sensing system.

RUN: RUNAWAY SLOP <0.0-10.0 DEG, 0.0=OFF>

The azim_runaway_slop_item specifies the amount of movement that may be sensed before a runaway condition is declared when the antenna is not supposed to be moving.

The unit of measure of the entered value is in hundredths of a degree (0.01 deg). If the installation has pulse-based sensing this value will indicate the number of pulses the system may see before declaring a runaway.

If the entered value is too low, normal noise from the fundamental position sensor or slight movement due to wind may trigger a runaway. If the value is too high, it may take a long time to generate a runaway.

Setting this value to 0 will disable the runaway sensing. (The RC3000 used the maximum value to disable runaway sensing.)

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

The azim_fast_deadband_msec and azim_slow_deadband_msec items are used for the anti-reversal system. To understand the purpose of these parameters, it is necessary to consider how position counts are accumulated. The feedback from the azimuth and elevation position sensors is pulses. When a pulse is received, the controller checks to see which way the antenna was last commanded to move. If the antenna is moving, or last moved, east (down), the azimuth (elevation) position count is decremented. If the antenna is moving, or last moved, west (up) the azimuth (elevation) position count is incremented.

In MANUAL mode, the user can jog the antenna. If the UP arrow key is depressed, the antenna will move up. If the user suddenly depresses the DOWN arrow key and the antenna drive signals were instantaneously reversed, the antenna continues to move up for some small period of time, then the antenna reverses direction and starts to move down. This can cause position count errors. When the antenna drive signals are configured for down movement but the antenna is still moving up, pulses which are received would cause the elevation position count to decrement when the count should really be incremented because the antenna is really still moving up.

The anti-reversal system keeps the antenna from rapidly changing direction. If the antenna has been moving in a given direction, the *'Deadband* CONFIG mode items specify the amount of time that the system will wait before asserting the antenna drive lines to move the antenna in the opposite direction. There are 2 different *'Deadband* values specified - there are unique fast and slow speed values. If the antenna has been moving fast, the *'Fast Deadband* parameters specify the wait interval; if the antenna has been moving slow, the *'Slow Deadband* parameters specify the wait interval. Both *'Deadband* values are given in milliseconds.

3.3.1.3.5 Elevation Angle Movement

The CONFIG-EL ANG screen contains configuration items for calibrating large automatic elevation movements based on angle (inclinometer or resolver-based) position feedback. See the Drive System theory section 4.3.3.

```
                                   CONFIG-EL ANG
FAST/SLOW: 2.5       COAST:0.5
MAX ERROR:0.20       TRIES: 3
FAST/SLOW THRESHOLD <0.0-10.0 DEGREES>
```

FAST/SLOW: **FAST/SLOW THRESHOLD <0.0-10.0 DEGREES>**

During an automatic move, the elev_fast_slow_threshold configuration item is used to set the number of degrees before a target position is reached when the controller switches the speed of the drive from fast to slow.

MAX ERROR: **MAX ERROR <0.01 - 1.00 DEGREES>**

The elev_max_position_error configuration item sets the maximum acceptable error between the final resting position and a target position during an automatic move.

COAST: **COAST RANGE <0.0 - 2.0 DEGREES>**

During an automatic move, the elev_coast_threshold configuration item sets the number of degrees before the target position is reached where the drive will be deactivated. The idea is to deactivate the drive and let the antenna coast into position. If prior to the initiation of the move operation the total number of degrees that the actuator has to move to reach the target position is less than the *'Coast Threshold*, the drive will be deactivated when its position is within *'Max Position Error* of the target position.

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

The elev_auto_move_max_retry_cnt configuration item sets the maximum number of attempts which will be made to hit a target position (within **Max Error** - described above) during an automatic move based on potentiometer feedback.

3.3.1.3.6 Elevation Count Movement

```
                              CONFIG_EL COUNT
FAST/SLOW: 50 COAST:   4
MAX ERROR: 2   TRIES: 3
FAST/SLOW THRESHOLD <0 – 999 PULSES>
```

FST/SLW: FAST/SLOW THRESHOLD <0 - 999 PULSES>

During an automatic move, the elev_fast_slow_pulse_threshold configuration item is used to set the number of pulses before a target position is reached when the controller switches the speed of the drive from fast to slow.

COAST: COAST RANGE <0 - 999 PULSES>

During an automatic move, the elev_coast_pulse_threshold configuration item sets the number of pulses before the target position is reached where the drive will be deactivated. The idea is to deactivate the drive and let the antenna coast into position. If prior to the initiation of the move operation, the total number of degrees that the actuator has to move to reach the target position is less than the *'Coast Threshold*, the drive will be deactivated when its position is within *'Max Error* of the target position.

MAX ERR: MAXIMUM ERROR <0 - 10 PULSES>

The elev_max_position_pulse_error configuration item sets the maximum acceptable error between the final resting position and a target position during an automatic move.

TRIES: MAX NUMBER OF TRIES <0 - 10>

The elev_auto_move_max_retry_pulse_cnt configuration item sets the maximum number of attempts which will be made to hit a target position (within **Max Error** - described above) during an automatic move based on potentiometer feedback.

3.3.1.3.7 Elevation Drive Parameters

The CONFIG-EL DRV screen contains configuration items for customizing the characteristics of the motor drive for the Elevation axis.

```
       FAST:100  ACC:250     CONFIG-EL DRV
       SLOW: 17  DEC:250 JAM: 0.2 FDB: 750
         CL:100   IR: 14 RUN: 2.0 SDB: 500
FAST VOLTAGE <0-100 % OF MAX>
```

FAST: **FAST VOLTAGE <0-100 % OF MAX>**
SLOW: **SLOW VOLTAGE <0-100 % OF MAX>**

The FAST/SLOW setting represents the percentage of maximum voltage that the motor drive will output to the motor for the elevation axis based upon the current speed (FAST or SLOW). The motor drive of the RC4000 will supply 24VDC by default. The output voltage is decreased by way of pulse width modulation.

CL: **CURRENT LIMIT <0-10 AMPSx10, 0=OFF >**

The RC4000 motor drive can supply up to 10 Amps. The current limit setting is a value between 0 to 100 and the unit of measure is tenths of an Amp. For example, if the desired current limit for the Elevation axis is 7.5 Amps, then enter a value of 75 (7.5 x 10 = 75.) Or the desired current limit is 10 Amps, then enter a value of 100 (10 x 10 = 100.)

ACC: **ACCELERATION <0-999 MSEC>**
DEC: **DECELERATION <0-999 MSEC>**

The ACC and DEC settings represent the acceleration and deceleration times respectively. This represents the time it takes (in milliseconds) to ramp from 0 to 24VDC during acceleration or to ramp from 24 to 0VDC in deceleration. If the Fast or Slow motor speeds are less than 24VDC, the ramp time is a percentage of the maximum based upon the percentage of maximum voltage at the set speed. The ACC and DEC values should be set before a COAST RANGE is set (refer to section 3.3.1.3.5 and 3.3.1.3.6.)

IR: **IR COMPENSATION <0-100 UNITS, 0=OFF)**

The IR setting adjusts the IR Compensation of the motor drive system. The default value of IR Compensation is 0 and can be adjusted higher as needed. This value adjusts gain in the motor drive that counteracts the impedance of the system.

JAM :   **JAM SLOP <0.0-10.0 DEG, 0.0=OFF>**

The elev_jam_slop_item specifies the amount of sensed movement the controller wants to see before declaring a jam condition. See the Drive System theory section 4.3.3.

The unit of measure of the entered value is in hundredths of a degree (0.01 deg).

The value should be set to avoid nuisance jams but allow a jam to be declared within a reasonable amount of time to avoid damage to the system. Too high of a value will trigger false jam conditions since the mount may sometimes not be able to move that far in the required interval. Too low of a value may allow mechanical slop in the system to appear as valid movement thus never triggering a jam.

Setting the value to 0.0 will disable the jam sensing since no movement will be required to be sensed to make the jam system think the mount has moved when it should. This may be a useful thing to do in emergency situations to alleviate unwanted jam declarations but should only be done temporarily vs. having an active jam sensing system.

RUN: RUNAWAY SLOP <0.0-10.0 DEG, 0.0=OFF>

The elev_runaway_slop_item specifies the amount of movement that may be sensed before a runaway condition is declared when the antenna is not supposed to be moving.

The unit of measure of the entered value is in hundredths of a degree (0.01 deg). If the installation has pulse-based sensing this value will indicate the number of pulses the system may see before declaring a runaway.

If the entered value is too low, normal noise from the fundamental position sensor or slight movement due to wind may trigger a runaway. If the value is too high, it may take a long time to generate a runaway.

Setting this value to 0 will disable the runaway sensing. (The RC3000 used the maximum value to disable runaway sensing.)

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

The elev_fast_deadband_msec and elev_slow_deadband_msec items are used for the anti-reversal system. To understand the purpose of these parameters, it is necessary to consider how position counts are accumulated. The feedback from the azimuth and elevation position sensors is pulses. When a pulse is received, the controller checks to see which way the antenna was last commanded to move. If the antenna is moving, or last moved, east (down), the azimuth (elevation) position count is decremented. If the antenna is moving, or last moved, west (up) the azimuth (elevation) position count is incremented.

In MANUAL mode, the user can jog the antenna. If the UP arrow key is depressed, the antenna will move up. If the user suddenly depresses the DOWN arrow key and the antenna drive signals were instantaneously reversed, the antenna continues to move up for some small period of time, then the antenna reverses direction and starts to move down. This can cause position count errors. When the antenna drive signals are configured for down movement but the antenna is still moving up, pulses which are received would cause the elevation position count to decrement when the count should really be incremented because the antenna is really still moving up.

The anti-reversal system keeps the antenna from rapidly changing direction. If the antenna has been moving in a given direction, the *'Deadband* CONFIG mode items specify the amount of time that the system will wait before asserting the antenna drive lines to move the antenna in the opposite direction. There are 2 different *'Deadband* values specified - there are unique fast and slow speed values. If the antenna has been moving fast, the *'Fast Deadband* parameters specify the wait interval; if the antenna has been moving slow, the *'Slow Deadband* parameters specify the wait interval. Both *'Deadband* values are given in milliseconds.

3.3.1.3.8 Polarization Angle Movement

The CONFIG-POL ANG screen contains configuration items for calibrating polarization movements based on potentiometer position feedback. See the Drive System theory section 4.3.3.

```
                              CONFIG-POL ANG
FAST/SLOW: 1.0      COAST:0.1
MAX ERROR:0.10      TRIES: 3
FAST/SLOW THRESHOLD <0.0-10.0 DEGREES)
```

FAST/SLOW: **FAST/SLOW THRESHOLD <0.0-10.0 DEGREES>**

During an automatic move, the pol_fast_slow_threshold configuration item is used to set the number of degrees before a target position is reached when the controller switches the speed of the drive from fast to slow.

MAX ERROR: **MAX ERROR <0.01 - 1.00 DEGREES>**

The pol_max_position_error configuration item sets the maximum acceptable error between the final resting position and a target position during an automatic move.

COAST: **COAST RANGE <0.0 - 2.0 DEGREES>**

During an automatic move, the pol_coast_threshold configuration item sets the number of degrees before the target position is reached where the drive will be deactivated. The idea is to deactivate the drive and let the antenna coast into position. If prior to the initiation of the move operation, the total number of degrees that the actuator has to move to reach the target position is less than the *'Coast Threshold*, the drive will be deactivated when its position is within *'Max Position Error* of the target position.

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

The pol_auto_move_max_retry_cnt configuration item sets the maximum number of attempts which will be made to hit a target position (within **Max Error** - described above) during an automatic move based on potentiometer feedback.

OPTIONAL MULTI-FEED OPERATION

Refer to section 3.3.1.2.4 Polarization Calibration. This following description is related to systems which implement a multi-feed scheme.

```
POL#:0                         CONFIG-POL ANG
FAST/SLOW: 1.0       COAST:0.1
MAX ERROR:0.10       TRIES: 3
<SCR> THRU LIST,  <ENTER> TO MODIFY DATA
```

POL#:   Feed index Number

This is the zero-based feed index number. It is tied to the data on the screen. You may SCROLL through all available feed indexes using the SCROLL keys. Press ENTER to move the cursor to other data fields.

3.3.1.3.9 Pol Drive Parameters

The CONFIG-POL DRV screen contains configuration items for customizing the characteristics of the motor drive for the Azimuth axis.

```
         FAST:100  ACC:100    CONFIG-POL DRV
         SLOW: 50  DEC:100 JAM: 0.2 FDB: 250
           CL: 20   IR:  5 RUN: 2.0 SDB: 100
FAST VOLTAGE <0-100 % OF MAX>
```

FAST: **FAST VOLTAGE <0-100 % OF MAX>**
SLOW: **SLOW VOLTAGE <0-100 % OF MAX>**

The FAST/SLOW setting represents the percentage of maximum voltage that the motor drive will output to the motor for the polarization axis based upon the current speed (FAST or SLOW). The motor drive of the RC4000 will supply 24VDC by default. The output voltage is decreased by way of pulse width modulation.

CL: **CURRENT LIMIT <0-10 AMPSx10, 0=OFF >**

The RC4000 motor drive can supply up to 10 Amps. The current limit setting is a value between 0 to 100 and the unit of measure is tenths of an Amp. For example, if the desired current limit for the Polarization axis is 7.5 Amps, then enter a value of 75 (7.5 x 10 = 75.) Or the desired current limit is 10 Amps, then enter a value of 100 (10 x 10 = 100.)

ACC: **ACCELERATION <0-999 MSEC>**
DEC: **DECELERATION <0-999 MSEC>**

The ACC and DEC settings represent the acceleration and deceleration times respectively. This represents the time it takes (in milliseconds) to ramp from 0 to 24VDC during acceleration or to ramp from 24 to 0VDC in deceleration. If the Fast or Slow motor speeds are less than 24VDC, the ramp time is a percentage of the maximum based upon the percentage of maximum voltage at the set speed. The ACC and DEC values should be set before a COAST RANGE is set (refer to section 3.3.1.3.8.)

IR: **IR COMPENSATION <0-100 UNITS, 0=OFF)**

The IR setting adjusts the IR Compensation of the motor drive system. The default value of IR Compensation is 0 and can be adjusted higher as needed. This value adjusts gain in the motor drive that counteracts the impedance of the system.

JAM :   **JAM SLOP <0.0-10.0 DEG, 0.0=OFF>**

The pol_jam_slop_item specifies the amount of sensed movement the controller wants to see before declaring a jam condition. See the Drive System theory section 4.3.3.

The unit of measure of the entered value is in hundredths of a degree (0.01 deg).

The value should be set to avoid nuisance jams but allow a jam to be declared within a reasonable amount of time to avoid damage to the system. Too high of a value will trigger false jam conditions since the mount may sometimes not be able to move that far in the required interval. Too low of a value may allow mechanical slop in the system to appear as valid movement thus never triggering a jam.

Setting the value to 0.0 will disable the jam sensing since no movement will be required to be sensed to make the jam system think the mount has moved when it should. This may be a useful thing to do in emergency situations to alleviate unwanted jam declarations but should only be done temporarily vs. having an active jam sensing system.

RUN:　　　　　**RUNAWAY SLOP <0.0-10.0 DEG, 0.0=OFF>**

The pol_runaway_slop_item specifies the amount of movement that may be sensed before a runaway condition is declared when the antenna is not supposed to be moving.

The unit of measure of the entered value is in hundredths of a degree (0.01 deg). If the installation has pulse-based sensing this value will indicate the number of pulses the system may see before declaring a runaway.

If the entered value is too low, normal noise from the fundamental position sensor or slight movement due to wind may trigger a runaway. If the value is too high, it may take a long time to generate a runaway.

