

RC2000A DUAL AXIS ANTENNA CONTROLLER

v 2.32



**SEE APPENDIX I FOR UPGRADED FEATURES FOUND IN SOFTWARE
VERSIONS 2.6 AND LATER.**

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REVISION HISTORY

3.3.92 v 1.11

- * Updated satellite list.
- * Revised antenna anti-reversal algorithm to function properly for short moves.

4.8.92 v 1.21 Effective S/N E1015, 1018 and thereafter

- * Setup mode modified to allow movement of the antenna.
- * For modified polar mounts, the elevation position can be displayed relative to the geosynchronous position.
- * The EAST and WEST keys have been reversed.
- * The user is prompted to enter a longitude when a satellite is added in SETUP mode.
- * A bug was corrected relating to the display of satellite names after a deletion took place.

9.24.92 v 1.22 Effective S/N 1073

- * Capability for angle display of the az and el axis has been added for elevation over azimuth mounts.
- * Two C programs are included for the derivation of the needed display constants for angle conversion.
- * The 32K x 8 SRAM was replaced with an 8K x 8, and new PLD is RC2KD.

4.27.93 v 1.30 Effective S/N 1136

- * Support has been included for a polarization motor which uses a pot for feedback.
- * The software has been modified for use with AC motors.
- * The remote mode code has been modified so that an auto move may specify an azimuth and elevation position in place of the satellite name.
- * A system has been designed which limits user access to certain config mode items and modes.
- * Whenever the baud rate is changed, the unit must be powered down and back up in order for the change to take effect. Note that invoking the reset-system-data command from CONFIG mode will reset the baud rate to the default value of 9600.

10.20.95 v 1.40 / v1.41 Effective S/N 1599

Versions 1.40 and 1.41 differ in the polarization control options which are supported. Version 1.40 can accept the RC2KPOL option, which is designed to interface with the Seavey model ESD-124D 4 port motorized feed (24 VDC, 500 milliamps max) with potentiometer feedback. Version 1.41 can accept the RC2KHPP option. The RC2KHPP option is designed to interface with motorized feeds with potentiometer feedback which require 5 to 40 volts DC at 3 amps.

- * Updated satellite list.
- * The 'POLAROTOR PRESENT?' CONFIG mode prompt was replaced with 'ROTATING FEED PRESENT?'

- * The azimuth and elevation angle display system has been modified to accept negative offset values, and the definition of the angle display scale factors has been modified. The scale.exe PC program was replaced with scale2.exe.
- * The azimuth slow speed system is essentially disabled if the AZIM SLOW SPEED is set to 254. The elevation slow speed system is disabled if the ELEV SLOW SPEED is set to 254.
- * The routine which prompts the user to enter the alphanumeric characters for a user-defined satellite name in SETUP mode has been modified to allow the user to select the hyphen (-) character.
- * Whenever the baud rate is changed (either via CONFIG mode or as part of a system reset) the microcontroller's internal baud rate select registers are re-initialized so that it is not necessary to power the controller down and back up to have the baud rate change take effect.
- * The EPROM for this version of the software may be used in systems currently running 1.30 code with minimal reconfiguration. The non-volatile memory map has not changed from 1.30. The definition of the *Azim Scale Factor* and *Elev Scale Factor* has changed, however. When upgrading a system running version 1.30 software, these two values should be increased by a factor of 10 (i.e. if the *Azim Scale Factor* in a system running v 1.30 software is 19, the *Azim