Setting this value to 0 will disable the runaway sensing. (The RC3000 used the maximum value to disable runaway sensing.)

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

The pol_fast_deadband_msec and pol_slow_deadband_msec items are used for the anti-reversal system. To understand the purpose of these parameters, it is necessary to consider how position counts are accumulated. The feedback from the polarization position sensor is pulses. When a pulse is received, the controller checks to see which way the feed was last commanded to move. If the feed is moving, or last moved, CCW, the polarization position count is decremented. If the feed is moving, or last moved, CW, the polarization position count is incremented.

In MANUAL mode, the user can jog the antenna and feed. If the Pol CW arrow key is depressed, the antenna controller will move the feed clockwise. If the user suddenly depresses the Pol CCW key and the feed drive signals were instantaneously reversed, the feed continues to move clockwise for some small period of time, then the feed reverses direction and starts to move counter-clockwise. This can cause position count errors. When the feed drive signals are configured for clockwise movement but the feed is still moving counter-clockwise, pulses which are received would cause the polarization position count to increment when the count should really be decremented because the feed is really still moving counter-clockwise.

The anti-reversal system keeps the antenna from rapidly changing direction. If the antenna has been moving in a given direction, the *'Deadband* CONFIG mode items specify the amount of time that the system will wait before asserting the antenna drive lines to move the antenna in the opposite direction. There are 2 different *'Deadband* values specified - there are unique fast and slow speed values. If the antenna has been moving fast, the *'Fast Deadband* parameters specify the wait interval; if the antenna has been moving slow, the *'Slow Deadband* parameters specify the wait interval. Both *'Deadband* values are given in milliseconds.

OPTIONAL MULTI-FEED OPERATION

Refer to <u>section 3.3.1.2.4</u> Polarization Calibration. This following description is related to systems which implement a multi-feed scheme.

```
POL#:0 FST:100 ACC:100    CONFIG-POL DRV
       SLW: 50 DEC:100 JAM: 0.2 FDB: 250
       CL: 20   IR:  5 RUN: 2.0 SDB: 100
<SCR> THRU LIST, <ENTER> TO MODIFY DATA
```

POL#:   Feed index Number

This is the zero-based feed index number. It is tied to the data on the screen. You may SCROLL through all available feed indexes using the SCROLL keys. Press ENTER to move the cursor to other data fields.

3.3.1.3.10 Stow & Deploy Positions

The STOW & DEPLOY group allows the user to change the target positions for STOW and DEPLOY movements.

```
AZ_STW:   0.0 AZ_DEP:   0.0  CONFIG-STOW
EL_STW: -67.5 EL_DEP:  17.3  SNUG: 0.0
PL_STW:   0.0 PL_DEP:   0.0  PL_MOVE:0
AZIMUTH STOW <-180.0/180.0>
```

AZ_STW: **AZIMUTH STOW <-180.0/180.0>**
EL_STW: **ELEVATION STOW <-90.0/120.0>**
PL_STW: **POL STOW <-180.0/180.0>**

These items define the STOW position.

AZ_DEP: **AZIMUTH DEPLOY<-180.0/180.0>**
EL_DEP: **ELEVATION DEPLOY <-90.0/90.0>**
PL_DEP: **POL DEPLOY <-180.0/180.0>**

These items define the DEPLOY position.

SNUG: **ELEV STOW DELAY TIME <0.0-10.0 SECS>**

On certain mounts there needs to be a delay between the time that the elevation stow limit is sensed and when the elevation motor is deenergized. For mounts where this is not the case, this item is ignored by setting to 0.0 seconds.

PL_MOVE: **POL MOVE<0-NONE 1-STOW 2-DEPLOY 3-BOTH>**

This item defines whether or not the polarization axis is moved during a STOW and/or DEPLOY.

0 – the polarization axis will not be moved as part of either STOW or DEPLOY

1 – polarization will move to the PL_STW position as part of STOW (no DEPLOY movement)

2 – polarization will move to the PL_DEP position as part of DEPLOY (no STOW movement)

3 – polarization will move during both STOW and DEPLOY

NOTE: the default value is to have polarization move during DEPLOY to be consistent with earlier versions of the software. Default STOW movement is per mount type.

STOW & DEPLOY WITH OPTIONAL MULTI-FEED OPERATION

Refer to section 3.3.1.2.4 Polarization Calibration. This following description is related to systems which implement a multi-feed scheme.

When a multi-feed scheme is in use, the STOW & DEPLOY screen is split into two separate CONFIG mode screens. The first screen is used to set the AZ and EL stow and deploy positions, the second screen is used to set the POL stow and deploy positions for each feed type implemented.

AZ/EL STOW & DEPLOY

The AZ/EL STOW & DEPLOY group allows the user to change the target positions for STOW and DEPLOY movements for the azimuth and elevation axes.

```
AZ_STW:   0.0 AZ_DEP:   0.0  CONFIG-STOW
EL_STW: -67.5 EL_DEP:  18.5  SNUG: 4.0


AZIMUTH STOW <-180.0/180.0>
```

AZ_STW: **AZIMUTH STOW <-180.0/180.0>**
EL_STW: **ELEVATION STOW <-90.0/120.0>**

These items define the STOW position.

AZ_DEP: **AZIMUTH DEPLOY<-180.0/180.0>**
EL_DEP: **ELEVATION DEPLOY <-90.0/90.0>**

These items define the DEPLOY position.

SNUG: **ELEV STOW DELAY TIME <0.0-10.0 SECS>**

OR

SNUG: **ELEV STOW CURRENT LIMIT <0.0-10.0 AMPS>**

On certain mounts there needs to be a delay between the time that the elevation stow limit is sensed and when the elevation motor is de-energized. For mounts where this is not the case, this item is ignored by setting to 0.0 seconds.

Alternatively, on antennas which implement a current-based stow, the SNUG item represents the amount of current output to the elevation motor that must be reached after the antenna reaches the stow limit for the motor to be de-energized.

POL STOW & DEPLOY

The POL STOW & DEPLOY group allows the user to change the target positions for STOW and DEPLOY movements for the polarization axis.

```
POL#:0                            CONFIG-STOW


PL_STW:   0.0 PL_DEP:   0.0  PL_MOVE:3
<SCR> THRU LIST, <ENTER> TO MODIFY DATA
```

PL_STW: **POL STOW <-180.0/180.0>**

These items define the STOW position.

PL_DEP: **POL DEPLOY <-180.0/180.0>**

These items define the DEPLOY position.

PL_MOVE: **POL MOVE<0-NONE 1-STOW 2-DEPLOY 3-BOTH>**

This item defines whether or not the polarization axis is moved during a STOW and/or DEPLOY.

0 – the polarization axis will not be moved as part of either STOW or DEPLOY

1 – polarization will move to the PL_STW position as part of STOW (no DEPLOY movement)

2 – polarization will move to the PL_DEP position as part of DEPLOY (no STOW movement)

3 – polarization will move during both STOW and DEPLOY

NOTE: the default value is to have polarization move during DEPLOY to be consistent with earlier versions of the software. Default STOW movement is per mount type.

3.3.1.3.11 SHAKE

```
AZ 1: -40.0 2:  50.0 3:   0.0 CONF-SHAKE
EL 1:  30.0 2:  40.0 3: -67.5 CYCLE: 100
PL 1: -10.0 2:  10.0 3:   0.0 DELAY:  15
MOVE 1 AZIM <-180.0/180.0>
```

AZ #:   **MOVE # AZIM <-180.0/180.0>**

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

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

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

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

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

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

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

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

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

3.3.2 Maintenance Items

```
1-VOLTS    2-DRIVE   3-TIME          MAINT
5-LIMITS   6-GPS COM 7-CMP COM 8-MOVETO
9-FG CAL   0-SHAKE
                             .-SYS INFO
```

This screen provides a menu system for selecting the various maintenance screens described in the following paragraphs. Pressing the Mode key from this screen will return the controller to the CONFIG-MENU screen.

Note that if expert access is not enabled, selections 9 (fluxgate calibration) and 0 (shake) are not made available.

3.3.2.1 Analog to Digital Voltage

The AD VOLTAGES maintenance screen shows the current voltage levels sensed at the microcontroller's analog to digital inputs. There are too many input channels to show all voltages on one screen, so the user is prompted to choose either 10 bit or 12 bit resolution voltages.

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

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

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

3.3.2.1.1 10 Bit ADC Voltages

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

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

```
1- SAC:1.590   493   5-  RF:0.106    38 ADC
2-TEMP:3.297  1022   6-SPAR:1.658   514   10
3-REC2:1.577   489   7-DRIV:1.597   495 BIT
4-REC3:1.955   606   8-BATT:3.081   955
```

1- SAC: single axis compass

2-TEMP: internal temperature sensor

3-REC2: Receiver 2

4-REC3: Receiver 3 (typically derived from Options Board connector J2 REC2 pin 7)

5- RF: L-Band power detector

6-SPAR: Spare 10 bit input

7-DRIV: Drive board feedback

8-BATT: Battery voltage

<u>3.3.2.1.2 12 Bit ADC Voltages</u>

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

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

Note that all of the analog to digital channels have some associated scaling and conditioning circuitry in the RC4000. Therefore the voltages seen at this screen may not be exactly the same as the input voltages external to the RC4000.

```
 AZ: 2.5000  2048              12 BIT ADC
 EL: 0.0012     1                    L1:1
POL: UNDER     0                     L2:0
SIG: 3.3346  2731                    L3:1
```

AZ: / EL: / POL:

The first three A/D channels are dedicated to the azimuth, elevation and polarization position sensing inputs.

SIG:

The fourth channel shows the voltage and count from the external receiver input.

L1: / L2 / L3:

These fields show the status of the signal lock 1 - 3 inputs. A logic high signal is indicated by a "1".

3.3.2.2 Drive Error Resets

```
1-AZIM: JAMMED                    DRIVE RESET
2-ELEV: RUNAWAY     <4>RESET PULSE COUNT
3- POL: OK              (AZ/EL AT STOW)
RESET <1-3>AXIS                 <MODE>EXIT
```

The DRIVE RESET maintenance screen provides the way to reset drive system errors (JAMMED / RUNAWAY / DRIVE) for each axis. See the drive system theory section (4.3.3) for descriptions of these conditions. An axis' drive status may be reset by pressing the corresponding key.

This screen also provides for resetting the azimuth and elevation pulse counts to their reset state of 32768 for each axis (azimuth and elevation).

3.3.2.3 Time Maintenance

The Time Maintenance screen allows the user to set the system and reference (see section 4.3.2) time.

Note that all dates are displayed and entered in day/month/year (DD/MM/YY) format. All times are displayed and entered in hour/minute/second (HH:MM:SS) format. Refer to section 3.1.3 for instructions on entering date and time.

```
 SYSTEM:11/10/97 22:26:40              TIME
DISPLAY:11/10/97 16:26:40         ZONE:UTC
GPS UTC:* WAITING FOR GPS *   OFFSET:  0
1-DATE 2-TIME 3-SYNCH 4-ZONE 5-OFFSET
```

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

Current date and time as maintained by the RC4000's real-time clock.

DISPLAY:

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

GPS UTC:

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

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

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

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

ZONE:

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

OFFSET:

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

The values for the time parameters may be altered by the actions described next:

1-DATE   **ENTER DATE DD.MM.YY**

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

2-TIME   **ENTER TIME HH.MM.SS**

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

3-SYNCH

If valid GPS UTC data is being received, pressing the 3 key will cause system time to be synchronized with the current GPS UTC.

4-ZONE   **ENTER 3 LETTER TIME ZONE**

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

5-OFFSET   **ENTER TIMEZONE OFFSET <-11/+12 HOURS>**

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

3.3.2.4 TBD Maintenance

Selection number 4 on the Maintenance menu has not been allocated yet.

3.3.2.5 Limits Maintenance

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

The limits maintenance screen shows the current state of each limit switch as sensed by the RC4000's microcontroller. The state of each limit is shown as 0 if off or 1 if on. An * is displayed if the particular limit switch is not relevant for the particular mount (there is no POL STOW switch in the above example).

The limits maintenance screen also shows the status of:

R: Red Button (Stow)

G: Green Button (Locate)

A, B, C, D   Auxiliary switch inputs, most commonly used as POL ID BITs (refer to section 3.3.1.2.4)

<BKSP>MAKE LIMITS INACTIVE   <MODE>EXIT

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

** WARNING – LIMITS INACTIVE **

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

Note that even if software limit sensing is made "INACTIVE", there are cases where movement of an axis may still be inhibited by hardware logic (sensing the state of limit switches) on the analog drive board. Good knowledge of how the various limit switches in a system are mechanized is required to determine if the limits inactive state will help in debugging any problems.

3.3.2.6 GPS Serial Port Diagnostics

This screen allows the user to ascertain if the GPS receiver is communicating correctly with the RC4000.

```
<BKSP> TO FREEZE DISPLAY        GPS COMM
$GPRMC,133544,V,3856.0856,N,09444.8377,
W,000.0,000.0,080499,003.6,E*7B≡≡$GPGGA,
190449,3856.0856,N,09444.8377,W,0,00,,,M
```

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

$GPRMC,133544,V,3856.0856,N,09444.8377, W,000.0,000.0,080499,003.6,E*7B

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

Another sentence "$PGRMT" is transmitted once a minute.

If no characters are being received from the GPS, the message "INITIALIZING GPS" will remain on line 4 of the display. Normally this message will go away within 10 seconds of entering this mode.

3.3.2.7 Fluxgate Serial Port Diagnostics

This screen allows the user to ascertain if the fluxgate compass is communicating correctly with the RC4000.

```
<BKSP> TO FREEZE DISPLAY        CMP COMM
$HCHDM,266.1,M*2A≡≡$HCHDM,266.0,M*2B≡≡
HCHDM,266.0,M*2B≡≡$HCHDM,266.0,M*2B≡≡$
$HCHDM,266.0,M*2B≡≡ HCHDM,266.0,M*2B≡≡
```

The screen shows the raw ASCII data coming from the fluxgate compass. If there is correct communication established with the compass, somewhere in the lines of displayed characters the string "HCHDM" should be recognizable.

Following the "HCHDM" should be a number indicating the current magnetic heading (266.0 in example) the compass is reading. If this value is 800.0, it indicates the fluxgate's sensor is either saturated by an unreasonably high magnetic field or the magnetic field strength is unreasonably low. If the "800.0" number is seen, the placement of the fluxgate should be checked.

3.3.2.8 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.

```
AZIM:-123.4 ( 123.4)                MOVETO
ELEV:  41.5 (  41.5)  <5>SENSOR:PRIMARY
 POL: -13.3 ( -13.3)  <3>SPEED:FAST
SET <1>AZ<2>EL<6>POL  <4>START MOVE
```

The current azimuth, elevation and polarization angles are displayed. When the mode is first entered, the current positions are shown as the target positions. After setting target positions and setting the desired speed, the automatic movement may be initiated by pressing the 4 key.

<5>SENSOR:PRIMARY

The state of this field when this mode is entered will be "PRIMARY". This means that the displayed angles and entered targets are generated and referenced to the axis sensor that generates angles. For instance, the typical primary elevation sensor is the electronic inclinometer.

If the mount is equipped with higher resolution sensors such as resolvers or pulse sensors, toggling the field to "SECONDARY" will cause the display and target to change to an integer representative of the high resolution sensor. This mode of operation allows actions such as the small movements made during inclined orbit tracking to be simulated.

3.3.2.9 Fluxgate Calibration Procedure

The fluxgate compass calibration procedure is performed to compensate for sources of hard and soft iron magnetic deviations from the host mount. Review the discussion on the importance of selecting a suitable site for performing the calibration in <u>section 4.1.9</u>.

NOTE: the fluxgate compass must be in a level orientation to perform a good calibration.

The user is prompted to hit the Enter key to begin the procedure. If the user is not confident that the location for calibration is adequate or does not have the ability to move the mount, the procedure may be exited by hitting the Mode key.

```
                              8 PT COMPASS CAL



<ENTER>BEGIN CALIBRATION         <MODE>EXIT
```

Fields to show the quality of the calibration are displayed. Until the calibration is finished, an "*" is displayed. Following successful completion of the procedure, the scores reported by the fluxgate compass will be displayed. Each procedure has unique messages for prompting the user on how to proceed.

MOVE TO INITIAL HEADING & <ENTER>
ROTATE 45 DEG.(START + 45/90/135/180/225/270/315) & <ENTER>

The eight point calibration procedure requires the mount to be moved 45 degrees at a time. The first prompt asks for the mount to be moved to an initial position. After moving to the requested position, the user must let the compass know by pressing the Enter key.   These steps will be repeated for 45, 90, 135, 180, 225, 270 and 315 degrees.

The requirement is not that the mount be initially placed at a true heading of 0 degrees initially. Rather the value indicates the number of degrees from the starting orientation. Also the movement each time needs only be +/- 15 degrees from the requested 45 each time. Marking out eight equidistant bearings before the procedure is performed may be beneficial.

MOVEMENT MAY STOP-PERFORMING CALCULATION

When the calibration has collected enough data, the "movement may be stopped" message is displayed. Do not mode out of calibration until the calibration finished message is displayed.

CALIBRATION FINISHED,<MODE> TO EXIT

This message indicates the fluxgate has finished performing its calibration calculations. At this time new calibration scores are displayed.

```
8 PT COMPASS CAL
CAL QUALITY:8        (0-9,>6 PREFFERRED)
MAG ENVIRON:7        (0-9,>5 PREFFERRED)
CALIBRATION FINISHED, <MODE> TO EXIT
```

COMM ERROR

At any time during the calibration procedures, if the RC4000 detects an abnormal response from the fluxgate, the communication error message is displayed. Exit the procedure by pressing the Mode key.

3.3.2.10 Shake

The SHAKE mode performs repetitive mount movements. The SHAKE mode is for support of mount testing and for automatic mount demonstrations such as trade shows. The SHAKE mode is only available if expert access is enabled.

The SHAKE mode implements a repetitive sequence of three "moves". Each "move" is programmed with azimuth, elevation and polarization targets. Moves # 1 and 2 proceed in the order elevation, polarization and azimuth. Move # 3 proceeds in the order of azimuth, polarization and elevation to accommodate a "stow-like" sequence. NOTE: if polarization movement is not desired, set the feed type (see Feed Definition 3.3.1.2.5) to "circular". When SHAKE is selected, the following screen appears.

```
AZ 1: -40.0 2:  50.0 3:   0.0       SHAKE
EL 1:  30.0 2:  40.0 3: -67.5 CYCLE: 100
PL 1: -10.0 2:  10.0 3:   0.0 DELAY:    1
<1>START <CONFIG-SHAKE>EDIT <MODE>MAINT
```

This opening screen shows the programmed values for the SHAKE mode. The azimuth(AZ), elevation(EL) and polarization(PL) targets for each of the three "moves" is displayed. Also displayed is the programmed number of movement CYCLES to accomplish and the time in seconds to DELAY between each "move". The pattern the above move targets describe is shown in the following figure.
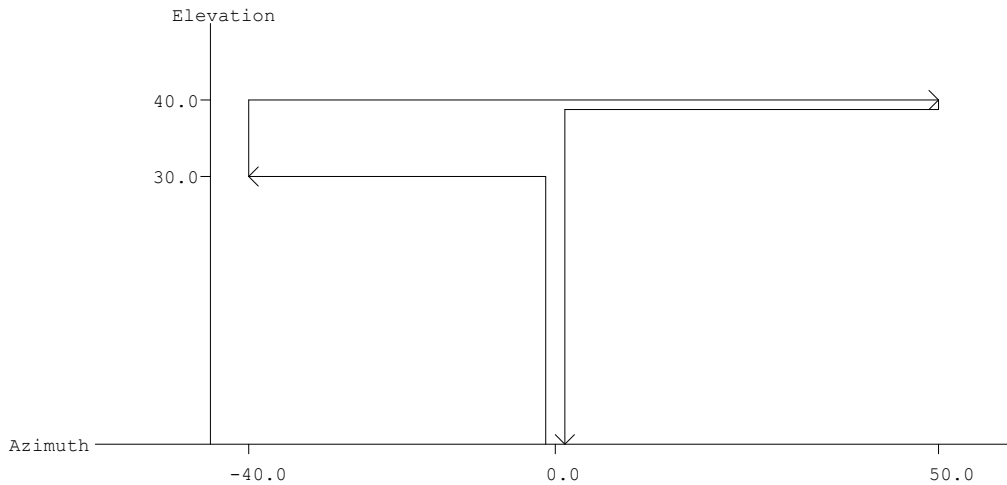
The programming of the targets, cycles and delay is accomplished via the SHAKE configuration screen (3.3.1.3.11). To initiate the SHAKE sequence, press the Pol CCW/1 key. If you wish to modify the SHAKE parameters go to the CONFIG-SHAKE mode. To exit out of SHAKE press the Mode key.

When SHAKE is started the following screen appears:

```
AZIM:   0.2                        SHAKE
ELEV: -55.3                        DELAY
POL:   0.6                 CYCLE:  1/   5
<STOP>HALT MOTION <MODE>MAINT
```

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

Movement may be stopped at any time by pressing the Stop or Mode keys.

3.3.2.11 System Information

Selecting the Stop/. key from the MAINTENANCE screen triggers a display of various system/software information.

```
Serial Number: 0          SYSTEM INFO
Firmware: RC4K-TEST-GTRSB
Version:  0.07 BN: EG0926
                          <MODE>EXIT
```

4.0 SUPPORT

4.1 Installation

Proper installation is important if the full capability and accuracy of the RC4000 is to be realized. The procedures that follow will insure the optimum level of performance from all sensors and the system in general.

Installation will be more efficient if each step in the physical installation and calibration be performed in the order in which it appears in the following schedule. Each step is referenced to a particular section of this manual and should be checked off as it is completed. Coordination between the mount manufacturer, vehicle integrator and end user is required. Some steps are applicable only if the tracking or remote control options were purchased with the unit. The installation procedures are written to cover the most common mount installations. Some steps are slightly different according to the type of mount the RC4000 is interfacing to (refer to Appendix B). Installation requires basic operational knowledge of the RC4000. Please review chapter 3 for information on how to navigate the RC4000's screens and how to enter data.

SECTION	ACTION	COMPLETE
Initial Configuration		
4.1.1	Software Initialization	
4.1.2	Elevation Calibration	
4.1.3	Azimuth Calibration	
4.1.4	Polarization Calibration	
4.1.5	Fast/Slow Motor Speed	
4.1.6	Pulse Sensor Checkout	
4.1.7	Drive System Checkout	
4.1.8	Navigation Sensor Communication	
Final Calibration		
4.1.9	Compass Calibration	
4.1.10	Azimuth and Elevation Alignment	
4.1.11	Signal Strength Adjustment	
4.1.12	Pulse Scale Factors	
4.1.13	Operational Presets	
4.1.14	Miscellaneous Adjustments	
4.1.15	Mechanizing Automatic Locates	

****

Whereas Final Calibration (sections 4.1.9 through 4.1.15) requires an open area with an unobstructed view of satellites, Initial Configuration may be done in any area (possibly a shop environment) where the antenna may be moved throughout its entire range of travel.

At this point, the installer will have to start operating the RC4000 from the front panel. Section 3 will need to be reviewed to perform the steps described below.

4.1.1 Software Initialization

Initial Power Application. Before powering the unit on for the first time, please confirm that the input voltage the unit is configured for matches the intended input supply voltage. See section 2.1.2.1.1.

Software Version Verification. When the RC4000 is turned on, a power up banner appears for 3 seconds. This banner indicates the software options enabled in the RC4000's EPROM and PLD. The software option data shown should be checked to confirm that all desired options are available. See section 3.1.5 (Software Initialization) for a description of the various software options.

Enable Expert Access. To perform RC4000 programming steps described below, expert access permission must be enabled. Expert access permission is enabled as the factory default, but may have been turned off if this is not the initial system configuration attempt. See section 3.3.1.1.1 (Expert Access Permission) for a description of how to view/modify the expert access configuration item.

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

Reset System Defaults. The RC4000 is shipped with the default parameters set for the particular mount and software options. Most of the default values stored in non-volatile memory should be applicable. A few items (antenna size, etc) may not be initially set to values appropriate for a particular installation. Setting these values will be described next.

If the RC4000 has previously been configured, the installer may want to reset the system defaults as described in section 3.3.1.3.1. **NOTE: the current value of all configuration items should be recorded prior to resetting system defaults.**

System Definition. The SYSTEM DEFINITION configuration screen (3.3.1.2.1) allows the user to indicate whether or not the optional GPS receiver is present, if and how the fluxgate compass is mounted, the size of the reflector in use and what mode the user prefers the RC4000 to go to upon power up.

```
    MODE:2                   CONFIG-SYSTEM
     GPS:1    ANT_SIZE: 120
COMPASS:1        DRIVE:3
<1-LOCATE 2-MENU 3-MANUAL 4-VSAT 5-POS>
```

Follow the description in section 3.3.1.2.1 and set the SYSTEM DEFINTION items to the correct value for this installation.

Azimuth/Elevation/Polarization Calibration. The next three steps calibrate the mount's elevation, azimuth and polarization axes. Place the RC4000 in MANUAL mode. Values for the azimuth, elevation and polarization axes should be displayed, though they may not be reasonable since calibration has not yet been performed.

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

NOTE: be careful when initially moving a mount since limit switches may not yet be configured correctly. In MANUAL mode, movement will stop whenever a particular jog key is released. The RC4000 may also always be turned off to stop movement.

Throughout the 3 axis' calibration procedures, two MAINTENANCE screens will be used extensively.

One of the MAINTENANCE screens used is the Analog to Digital Voltage screen (see 3.3.2.1). This screen shows raw data coming from antenna position sensors (potentiometers and resolvers).

```
 AZ: 2.5000  2048            12 BIT ADC
 EL: 0.0012     1                  L1:1
POL: UNDER     0                  L2:0
SIG: 3.3346  2731                 L3:1
```

Another MAINTENANCE screen that will be used is the Limits Maintenance screen (see 3.3.2.5). This screen shows the current sensed state of limit switches for all three axes.

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

Before beginning axes calibration, the installer should become familiar with accessing these screens.

4.1.2 Elevation Calibration

Steps to perform elevation calibration will be described starting with the elevation axis in the stowed position.

STEP 1. STOW Limit Confirmation

With the elevation axis in the stowed position, go to the Limits Maintenance screen (3.3.2.5) to confirm that the ELEV STOW and Down (DN) limits are active.

Also confirm that the elevation UP limit is inactive. If the UP limit is active, the RC4000 will be prevented from moving the elevation axis up from the stowed position.

If the initial state of the elevation STOW, DOWN and UP limits is not correct, check the limit switches and wiring (section 2.1.2.2.16).

STEP 2. Initial Movement

The next action is to raise the antenna in elevation. Push the UP key from MANUAL mode. The antenna should rise. If not, check the polarity of the motor drive lines (section 2.1.2.1.5).

As the elevation axis comes out of the stow position, the STOW limit should inactivate but the DOWN limit should remain active. This may be observed from the MANUAL screen by seeing the elevation "STOW" indication change to a "DOWN" indication.

The elevation sensor should be mounted on the antenna so that the sense voltage produced at the sensor increases as the antenna is jogged upward. In MANUAL mode, when the EL UP (2) key of the RC4000 is depressed (and if the antenna moves up) the elevation position should increase (section 2.2.1).

Note that the elevation position seen in the MANUAL screen might not initially change if the inclinometer is still outside of its operational range or if the inclinometer is mounted on a feedboom that doesn't rise until the reflector has moved up a certain distance.

The following steps will require values to be entered in the ELEVATION CALIBRATION configuration screen (see 3.3.1.2.2).

```
REF_V:1.69 OFF:  0.0          CONFIG-ELEV
 DOWN:  0    UP: 90.0    SF:50.00
 LOOK:1
SET REFERENCE VOLTAGE <0.50 – 3.50>
```

NOTE: the elevation offset item should be set to 0.0 before any further elevation calibration is performed. Any required elevation offset will be determined during the azimuth and elevation alignment step (section 4.1.10) as part of the final calibration steps. The LOOK configuration item is meaningful for only a small number of mounts (see appendix B). In most cases the value of this item is irrelevant.

STEP 3a. Inclinometer Reference Voltage

To perform this step, raise the antenna until the reflector is in the reference position appropriate for this mount (see Appendix B). For the majority of mounts, the reference position corresponds to having the reflector's face vertical. This angle can be confirmed by use of a level or digital inclinometer placed on a correct portion of the antenna structure.

The elevation voltage shown on the AD VOLTAGES screen (3.3.2.1) should be near the target value for your mount as noted in Appendix B. For the majority of mounts, this target voltage will be around 1.69 volts. This voltage allows for the greatest range of linear feedback from the elevation inclinometer throughout the mount's operational range. If not, loosen the elevation sense restraining plate and rotate the inclinometer until the elevation voltage is as near to the target voltage as possible. Secure the restraining plate and record the voltage.

Recorded Elevation Reference Voltage _____V

Move to the Elevation Calibration configuration screen and enter the recorded value in the REF_V item. This will define to the RC4000's software the voltage that should be seen when the elevation axis is in its reference position. To verify that data has been entered correctly, return to the MANUAL mode screen. The displayed elevation angle should be near the RF look angle offset of the reflector (see Appendix B).

STEP 3b. Elevation Resolver Reference

NOTE: this step only needs to be performed for those mounts that incorporate a resolver sensor on the elevation axis.

This step should be performed at the same elevation axis position as in step 3a. Additionally, the vehicle/platform should be level since the resolver will not compensate for tilt as does the inclinometer.

Rotate the elevation resolver until a raw resolver angle of approximately 180.0 degrees in seen in the MAINTENANCE-VOLTS screen. Lock the elevation resolver in place and observe the raw resolver angle. Subtract this observed angle from the reflector's RF angle and enter it as the elevation resolver offset (see 3.3.1.2.2).

EXAMPLE

Raw resolver angle at elevation reference position: 179.2

Reflector's RF angle at elevation reference position: 22.3

Required elevation resolver offset: -156.9 (22.3 – 179.2)

NOTE: on mounts equipped with an elevation resolver sensor, the elevation angle displayed when below the DOWN limit is derived from the resolver, not the inclinometer. To perform a "sanity check" of the resolver calibration, move the reflector up and down around the point that the DOWN limit occurs. With the vehicle/platform level there should be very little discernible jump in the displayed elevation angle.

STEP 4. Elevation Scale Factor Calibration

This step is performed to characterize the output signal from the elevation inclinometer.
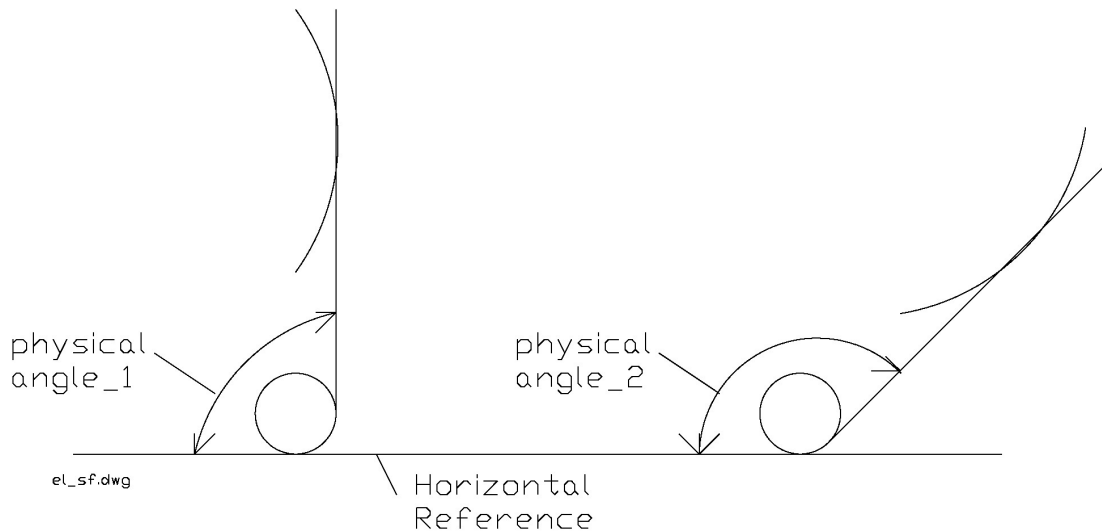
1) With the elevation axis in the reference position, note the angle **(using an accurate inclinometer placed on the mount itself, not the angle displayed on the RC4000)** and the A/D voltage at that point.

    Physical_Angle_1 (Reference) _____Degrees

     Voltage_1 (Reference) _____Volts

2) Raise the antenna approximately 30 to 50 degrees and note the angle and voltage.

          Physical_Angle_2_____ Degrees

          Voltage_2 _____ Volts

3) Calculate the output signal from the elevation inclinometer.

    Degrees/Volt = (Voltage_2 – Reference Voltage) / (Physical_Angle_2 – Reference_Angle)

    MilliVolts/Degree = Volts/Degree * 1000

4) Enter the mV./deg. in the SF field of the configuration screen.

NOTE: an alternate method for calculating the output signal from the inclinometer is to use the data supplied by the inclinometer manufacturer for each individual inclinometer and multiply by the gain (0.823) in the RC4000's circuitry. (example: 59.27 mV/deg * 0.823 = 48.78)

STEP 5. Up Limit Confirmation

Move the elevation axis to the UP physical limit and confirm that the "UP" limit is displayed in the MANUAL mode.

Go to the Limits Maintenance screen (section 3.3.2.5) to confirm that the ELEV STOW and Down (DN) limits are inactive.

If the state of the elevation STOW, DOWN and UP limits is not correct, check the limit switches and wiring (section 2.1.2.2.16).

STEP 6. Software Elevation Limits

The DOWN and UP elevation limit values in the configuration screen should be set to reflect the physical limits of elevation travel. Note that these limits don't actually limit the elevation travel but are used by software during the LOCATE function to determine if a calculated pointing solution is outside of the mount's range of movement. If a calculated pointing solution is beyond these limits, the message "ELEV RANGE ERROR" will be displayed in the LOCATE screen.

4.1.3 Azimuth Calibration

Steps to perform azimuth calibration will be described starting with the azimuth axis in the stowed position and the elevation axis above the DOWN limit. Movement in the azimuth axis is not allowed until the elevation DOWN limit switch is inactive.

The mount should be moved to the exact azimuth position that it will be stowed. Typically this is near the midway point of its range of movement in azimuth. Also, the azimuth stow limit switch should be in the center of its activation region. It is very important that this position be confirmed in this manner or problems could be encountered during the automatic stow function.

The following steps will require values to be entered in the AZIMUTH CALIBRATION configuration screen (see 3.3.1.2.3). NOTE: RES and REV items only appear if an azimuth resolver is present.

```
REF_V:2.50  FG: 0.0            CONFIG-AZIM
  CCW:180   CW:180     SF:65.62
  RES:0.0   REV:0
SET REFERENCE VOLTAGE <2.00 - 3.00>
```

STEP 1a. Azimuth Potentiometer Reference Voltage.

This step is applicable if the mount is fitted with a potentiometer to sense the azimuth position. If the mount is fitted with a resolver, go to step 1b.

Move to the MAINTENANCE MENU screen and select the AD VOLTS item. Voltage values read from the azimuth potentiometer can be read from the AD VOLTS screen (3.3.2.1).

The azimuth voltage shown on the screen should be 2.5 +/- 0.1 volts (Since 5 volts is sent to the sensor, if the pot is adjusted at the center tap position correctly, the reading should be half). If the value is within this range, record it for later entry in the configuration items. If not, loosen the potentiometer restraining collar and rotate the shaft such that the displayed value is as near 2.50 volts as possible. Secure the collar and record the voltage.

RECORDED AZIMUTH CENTER VOLTAGE_____ V.

Move to the Azimuth Calibration screen and enter the recorded value in the REF_V item. This will define to the RC4000's software the voltage that should be seen when the azimuth axis is in its centerline position. To verify that data has been entered correctly, return to the MANUAL mode screen. The displayed azimuth angle should be 0.0 +/- 0.1 degrees.

STEP 1b. Azimuth Resolver Reference Angle.

NOTE: this step only needs to be performed for those mounts that incorporate a resolver sensor on the azimuth axis.

Loosen and adjust the azimuth resolver to be as close to 180 degrees (seen at a/d volts screen 3.3.2.1) as possible. Lock the azimuth resolver in place and observe the raw resolver angle. Subtract this observed angle from 0.0 and enter it as the azimuth resolver offset (3.3.1.2.3).

After entering the azimuth resolver offset, the azimuth angle displayed in MANUAL mode should be 0.0.

STEP 2. Initial Movement.

The next step is to move the azimuth axis to confirm drive and sensor polarity. Azimuth clockwise and counterclockwise is defined as seen by an observer located above the antenna looking down on the antenna.

In MANUAL mode, when the AZ CW (6) key of the RC4000 is depressed the antenna motors must be wired (section 2.1.2.2.15) so that the antenna moves clockwise.

The azimuth potentiometer or resolver should be wired so that clockwise movement results in a higher azimuth position.   When moving clockwise, the displayed azimuth position should increase.

STEP 3. Stow Limit Confirmation.

Move the azimuth axis clockwise and counterclockwise through the stow limit switch's area of activation. Confirm that the STOW indication appears and disappears in MANUAL mode.

Failure of the stow switch to deactivate would allow the reflector to potentially move below the elevation DOWN limit in an unsafe manner. If the initial stow limit does not function correctly, check the limit switch and wiring (section 2.1.2.2.15).

STEP 4. Clockwise and Counterclockwise Limits.

Discrete Limit Switches. Some mounts may mechanize azimuth clockwise and counterclockwise limits via actual limit switches. If this is the case, move the azimuth axis through its range of motion and verify that the CW and CCW limit indications appear in the MANUAL screen. After confirming these indications move on to the next step.

Azimuth Electrical Limits. Other mounts may not have azimuth limit switches.   In this case, the RC4000 allows for the CW and CCW limits to be set based on the azimuth potentiometer voltage. The position of these limits is defined in the MAINTENANCE – AZIMUTH CALIBRATION screen (3.3.1.2.3) under the CW and CCW entries.

To set the azimuth clockwise limit, go to MANUAL mode and jog the antenna in azimuth to the desired azimuth clockwise limit. If the controller indicates that the azimuth clockwise limit is reached before the antenna reaches the desired position for that limit, the AZIMUTH CALIBRATION – CW entry may have to be adjusted to allow the antenna to move.   Adjust CW by the number of degrees needed. To verify that the CW has been adjusted properly, verify that the antenna cannot move clockwise in azimuth but can move counter-clockwise.

A similar procedure is used to set the azimuth counter-clockwise limit. A default limit will be set in software based upon specific antenna types.

STEP 5. Azimuth Scale Factor.

NOTE: in most cases the default azimuth scale factor for a mount will be correct and should not be changed. Perform this substep only if appendix B suggests that the azimuth scale factor for your mount should be characterized.

To calculate the azimuth scale factor, move the dish between two known physical azimuth positions and note the difference in the sensed azimuth voltage between the two locations.   If definite reference points are available on the mount (+/-90 degree positions for example), these may be used. Otherwise use the difference in azimuth pointing solutions to two satellites. Record the azimuth voltage at the peaked up position of the two satellites.

Example: at +90 degree reference position the azimuth voltage is 3.86. At the –90 degree reference position the azimuth voltage is 1.14. The azimuth scale factor is calculated as:

180 degrees / (3.86 –1.14) = 66.16 degrees / volt.

66.16 would be entered as the scale factor.

STEP 6. Azimuth Software Limits.

The CCW and CW configuration item values found in the AZIMUTH CALIBRATION screen should be set to reflect the physical limits of azimuth travel. Note that these limits don't physically limit azimuth travel but are used by software to determine if a calculated pointing solution is outside of the mount's range of movement. If a calculated pointing solution is beyond these limits the message "AZIM RANGE ERROR" will be displayed in the LOCATE screen.

STEP 7. Fluxgate Offset.

NOTE: this item defines the difference in orientation (in the azimuth axis) between the fluxgate compass (section 4.1.9) and the azimuth reference (displayed 0.0) position. This value should initially be set to the apparent difference between the compass' and azimuth axis orientations. For example, if the compass is placed on the vehicle facing forward and the dish actually faces backward, an azimuth offset of 180 would be entered. It is recommended that the compass be placed facing in the same direction as the azimuth centerline thus requiring an offset of 0.0.

4.1.4 Polarization Calibration

The following steps will require values to be entered in the POLARIZATION CALIBRATION configuration screen (see 3.3.1.2.4).

```
REF_V:2.50 OFF:  0.0            CONFIG-POL
  CCW: 90.0 CW: 90.0 SF:41.67
TYPE:2 REF:1 H: -45.0 V:  45.0 AUTO: 1
SET REFERENCE VOLTAGE <2.00 - 3.00>
```

STEP 1. Polarization Type.

Typically the default polarization type will be appropriate for a particular mount. If not, the type of polarization axis configuration must be specified as one of the following:

Circular – no movement of the polarization axis is required. NOTE: if the polarization configuration is circular, the rest of the polarization calibration steps may be skipped.

Single – If the polarization axis must be moved to distinct positions to orient with horizontal and vertical, the type is considered single.

Dual – If the polarization system contains two feeds (or sets of feeds) such that the axis only has to be moved to one position to achieve both horizontal and vertical orientation, the type is considered dual.

STEP 2. Polarization Reference Position.

The polarization axis should be positioned so that it is aligned with the local vertical. Local vertical is considered the 0.0 polarization angle.   Clockwise and counterclockwise is defined as seen by a person looking from behind the antenna out towards the arc of satellites. In MANUAL mode, when the Pol CW key is pressed the polarization axis must rotate in the clockwise direction as shown in the figure repeated from section 4.3.4.
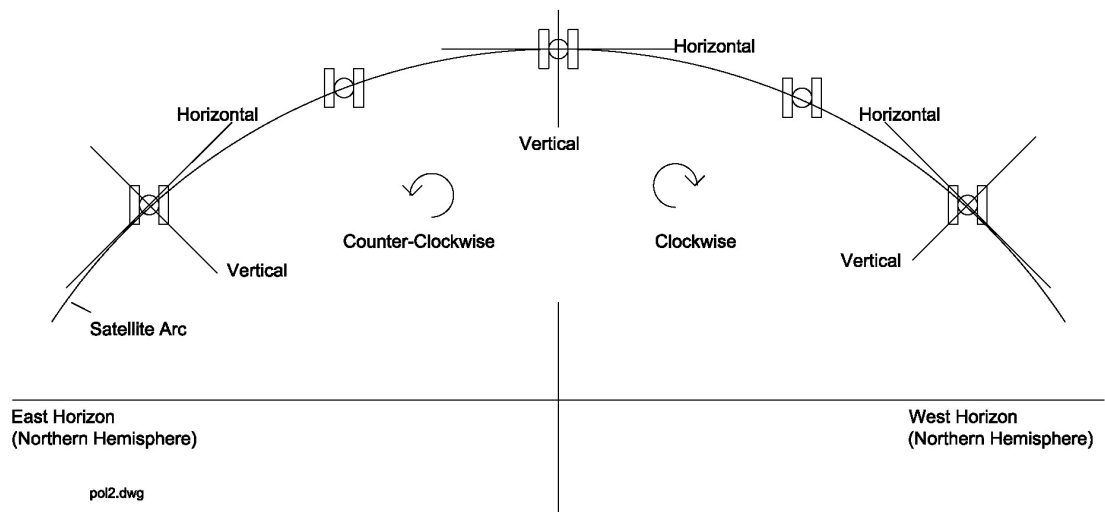
The following diagram shows a typical situation of two waveguides that rotate together. Note that the diagram should be considered as if the observer is behind the reflector looking towards the arc of satellites. This representation is relevant for both prime focus and dual reflector antennas.
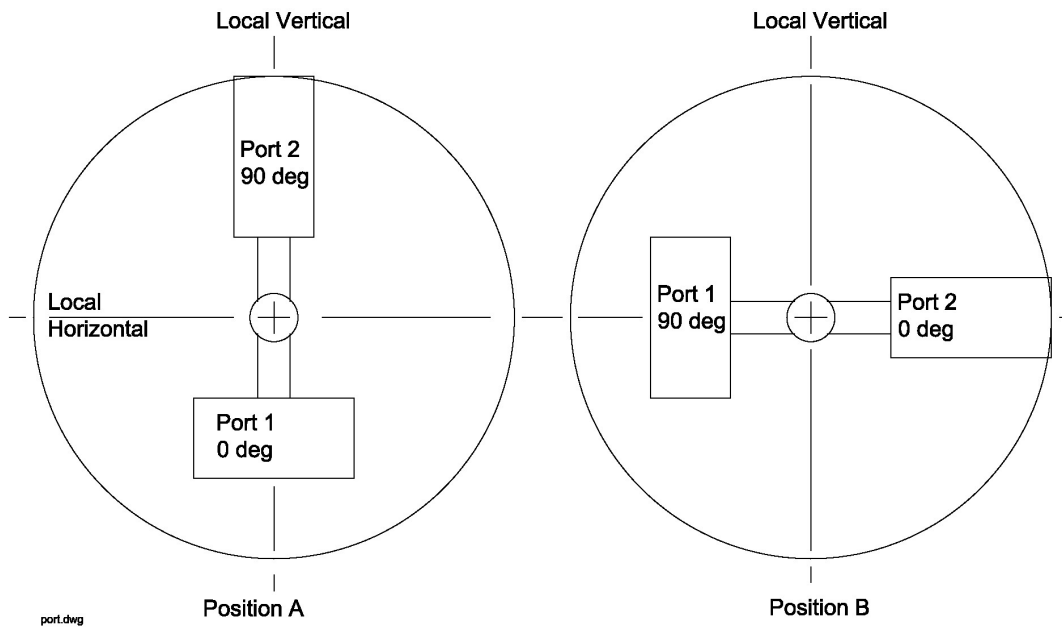
The polarity of a waveguide is determined by its narrow dimension. In the diagram, position A shows port 1 as being at the 0.0 degree orientation. In position B, port 2 is at the 0.0 degree orientation.

NOTE: before establishing the polarization reference position, the antenna platform must be leveled so there is no pitch or roll. Any platform pitch and/or roll present in this calibration step will later cause inaccuracy in automatic polarization movements.

Using an accurate inclinometer or level, position the polarization axis so that the waveguides align with the local vertical and horizontal. Typically this position will also be close to the center or travel of the polarization potentiometer. If not, adjust the polarization potentiometer to achieve this value. Secure the pot and record the voltage read from the VOLTAGES maintenance screen (3.3.2.1).

Recorded Polarization Reference Voltage _____ V.

Enter the recorded voltage in the REF_V configuration item. To verify that data has been entered correctly, return to the MANUAL mode screen. The displayed polarization angle should be 0.0 +/- 0.1 degrees.

STEP 3. Drive and Sensor Polarity.

The polarization motor should be wired so that the polarization axis rotates per the convention shown in the above diagram. Jog the polarization from the MANUAL mode to confirm the correct rotation. If not correct, check the polarity of the motor drive lines (section 2.1.2.2.13).

The polarization potentiometer must be wired so that the sensed polarization position increases as the Pol CW key is depressed. If not correct, check the sensor wiring (section 2.1.2.2.13).

STEP 4. Clockwise and Counterclockwise Limits.

Discrete Limit Switches. Some mounts may mechanize polarization clockwise and counterclockwise limits via actual limit switches. If this is the case, move the polarization axis through its range of motion and verify that the CW and CCW limit indications appear in the MANUAL screen. After confirming these indications move on to the next step.

Polarizaiton Electrical Limits. Other mounts may not have polarizaiton limit switches.   In this case, the RC4000 allows for the CW and CCW limits to be set based on the polarization potentiometer voltage. The position of these limits is defined in the MAINTENANCE – POL CALIBRATION screen (3.3.1.2.4) under the CW and CCW entries.

To set the polarization clockwise limit, go to MANUAL mode and jog the antenna in polarization to the desired polarization clockwise limit. If the controller indicates that the polarization clockwise limit is reached before the antenna reaches the desired position for that limit, the POL CALIBRATION – CW entry may have to be adjusted to allow the antenna to move.   Adjust CW by the number of degrees needed. To verify that the CW has been adjusted properly, verify that the antenna cannot move clockwise in azimuth but can move counter-clockwise.

A similar procedure is used to set the polarization counter-clockwise limit. A default limit will be set in software based upon specific antenna types.

STEP 5. Polarization Scale Factor.

NOTE: in most cases the default polarization scale factor for a mount will be correct and should not be changed. Perform this substep only if Appendix B suggests that the polarization scale factor for your mount should be characterized.

To calculate the polarization scale factor, move the feed between two known physical polarization positions and note the difference in the sensed polarization voltage between the two locations

Example: at +90 degree reference position the polarization voltage is 3.86. At the –90 degree reference position the polarization voltage is 1.14. The polarization scale factor is calculated as:

180 degrees / (3.86 –1.14) = 66.16 degrees / volt.

66.16 would be entered as the scale factor.

STEP 6. Polarization Reference Orientation Definition.

The orientation achieved by placing the polarization axis in the reference position must be specified as horizontal or vertical. This choice will depend on whether the operator wants to refer to the receive or the transmit port when commanding the controller to move polarization to the horizontal or vertical position. The RC4000 uses this definition when automatically calculating the polarization angle for single port feeds.

STEP 7. Additional Polarization Settings.

Polarizaiton Offset. This item describes any difference between the electrical and physical position of the polarization axis. In almost all cases the polarization offset will be 0.0. Offset might not be able to be characterized until final calibration.

Default Horizontal and Vertical Positions. Preset locations for polarization horizontal and vertical positions (3.2.1) are entered for use in the MANUAL mode.

Automatic Polarization Movement. Automatic movement of the polarization axis as part of the LOCATE function may be enabled/disabled by the AUTO configuration item.

4.1.5 Fast/Slow Motor Speed

The fast and slow output voltages for your particular mount will be set at the factory and typically will not need to be adjusted. The FAST and SLOW speed parameters can be adjusted in the AZIMUTH/ELEVATION/POLARIZATION DRIVE PARAMETERS Config Menu screens (3.3.1.3.4, 3.3.1.3.7, 3.3.1.3.9). The values entered for FAST and SLOW speeds are a percentage of the maximum speed for that axis.

The slow speed for an axis should be set low enough that automatic movements perform smoothly. Care should be taken that slow speed is not set so low that the axis is prone to jamming.

4.1.6 Pulse Sensor Checkout

This step resets and tests the pulse sensor system. It is only applicable for controllers that support pulse feedback.

The first step is to position the mount to the appropriate place for resetting the pulse count (see Appendix B). After moving to this position, initiate the pulse count reset from the DRIVE RESET maintenance screen (see 3.3.2.2).

Next move the mount to the limits of azimuth and elevation travel and note the pulse count. The pulse count can be viewed from the MANUAL screen by pressing the Scroll Up/Yes key. Record the pulse count values at the four limits.

Azimuth CW Pulse Count_____   **Azimuth CCW Pulse Count_____**

Elevation UP Pulse Count_____   **Elevation Down Pulse Count_____**

4.1.7 Drive System Checkout

This step confirms the configuration of the drive system for all three axes. Manually move the mount to each axis limit and confirm drive current to the motor is shut off when the limit is reached. Also check the displayed position value and confirm that it is reasonable.

Perform the STOW (3.2.2.2) and DEPLOY (3.2.2.1) functions and confirm the mount correctly stows and deploys.

STORE (3.2.2.4) several dummy satellites and RECALL (3.2.2.5) them to checkout the automatic drive system. If the mount does not smoothly move to the target position, the drive parameters may have to be adjusted.

4.1.8 Navigation Sensor Communication

If the optional GPS receiver and/or fluxgate compass are present, confirm that valid serial data is coming from the unit(s). See the GPS COMM (3.3.2.6) or FLUX COMM (3.3.2.7) maintenance screen descriptions.

4.1.9 Compass Calibration

Ferrous metal on the vehicle distorts the earth's magnetic field in the vicinity of the vehicle. The flux gate indicates the direction of the distorted magnetic field. The flux gate calibration procedure provides a method to correct for this distortion (caused by the vehicle/platform) of the earth's magnetic field and obtain the vehicle's actual magnetic heading.

mag.dwg
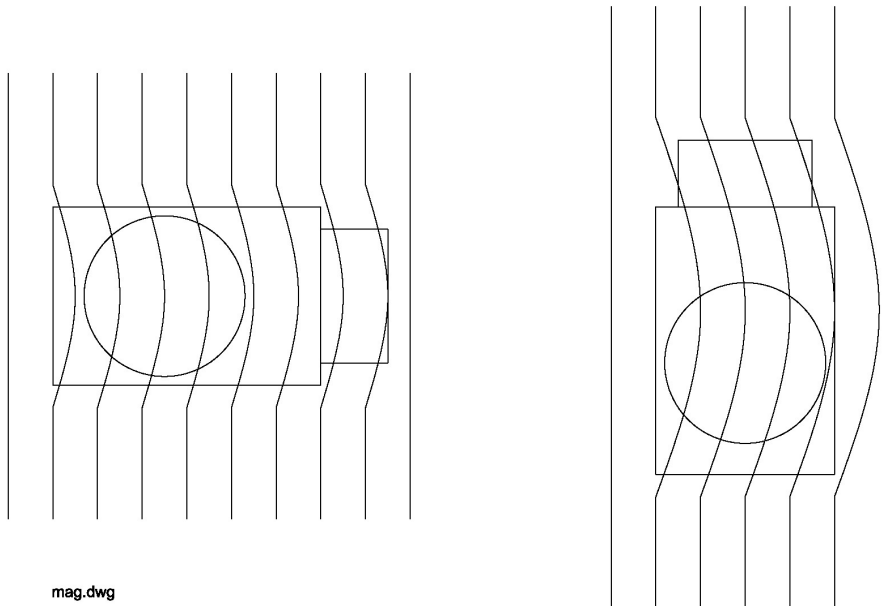
Review the discussion of system accuracy in section 4.3. Since the flux gate calibration only corrects for distortion of the magnetic field caused by the vehicle itself, it is important that the calibration take place in an area where the earth's magnetic field is not disturbed by structures or objects containing ferrous metals. Below is a listing of the characteristics of a good calibration site.

1. Level ground, preferably higher than the surrounding area. Avoid low valleys.

2. Free from structures containing a large amount of ferrous metal. It is of key importance to avoid areas adjacent to multi-story buildings, railroad tracks, bridges, truck yards, parking lots full of cars, and high voltage power lines.

3. Trees and wooden objects pose no problem for calibration.

4. Asphalt parking lots can provide a good calibration site. Care should be taken, though, in that asphalt is often laid over concrete which may contain reinforcing rod.

If a particular location is questionable, walking around with a simple wet compass will often show whether magnetic irregularities are present. A good site is important since the overall performance of the Satellite Locator is only as good as its calibration.

Section 3.3.2.9 describes how to perform the compass calibration procedure.

4.1.10 Azimuth and Elevation Alignment

This step attempts to discover and compensate for offsets in azimuth and elevation position sensing.

Offsets may be introduced due to several factors including mechanical tolerances and slight inaccuracies in installation. For example, the compass may not be exactly aligned with the azimuth reference position.

The following alignment procedure relies on the fact that is it possible to determine how the dish is pointing based on the actual antenna angles required to intercept a satellite (at a known longitude) when the vehicle's latitude and longitude are known.

The following test should be performed as many times as possible. The steps required are:

1) Set the azimuth and elevation offsets to zero.
2) Record the vehicle heading in the following table.
3) Command the ACU to LOCATE a satellite and record the target azimuth and elevation positions in the CALC'D column.
4) Manually peak the antenna so it's perfectly aligned with the satellite and record the actual angles in the ACTUAL column.
5) Compute the difference between the target and actual positions.
6) Repeat steps 3-5 for a second satellite.

| HDG.	SAT	AZIMUTH			ELEVATION		
		CALC'D	ACTUAL	DIFF.	CALC'D	ACTUAL	DIFF.
1	1						
	2						
2	1						
	2						
3	1						
	2						
4	1						
	2						
5	1						
	2						
6	1						
	2						
7	1						
	2						
8	1						
	2						
TOTAL							
AVG.							

Elevation Alignment

It is fairly easy to observe errors in the elevation calibration.

If test data shows that the actual elevation angle that a satellite is found is consistently above or below the calculated target, then it can be concluded that an elevation offset should be applied. Enter the appropriate value in the OFF field of the elevation calibration screen (3.3.1.2.2).

If the difference between actual and calculated elevation angle is not consistently of the same magnitude, then the calculated elevation inclinometer scale factor should be questioned. Step 4 of the elevation calibration procedure should possibly be rerun.

Also consider that a combination of elevation offset and inaccurate scale factor may be applicable. Rerun tests across the arc of satellites to confirm that applied corrections yield good results.
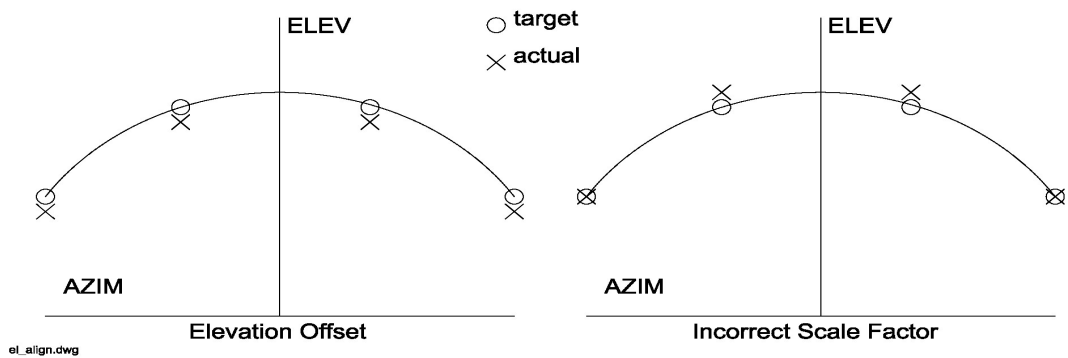
Azimuth Alignment

It is not as easy to observe errors in azimuth calibration. This is mainly due to the fact that the error from the compass reading will not be consistent from location to location and even from different vehicle headings at the same location.

If, after multiple tests, a consistent error in actual vs. calculated azimuth target is observed, then a modification of the offset in the azimuth calibration screen may be applied.
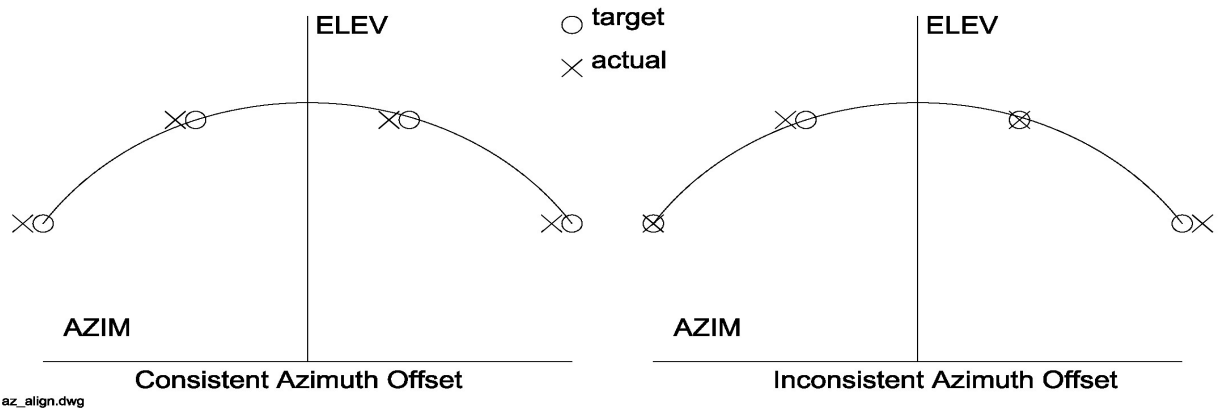
4.1.11 Signal Strength Adjustment

The RC4000 can sense satellite signal strength via the L-band power detector (2.1.2.4.8) or the signal strength input circuits (2.1.2.2.3 or 2.1.2.4.2). This section describes how to configure the signal strength input circuits for use with the satellite receivers used for a particular installation. Correct adjustment of the signal strength circuitry is required for autopeak and tracking operations to peak up on a satellite.

4.1.11.1 L-Band Power Detector

The simplest detection scheme is to connect the LNB output to the L-band power detector. For best results, insert inline attenuation or amplification so that the RF display is approximately 400 when the reflector is pointed at open sky. The L-band input power detector makes use of a 10-bit ADC labeled "5-RF" (3.3.2.1.1). See section 3.3.1.2.6 (Autopeak configuration) for a discussion of the characteristics of the L-Band power detector.

4.1.11.2 Signal Strength Channel

To implement tracking algorithms and the LOCATE mode's scan/search, the controller requires an input signal which indicates the strength of the received signal. Such a signal is generated within a satellite receiver and is referred to as an AGC signal. (AGC is the abbreviation for Automatic Gain Control.) On satellite receivers, this signal may also be referred to as a 'Signal Strength' or 'Tuning Meter' output. An AGC output typically varies in proportion to the received power of the transponder to which the receiver is currently tuned.

Signal strength indications from receivers, modems, etc. vary widely. The RC4000 provides two circuits that are designed to accommodate any signal strength input that varies between +/- 10 VDC. These inputs are labeled "REC1" (2.1.2.2.3) and "REC2" (2.1.2.4.2). The REC1 hardware input is routed to the microcontroller's 12 bit ADC and can be seen in the AD VOLTAGES Maintenance as source "SIG". The REC2 hardware input is routed to the microcontroller's 10 bit ADC and can be seen in the AD VOLTAGES Maintenance as source "4-REC2".

Each receiver input is scaled for a -10 to +10VDC range. REC2 can be optionally setup on the circuit board to accommodate other ranges of input voltages (this type of modification should only be performed at Research Concepts.)

4.1.11.3 Signal Strength Channel Configuration

The following are guidelines that should be followed when programming the RF/SS1/SS2 SIG FACTORS screens.

RF SIG FACTORS Refer to section 3.3.1.2.9 for full details. The "THRES" entry refers to the Minimum Signal Threshold. The minimum value refers to the minimum difference in signal strength which allows the antenna controller to confirm that it is pointing to a satellite rather than pointing to open sky.

Example: The RF value is around 300 when pointing to the open sky. It raises to 475 when fully peaked on a satellite. The value of the RF THRES may be set to 50 to indicate that when the RF strength has risen from 300 to 350, it confirms that it is on a satellite.

SS1 SIG FACTORS / SS2 SIG FACTORS Refer to sections 3.3.1.2.7 and 3.3.1.2.8 respectively for full details. The "THRES" entry refers to the Minimum Signal Threshold. The minimum value refers to the lowest signal strength above zero (0) which allows the antenna controller to confirm that it is pointing to a satellite rather than pointing to open sky.

4.1.11.4 Amplifier Gain vs. Frequency Characterization

An amplifier's gain vs. frequency characteristic, or gain flatness, is the variation of the amplifier's gain with changing frequency. The ideal response is to have a flat gain characteristic (the gain does not vary with frequency). Amplifiers with poor gain flatness characteristics can cause problems for the tracker. This section describes a simple test (no equipment required) that the user can carry out to check the receiving system's gain flatness.

There are four places in a satellite receiving system that may have gain flatness problems that can affect the operation of the tracker. These are the LNB, the coaxial cable connecting the LNB to the receiver, line amps (or bullet amps) inserted in the 950 - 1750 MHz IF, and the receiver's IF or AGC stages. If a spectrum analyzer is connected into the receiver's block IF line, the gain flatness of the LNB and any line amps present can be observed. When the antenna is pointed away from any satellite, the spectrum analyzer displays the received noise, which should be constant with frequency. If the display is not a horizontal line then some gain variation with frequency is present.

To understand how a poor gain flatness characteristic can cause problems, remember that the purpose of the signal strength input is to let the controller determine whether a satellite signal is present or not, and to provide relative signal strength information when peaking the antenna. A signal is assumed to be present whenever the input is above the threshold level for whichever band has been selected. When the receiver is tuned to various transponders, gain flatness problems could cause the signal to be above the threshold, when in fact no satellite signal is present. For certain transponders, gain flatness problems could also cause the controller's input scaling network to be saturated when the antenna is aligned with a strong satellite, making it impossible for the controller to detect changes in signal strength when attempting to peak the antenna.

To test the gain flatness of the satellite receiver, perform the following procedure. The procedure assumes a single receiver, single frequency band system.

1. Position the antenna well off of any satellite. Tune the receiver to each transponder. Make sure that the signal strength reading is below the threshold assigned via CONFIG mode.

2. Align the antenna with a strong satellite. Tune the receiver to each active transponder on the satellite. Make sure that the signal strength is well above the threshold and below 999.

If the system fails either of the tests above, then the user can either attempt to correct the problem by readjusting the GAIN and OFFSET pots (using the procedure outlined earlier), or by correcting the gain flatness problem. Most gain flatness problems can be traced to a problem with the coaxial cable connecting the antenna to the receiver (sometimes called a 'suck-out') or to bullet amplifiers. Some bullet amplifiers have been observed to have terrible gain flatness characteristics.

4.1.12 Pulse Scale Factors

The pulse scale factors specify the number of pulses counted per degrees (in radians) of movement for the azimuth and elevation axis. It is critical that these numbers are accurate since the tracking algorithms use them to determine step sizes (in pulse counts). Note that the RC4000 counts both rising and falling edges of the position pulses so that a single position pulse generates 2 position counts.

NOTE: In the majority of cases, the antenna scale factors will have already been characterized for a mount and the appropriate values stored as defaults. The following procedures will only be required if a condition (different gear ratios, different pulse sensors, etc.) exists.

The azimuth and elevation scale factors may be derived from the antenna mount manufacturer's data or from data measured by moving the mount.

SCALE FACTORS FROM MANUFACTURER'S SPECIFICATIONS

If the antenna manufacturer gives the position pulses per degree specification for the antenna's azimuth and elevation axes, simply multiply the value by 2 to obtain 'position counts per degree' (because the RC4000 counts both the rising and falling edges of the position pulses). Multiply this 'position counts per degree' value by 57.29 to obtain 'position counts per radian'. Round to the nearest whole number value to obtain the *Elev Constant* CONFIG mode item.

Elev position pulses per degree _____ * 2 * 57.29 = _____ (position counts per radian)

SCALE FACTORS FROM MOUNT MEASUREMENTS

The elevation scale factor is obtained by moving the antenna in elevation over a known angle and obtaining the number of counts which corresponds to the angular movement. The elevation region over which the measurements are made should correspond to the range of elevation angles which will be encountered in operation

The following steps are required:

1) Identify a location on the antenna to place the inclinometer. The location on the mount should be selected so that one degree of movement about the elevation axis registers as one degree on the inclinometer. It is best to use an inclinometer which has a magnetic base. These are available in hardware stores.

2) Record the elevation position count and the reading of the inclinometer. These will be designated CNT_1 and DEG_1, respectively.

3) Jog the antenna in elevation. It is recommended that the antenna be moved 15 to 20 degrees in elevation. Record the elevation position count and the inclinometer reading. These will be designated CNT_2 and DEG_2.

4) Use the following formula to calculate the Elev Constant:

((CNT_2 - CNT_1) / (DEG_2 - DEG_1)) * 57.29

If the result is negative, change the sign to positive. Here is an example:

	Inclinometer Angle	Pulse Count
Higher Position	50.2	32768
Lower Position	29.8	541
Difference	20.4	32227

(32227 / 20.4) * 57.29 = 9062 pulses/radian

The azimuth scale factor is obtained by noting the difference in the azimuth pointing solution angles between two satellites and the pulse counts when on the satellites. For best results, use satellites that are as far apart as possible and make sure you have positively identified the satellites.

Example : Kansas City (38'56N,94'45W) heading of 180.0

SATELLITE	AZIMUTH POINTING SOLUTION ANGLE	PULSE COUNT
SPACENET 2 (69.0W)	-37.5	33333
SATCOM C5 (135.0W)	53.4	11000
Difference	90.9	22333

(22333 / 90.9) * 57.29 = 14075 pulses/radian

SCALE FACTOR FOR RESOLVER SYSTEMS

The RC4000 uses the actual digitized resolver count in the same way it uses a pulse count. The RC4000 utilizes a 16 bit resolver to digital converter which generates a count value from 0 to 65,535. Typically the resolver sensor rotates with the antenna. The resulting "pulse scale factor" therefore is:

65536 reslover counts / (360 degrees * 1 radian/57.29 degrees) = 10430.2 "pulses" / radian

The default scale factor for a resolver system is therefore rounded up to 10431.

The constants are entered via the azimuth count movement (3.3.1.3.3) and elevation count movement (3.3.1.3.6) configuration item screens.

4.1.13 Operational Presets

This section has been included in the outline because it may simplify the user's day-to-day operation. The user cannot make use of preset truck locations or preset satellites if they are never entered into the memory. This is a straightforward procedure, but one which can be overlooked once the system is installed, since the RC4000 functions perfectly well without the presets. However, the presets streamline the operation by allowing the user to tell the program very quickly where the truck is, and what satellite is desired, without entering the data each time.

If a list of user preferred satellites or truck locations are available, they may be entered as described in sections 3.3.1.1.2 and 3.3.1.1.3.

4.1.14 Miscellaneous Adjustments

LCD Contrast. An LCD contrast potentiometer (P2) is located on the RC4000 digital board. This potentiometer will be set at the factory, but the user may want to adjust its setting for a particular installation's lighting conditions.

Setting Time. Set the time, specify local time zone and offset per instructions for Time Maintenance (3.3.2.3.)

4.1.15 Mechanizing Automatic Locates

Performing all of the previous installation steps correctly should place the RC4000 into a state where automatic locating of satellites may be accomplished. This section discusses the typical final actions necessary to mechanize an automatic locate. The LOCATE mode is described in section 3.2.2.3.

The first issue typically related to LOCATE performance is the pointing accuracy of the compass. The azimuth and elevation alignment calibration step (4.1.10) should be performed in order to fine tune the mount's position sensing.

Even with a well calibrated compass, local magnetic effects will cause the estimated mount heading to not be consistently perfect. Mechanizing the "autopeak" search movements described in sections 3.2.2.3.3 and 3.2.2.3.4 will provide a way to compensate for the inherent variability in heading estimate performance.

In order to mechanize the autopeak function, the RC4000 must be interfaced with the antenna system's receiving equipment. The receiving equipment must provide a signal strength indication to the RC4000 as a "positive identification" of the selected satellite during the autopeak function. Section 3.3.1.2.6 describes enabling and configuring the autopeak function. Having selected a signal source, the characteristics of the signal must be described to the RC4000 via the signal strength configuration screen (3.3.1.2.7 through 3.3.1.2.9).

Many variations of receiving equipment exist. The following provides one example setup.

Example Usage. Suppose an installation has a modem that generates a signal lock output but no relative signal strength output. An indication of relative signal strength may be obtained by inputting a RF signal (2.1.2.4.8) into J8 of the Options Board. The modem's signal lock output may be input to either pin 3 of J3 on the Computing and Interface Board (2.1.2.2.3) or pin 8 of J3 on the Options Board (2.1.2.4.2).

Program the RF LOCK item to indicate which signal lock input (1 or 2) is being used and what is the polarity (high or low) of the signal lock input. Program the RF TIME item with a large enough delay to

ensure that a signal lock indication is generated by the modem before the autopeak scan operation steps past the satellite of interest.

In the AUTOPEAK configuration screen (3.3.1.2.6), enable the autopeak function using RF, LOCATE SOURCE:5 (RF).

4.2 Troubleshooting

This section provides tips for debugging typical problems. There are many interfaces between the RC4000 and position sensors, limit switches, mechanical components of the mount, other satellite equipment, etc. Some problems are due to interactions that are not readily apparent. Review all of the troubleshooting sections to see if a situation similar to yours is described.

4.2.1 Limit Switches

The various limit switches serve as safety interlocks to prevent mount damage. The RC4000 checks for limit conditions via both software and a Programmable Logic Device on the analog board. The following table summarizes the interlock logic employed:

LIMIT	INTERLOCK LOGIC
Azimuth STOW	Elevation movement below the Elevation DOWN position is not allowed unless the Azimuth STOW condition is active.
Azimuth CCW	CCW movement in azimuth is not allowed when the azimuth CCW condition is active.
Azimuth CW	CW movement in azimuth is not allowed when the azimuth CW condition is active.
Elevation DOWN	No azimuth movement is allowed when the Elevation DOWN condition is active.
Elevation STOW	No further elevation down movement is allowed when the Elevation STOW condition is active. NOTE: when the Elevation STOW condition is active, the RC4000 internally generates an Elevation DOWN condition.
Elevation UP	No further elevation up movement is allowed when the Elevation UP condition is active.
Polarization CCW	CCW movement in polarization is not allowed when the polarization CCW condition is active.
Polarization CW	CW movement in polarization is not allowed when the polarization CW condition is active.
Polarization STOW	Elevation movement below the Elevation DOWN position is not allowed unless the Polarization STOW condition is active. NOTE: only certain mounts mechanize the Polarization STOW limit switch – refer to Appendix B for your mount.

Many problems are caused by limit switches either activating incorrectly or the RC4000 not sensing the limit switch's state correctly. The following are some examples of problems caused by limit switch sensing:

Mount will move down in elevation but not up. Check that the Elevation UP limit switch is not stuck in the active state.

Mount will not move below the DOWN elevation limit. Check that the Azimuth STOW limit switch has activated correctly. Also check the polarization STOW limit switch if the mount is so equipped.

Mount will only move up in elevation. Check that the Elevation STOW limit switch is not stuck in the STOW condition.

Mount is above the Elevation DOWN position but will not move in azimuth. Check that the Elevation DOWN limit switch is not active.

Failure of a limit switch to activate properly may be due to the limit switch mechanism itself, cabling to the limit switch or failure of the RC4000 to sense the limit switch correctly. Isolating the problem to the RC4000 or switch/wiring may be accomplished by placing wire jumpers across appropriate pins on the J13A connector (2.1.2.2.13), the J14A connector (2.1.2.2.15) and the J14B connector (2.1.2.2.16). NOTE: only the Elevation STOW/DOWN/UP, Azimuth STOW and Polarization STOW (if applicable) are mechanized via discreet limit switches – Azimuth CW/CCW and Polarization CW/CCW limits are mechanized differently and will be discussed later.

After removing the wiring harness from J13 or J14, the first thing to check is that 5 VDC is present at the "+" pin of each limit switch. Pins 11, 13 and 15 of each connector should have +5 VDC present. If +5 VDC is not present, there is a power supply failure within the RC4000. Contact your vehicle integrator, mount manufacturer or RCI for further instructions on how to proceed.

If +5 VDC is present, the limit switch sensing logic may be checked by placing wire jumpers between the appropriate pins and noting if the limit switch condition is sensed correctly by the RC4000. The state of the limit switches should be monitored via the Limits Maintenance (3.3.2.5) screen. The following table shows which pins to jumper and state that should be seen via the Limits Maintenance screen.

LIMIT	PINS	JUMPERED	OPEN
Azimuth STOW	J14A, pins 15,16	1	0
Elevation DOWN	J14B, pins 13, 14	0	1
Elevation STOW	J14B, pins 15, 16	1	0
Elevation UP	J14B, pins 11, 12	0	1
Polarization STOW	J13A, pins 15, 16	1	0

The azimuth CW/CCW and polarization CW/CCW limit conditions are based on voltage feedback from the axis' position sense potentiometer on the antenna. The limits are set in the azimuth and elevation calibration screens (3.3.1.2.3 and 3.3.1.2.4.) If these limits appear to be activating at the wrong time, check the settings in the calibration screens and reference the calibration procedures (4.1.3 and 4.1.4.)

4.2.2 Motor Drive

Axis JAMMED error displayed. A jammed error indicates that the axis was commanded to move, but the RC4000 did not sense any movement within several seconds. A jammed condition may indicate one of several conditions:

The mount's mechanical drive mechanism is physically jammed. Inspect the mount to determine if some mechanical problem (slipped gears, etc) exists. Unusual conditions such as icing may also cause the mount to jam.

The mount's position is not being sensed correctly by the RC4000. After resetting the drive error, go to MANUAL mode and attempt to jog the axis in question. If the axis does move, check to see if the axis' displayed position is updating. If the RC4000 doesn't sense movement, it will declare a jam even though the axis is moving.

The RC4000's motor drive is failing to output the required voltage to move the axis. Attempt to move the axis in question via the MANUAL mode. There are several things to note:

When a jog key is pushed, can relays inside the RC4000 be heard activating? If no relays are heard, a limit switch condition may be present that disallows movement in the axis in question. Review the above limit switch discussion.

Can the axis move in slow speed but not in fast? If this is the case, the fast voltage setting or current limit setting of the motor drive may need to be adjusted.

Is there voltage present at the appropriate Motor Drive Board connector J5 pins when the axis jog is attempted? If no voltage is present, there's the possibility that a fuse inside the RC4000 has blown (take care inside unit => must disconnect power, etc.)

If a fuse is blown, replace with the appropriate fuse. Reconnect J5 and remove the drive wires at the motors. Attempt to jog the axis. If the fuse blows again, the drive cables should be checked for a short. If the fuse does not blow, the motor should be checked.

The axis' motor is damaged. If possible, attempt to apply DC voltage to the motor from an external source such as a series of batteries. If the motor will not move, the motor is probably damaged.

When a manual jog key is released, the axis continues moving for about 5 seconds. This condition is indicative of a drive relay failure inside the RC4000. The RC4000 has a "safety" relay in series with the normal drive relays that opens 5 seconds after any commanded movement is stopped.

4.2.3 Automatic Movements

The mount does not go below the elevation DOWN limit when stowing. To proceed below the DOWN limit, the azimuth stow limit must be active. The RC4000 drives to the azimuth stow position and checks to confirm that the azimuth stow switch is active. If the azimuth stow limit is not active, the controller will make several attempts to find the stow switch in the immediate vicinity.

If the azimuth stow switch is not sensed in the correct position, check that the limit switch is working properly. There is also the possibility that the azimuth potentiometer has slipped causing the sensed stow position not to be in the same place the stow switch is active.

On some mounts, the polarization stow switch must also be active before movement below the DOWN limit may occur.

When stowing, the mount reaches the elevation stow position but the elevation motor continues to run. The stow routine does not stop until the elevation stow switch has been activated. If the elevation stow switch is faulty, the controller will continue to drive down. The RC4000 does implement a 5 minute "timeout" of the elevation axis drive in an attempt to prevent elevation motor "meltdown".

The mount begins an automatic movement (stow, deploy, etc.) but generates an "axis jammed" error. All automatic movements move to a "target" location. If far enough away from the target, the move will initially be done in the FAST speed for the axis and then switch to SLOW when close to the target. If the SLOW speed has been set too low, the axis may jam. Attempt to move the axis in SLOW speed from the MANAUL mode to duplicate the situation. If SLOW speed seems to be the problem, adjust the drive voltage up as discussed in 4.1.5.

4.2.4 GPS

The interface between the RC4000 and the optional GPS receiver is via an RS-232 serial port. The data stream from the GPS receiver is parsed in multiple places in order to receive latitude, longitude and time data. The following messages may be displayed when the RC4000 is attempting to receive data from the GPS:

** NO GPS PRESENT **. This message indicates that the gps_present item in the System Components (3.3.1.3) configuration item as been set to 0 indicating that no GPS is attached to the RC4000. No attempt will be made to parse GPS data in this state. If a GPS is truly attached, set the gps_present item to 1. Note that if the GPS option was not purchased with the controller, the gps_present item will not be allowed to be set to 1.

INITIALIZING or STARTING GPS. This message indicates that the RC4000 has sent a command to the GPS receiver to start communication. Normally this message should only appear momentarily until the first response from the GPS has been received.

GPS OFFLINE. This message means that no data has received from the GPS. If this message persists, troubleshooting of GPS communications as described below should be performed.

To check that communication with the GPS is occurring, move to the GPS Serial Port Diagnostics (3.3.2.6) screen. The data on the screen should update approximately once a second. If no data is being

displayed or the GPRMC data stream described in 3.3.2.6 is unrecognizable, the integrity of the cabling between the RC4000 and the GPS receiver should be checked.

NO GPS NAV. This message means that correct data streams are being received from the GPS, but the received data indicates that the GPS has not yet formulated a navigation solution (latitude and longitude.)

Under normal conditions the GPS should generate a navigation solution within 4 minutes of powering on. If the GPS has not been powered on for several weeks or if the GPS has been moved a considerable distance from the last position that it generated a navigation solution, the time it takes to generate a solution may go beyond 4 minutes. When the GPS is powered up, it assumes it is at the same lat/lon as when it was powered down. It also has stored the ephemeris data it had at that time. While powered down the GPS' real time clock will continue to timekeep.

The GPS will not generate a navigation solution if it cannot "see" 4 satellites. Check that the GPS unit has a clear view of the sky. If parked next to a tall building, even if the GPS has a seemingly clear view of the sky, the current GPS satellite constellation may be such that too many satellites are masked.

RF Interference. Strong interference from transmitting antennas close to the GPS receiver may also disrupt the receiver's ability to "see" satellites. Attempt to turn off transmitting sources (satellite phones, etc.) close to the GPS antenna to see if that affects the GPS' performance.

4.2.5 Fluxgate Compass

The interface between the RC4000 and the optional fluxgate compass is via a RS-232 serial port.

NO COMPASS. This message indicates that the compass_present item in the System Definition (3.3.1.2.1) configuration item has been set to 0 indicating that no compass is attached to the RC4000. No attempt will be made to parse compass data in this state. If a compass is truly attached, set the compass_present item to 1 or 2. Note that if the compass option was not purchased with the controller, the compass_present item will not be allowed to be set to a value other than 0.

"*****" in compass data field. The "*****" string in a position where compass data should normally appear indicates that the RC4000 cannot parse a valid heading string from the compass. Use the Fluxgate Serial Port Maintenance screen (3.3.2.7) to see if data from the compass is arriving at the RC4000.

If the heading string within the compass data shows "800.0" instead of a valid heading value (0.0 to 359.9), the compass is reporting that the magnetic field it is sensing is either too high or too low. Usually this means that another strong magnetic field is close to the compass. Try to relocate the compass away from any sources of magnetic fields (generators, air conditioners, etc.) Sometimes equipment that normally doesn't generate a magnetic field may become magnetized by some event such as a nearby lighting strike.

COMM ERROR during compass calibration. During a compass calibration procedure, the RC4000 sends commands to the compass and checks for correct replies. The COMM ERROR message indicates that a) a response from the compass was not received correctly or b) the calibration command from the RC4000 was not received by the compass. First check communication from the compass as above. If correct data is coming from the compass, then inspect the wiring to determine if the transmit (from RC4000 to compass) line is correct.

4.2.6 Alarm Displays

The alarm system monitors important parameters and flashes a message on the bottom line of the LCD display if an error is found. The parameters monitored include the condition of the lithium battery, status of the azimuth and elevation antenna drive systems and the values of certain variables. Some error codes have priority over others. Alarm conditions are sampled sequentially, with the highest priority sampled first. As corrective action is taken for each error, the code is eliminated, and if there is a lesser error, it will then appear.

4.2.6.1 FLASH / NVRAM VERSION MISMATCH

If the RC4000 recognizes a mismatch in the stored data (antenna mount type data) then this error code will appear. The only time this error typically would occur is during a software change in the ACU. A system reset to defaults may clear this error (3.3.1.3.1).

4.2.6.2 FLASH / NVRAM DATA CORRUPT

If there is corrupt data stored, then this error code will appear. The only time this error typically would occur is during a software change in the ACU. A system reset to defaults may clear this error (3.3.1.3.1).

4.2.6.3 LOW BATTERY ALARM

The RC4000 constantly monitors the level of the lithium battery via a 10 bit ADC channel on the microcontroller. When the power level is low, this error code will appear. Replace the battery with a Duracell DL2450. Make sure that the unit is unplugged from the AC or DC input power before removing the cover to change the battery.

4.2.6.4 TIME / DATE ERROR

This alarm code indicates either the Time or Date is corrupt. The time and date are entered via the Maintenance menu; refer to section 3.3.2.3, Time Maintenance.

4.2.6.5 AZIMUTH / ELEVATION / POLARIZATION JAMMED

The RC4000 continuously monitors the axis positions to detect incorrect movement of the mount. If an axis has been commanded to move and the RC4000 does not detect movement within a prescribed time, the controller will declare a "JAMMED" condition and not allow further movement in that axis until the condition has been reset.

More information is provided with regards to troubleshooting JAMMED errors in section 4.2.2.

4.2.6.6 AZIMUTH / ELEVATION / POLARIZATION RUNAWAY

If the RC4000 senses movement in an axis when no movement should be occurring, the RC4000 will declare a "RUNAWAY" condition. Like JAMMED, the RUNAWAY condition must be reset before further movement in the axis may occur.

4.2.6.7 LIMITS INACTIVE WARNING

It is possible to inactivate software logic that prevents axis movement due to a limit switch via the MAINTENANCE – LIMITS mode. Refer to section 3.3.2.5.

4.2.6.8 DRIVE OVERTEMP

When the Power / Drive Board receives a motor over-temp error signal, it will pass the error signal to the Computing Board. This error will only be applicable to those antennas which have motors that include an over-temp sense that is fed back into the ACU.

4.2.6.9 DRIVE ERROR

When the Power / Drive Board receives a drive error from an external source, it will pass the error signal to the Computing Board. This error will only be applicable to those antennas which have motors that include drive error feedback that is routed into the ACU.

4.2.6.10 EMERGENCY STOP

If the RC4000 is interfaced with an emergency stop switch, it will display this alarm code when the emergency stop switch has been depressed. The alarm will continue to display until the switch has be deactivated. During the time when this alarm is active, the RC4000 will not allow any movement of the antenna.

4.2.6.11 REPLACE HAND CRANKS

If the antenna has hand cranks that have sensed feedback to the RC4000, this error code will display if the hand cranks are not in a position that allows safe antenna movement via the ACU.

4.2.6.12 ELEVATION INTERLOCK

If the antenna has an elevation interlock switch that has feedback to the RC4000, this error code will display if the interlock is not in a position that allows safe antenna movement via the ACU.

4.2.6.13 MOVEMENT INTERLOCK

If the antenna has a movement interlock switch that has feedback to the RC4000, this error code will display if the interlock is not in a position that allows safe antenna movement via the ACU.

4.2.6.14 LOCAL JOG CONTROLLER CONNECTED

If a local jog controller (2.2.7) is connected to the RC4000, the alarm code "LOCAL JOG CONTROLLER CONNECTED" is displayed. The RC4000 will not allow any type of axis move via remote (serial or Ethernet) while the jog controller is connected.

4.3 ACU Topics

4.3.1 Antenna Pointing Solution

The position (latitude and longitude) of the mount and the longitude of a selected satellite are required to calculate a pointing vector from the mount to the selected satellite.

Pointing Vector

Lat/Lon of Mount

Sat Lon

eq6.dwg

Elevation
Target

To Sat

eq7.dwg   Local Horizontal
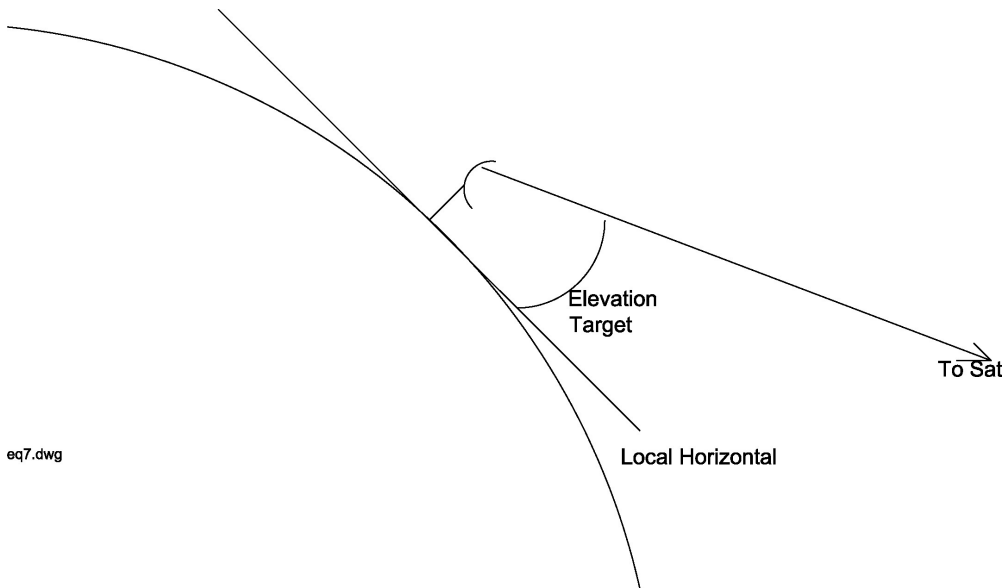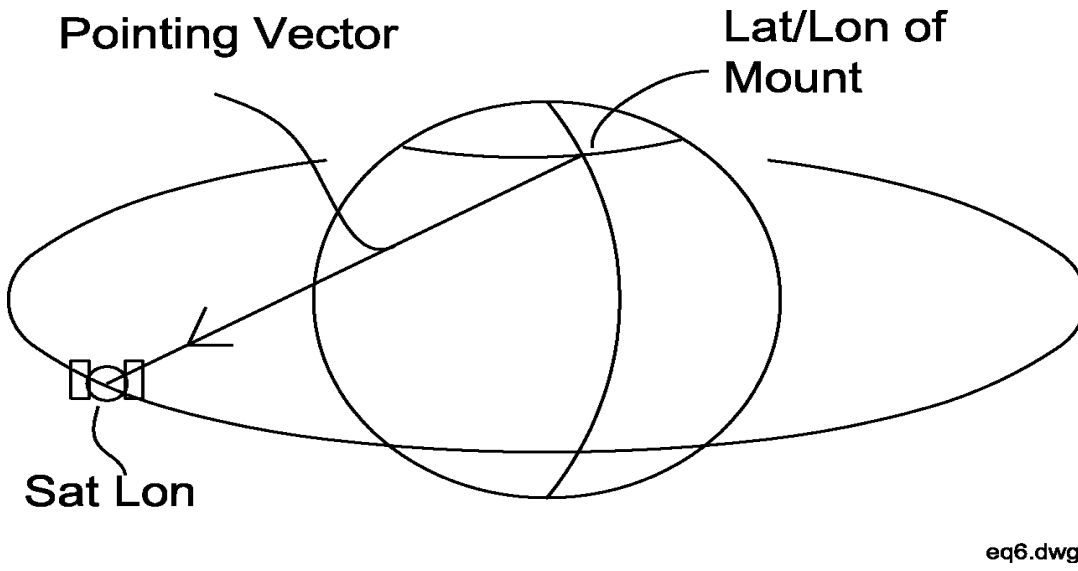
Given the mount's latitude and longitude and the pointing vector to the satellite, the RC4000 calculates the elevation (with respect to local horizontal) required. Feedback from the inclinometer on the elevation axis will be used to move the mount to the required elevation.

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

az_point.dwg
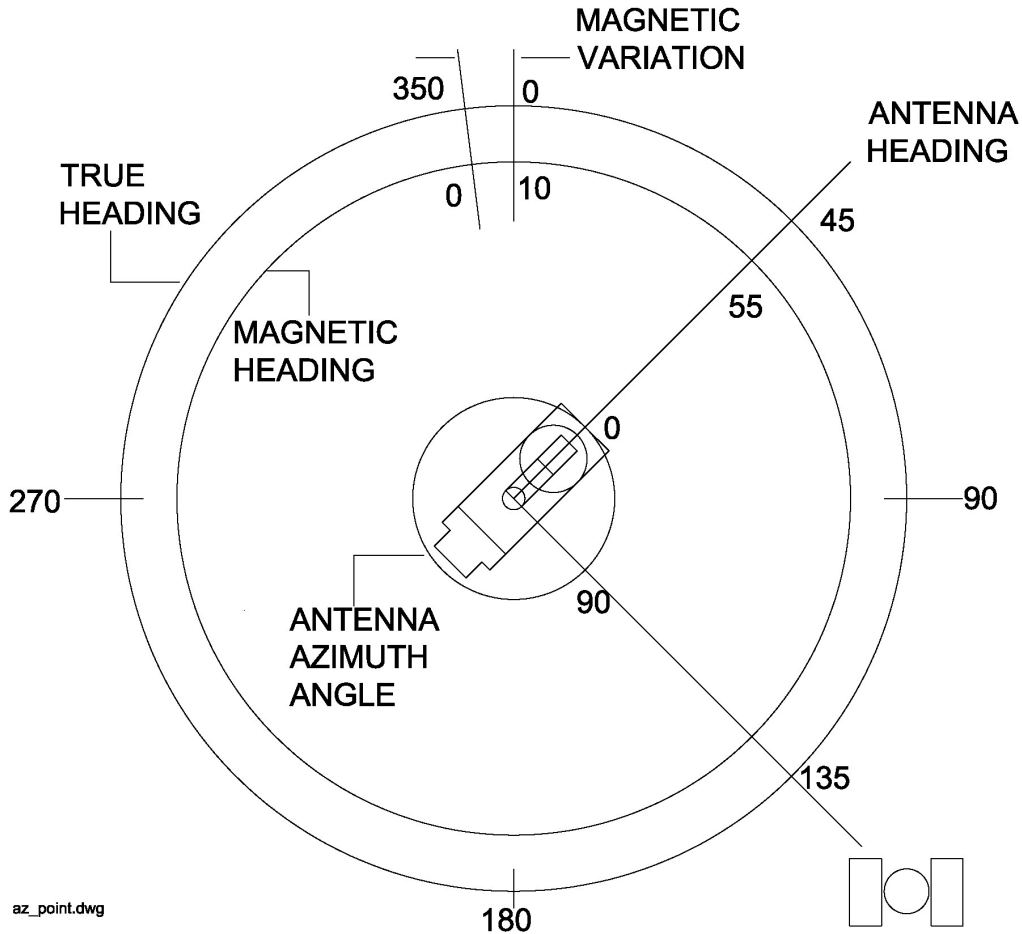
In the above example a true heading of 135 degrees to the satellite has been calculated. Based on the mount's latitude, longitude and date, a local magnetic variation (see 4.3.5) of 10 degrees is calculated. The compass senses a magnetic heading of 55 for the azimuth reference direction. Applying the 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 RC4000'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 (3.2.1) and LOCATE (3.2.2.3) modes.

4.3.2 Timekeeping

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

System time is maintained by the RC4000's real time clock. The real-time clock is backed up by battery so that system time is available as soon as the RC4000 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 RC4000'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 RC4000 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 RC4000 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 RC4000 determines at what point in a sidereal day (with respect to the RC4000 reference) it is by calculating how many sidereal days have passed from January 1, 1992 until the present system time.

In several screens the RC4000 displays a **reference time**. The user may designate a three letter timezone designation and an hourly offset from system time. This allows the user to display local time or some other reference time without modifying system time. If system time is maintained close to UTC, the reference time displayed may be of use to operators for coordinating events.

See section 3.3.2.3 for details on time maintenance.

4.3.3 Drive System

The RC4000 implements several mechanisms for the driving and monitoring of the azimuth, elevation and polarization axis.
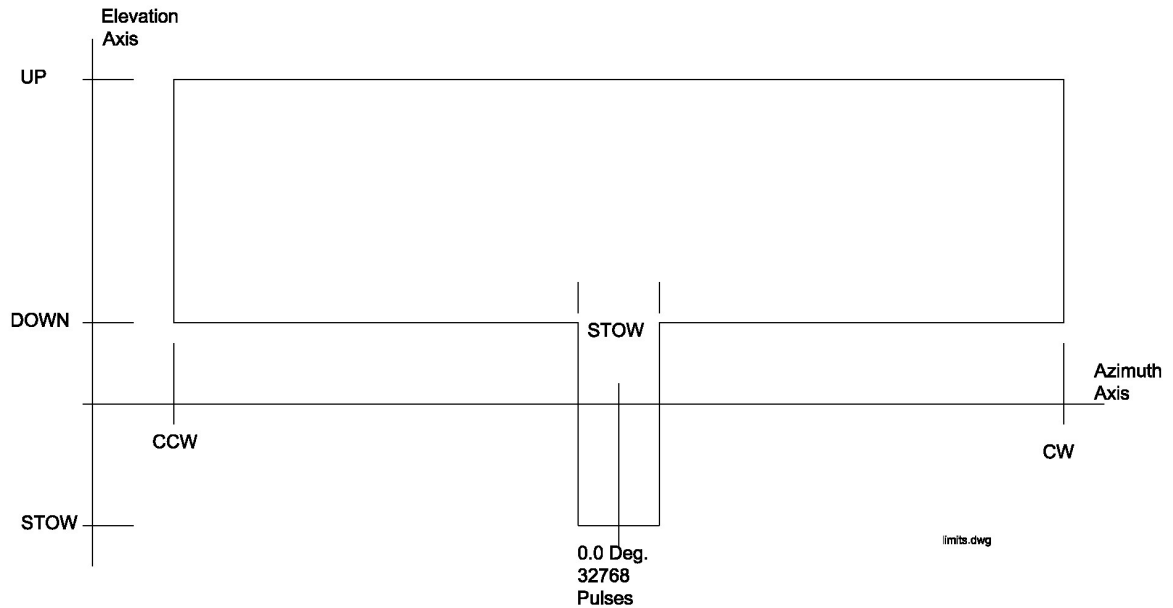
Position Sensing and Limits

The RC4000 senses absolute axis position using feedback from various sensors (potentiometers, resolvers, inclinometer for elevation, etc). The sensed voltage is scaled appropriately for the particular mount. This sensed position is displayed in angular format.

For systems requiring very small movements for inclined orbit tracking, the RC4000 also supports pulse feedback from the azimuth and elevation axis. Sensed pulses from the axis motor don't provide an absolute indication of position but allow for very precise relative movements.

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.

```
        Elevation
        Axis
UP ──┬──┐┌────────────────────────────────────────────┐
     │  │                                              │
     │  │                                              │
     │  │                                              │
     │  │                                              │
     │  │                                              │
DOWN ──┬──┘│          │ STOW │                        │
     │     │          │      │                 Azimuth
     │     │          │      │                 Axis
─────┼─────┼──────────┼──────┼───────────────────────
     │     CCW        │      │                    CW
     │                │      │
STOW ──┴──            │      │        limits.dwg
     │                └──────┘
                      0.0 Deg.
                      32768
                      Pulses
```

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.

Jam and Runaway Sensing

The RC4000 continuously monitors the axis positions to detect incorrect movement of the mount. If an axis has been commanded to move and the RC4000 does not detect movement within a prescribed time, the controller will declare a "JAM" condition and not allow further movement in that axis until the condition has been reset.

Similarly if the RC4000 senses movement in an axis when no movement should be occurring, the RC4000 will declare a "RUNAWAY" condition. Like JAM, the RUNAWAY condition must be reset before further movement in the axis may occur.

Anti-Reversal

In order to save wear on the drive motors, the RC4000 limits how fast an axis may reverse its direction. This mechanism prevents a motor from instantly changing direction before coasting to a stop in the original direction. This mechanism is also useful for correct counting of pulses. Since the RC4000 counts a pulse as being in the direction that the controller thinks the axis should be going, it is imperative to stop the motor completely before moving in the opposite direction.

Automatic Movements

In order to provide smooth automatic movement to target positions, the RC4000 utilizes several parameters to account for different mount characteristics.


automove.dwg
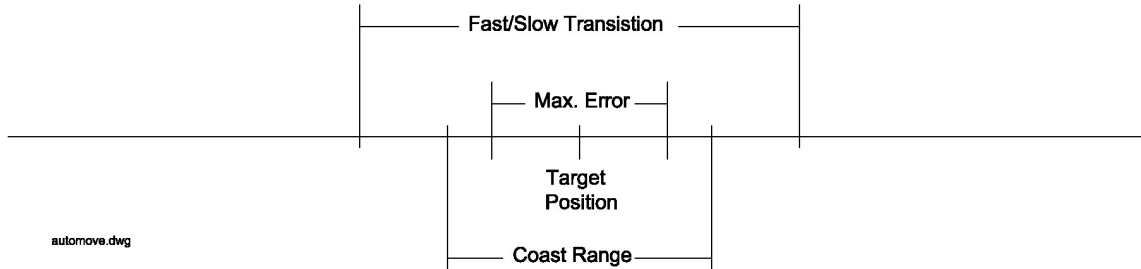
The Fast/Slow Transition parameter defines how far away from a target position the RC4000 will switch from fast to slow motor speed. The Coast Range defines where the RC4000 will de-energize the motor drive to allow the mount's inertia to coast into the target position. The Max Error parameter defines how close to the target position will be considered good enough.

Note that the DC motor control module in the RC4000 provides for smooth acceleration/deceleration, load regulation and dynamic braking of the motors.

4.3.4 Polarization Control

The RC4000 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.

pol2.dwg
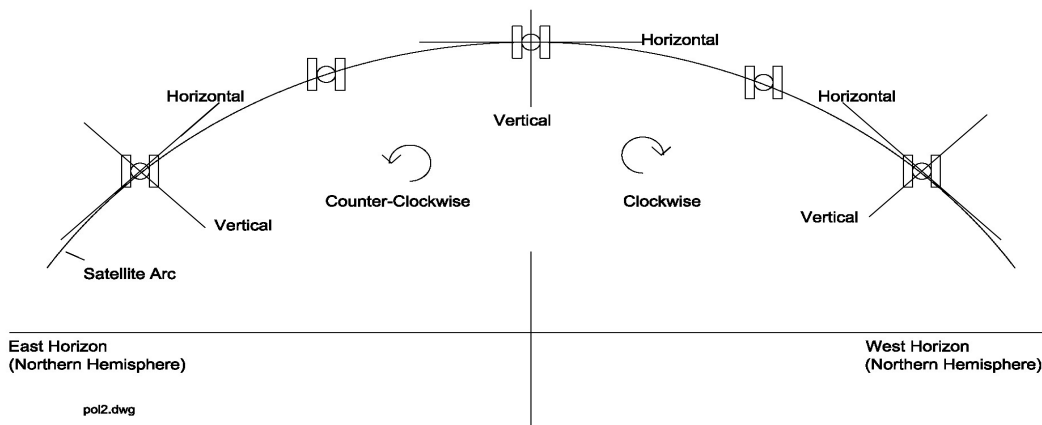
The RC4000 allows the user to specify the type of polarization axis mechanism present. If a circular polarization scheme is present, no automatic movement of the polarization axis is performed. If a linear polarization scheme is present, the RC4000 will calculate the theoretical position as a function of mount latitude, mount longitude and satellite longitude.

4.3.5 Magnetic Variation

In order to calculate satellite pointing solutions, the mount's orientation with respect to True North must be known. The RC4000 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.
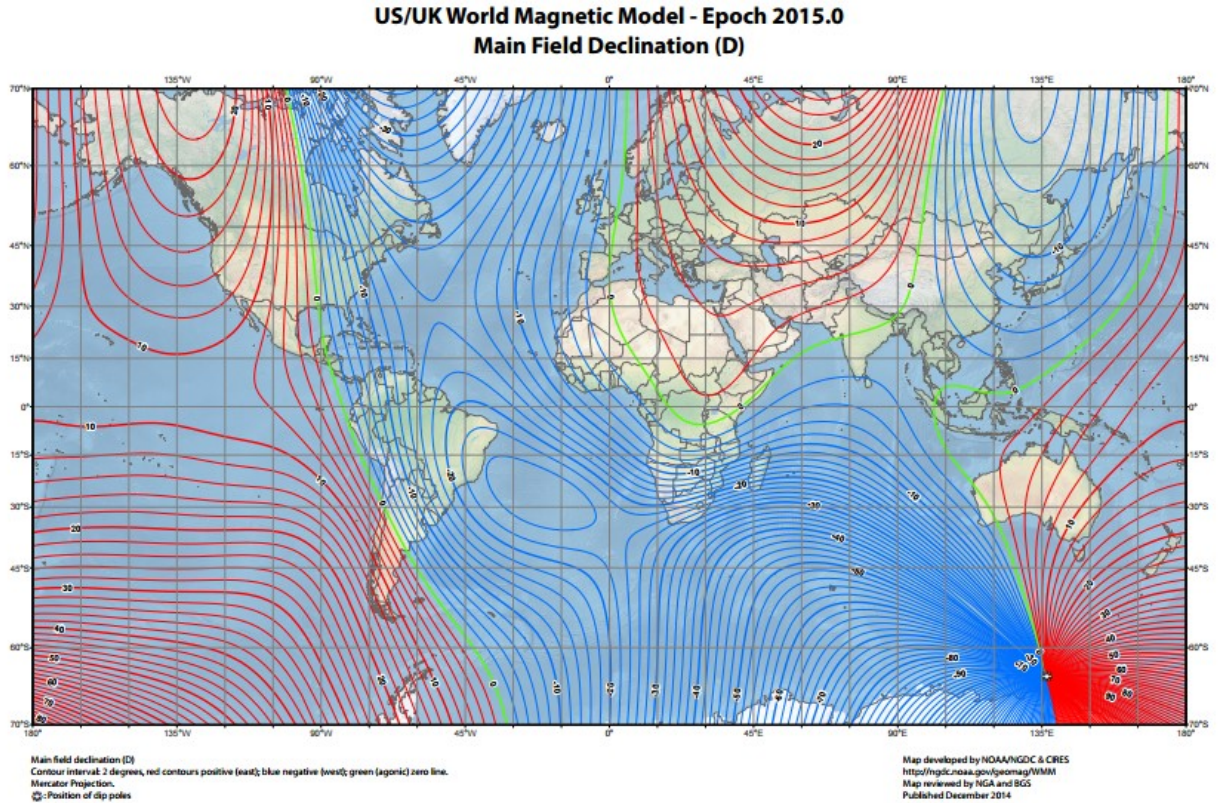
The magnetic field also changes slowly over time. The following table shows how the magnetic variation for Washington D.C. has changed over the last 250 years.

YEAR	MAGNETIC VARIATION
1750	-3.3
1800	-1.0
1850	-2.5
1900	-5.5
1950	-7.5
2000	-10.6

The RC4000 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 mount'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 autopeak scan functions (3.2.2.3.3 and 3.2.2.3.4) are used to compensate for these heading calculation errors.

4.3.6 System Performance

The performance achieved by the RC4000 in locating and tracking satellites is dependent on the mechanical tolerances of the mount, 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 truck's magnetic heading. Errors in heading primarily affect the accuracy of the antenna's calculated azimuth position. The flux gate determines the magnetic heading by measuring the direction of the magnetic field at the sensor tower. 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, as well as those "worked into" the coach body during manufacturing.

For the flux gate 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 truck 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 truck is being operated. This component of the distortion varies as the truck 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 date, the largest known azimuth error due to these interactions is less than 10 degrees. To help alleviate this azimuth error, the Auto Peak feature scans an azimuth range about the target azimuth and seeks the strongest signal. This feature is explained in full in section 3.2.2.3.

The RC4000 uses a 12-bit analog to digital converter for measuring voltages from azimuth, elevation and polarization potentiometers as well as measuring signal strength inputs. In most cases this provides adequate resolution but should be considered. For example, if the azimuth axis has 360 degrees of travel, the resolution achieved is 360/4096 = ~0.088 degrees. This example highlights why pulse or resolver sensors are used to make precise movements for inclined orbit tracking. The optional resolver interface uses a 16 bit resolver to digital converter. This allows resolution of 360/65536 = ~0.0055 degrees.

APPENDIX A - EXPERT ACCESS CODES

To initiate INSTALL ACCESS permission or to RESET SYSTEM DEFAULTS, the user must enter the five digit code:

42458

To initiate SUPER-USER ACCESS permission, the user must enter the five digit code:

20261

These codes have been printed in this final section of the manual so that management may choose to remove the information to restrict the possibility of inexperienced users incorrectly programming the RC4000. USE CAUTION!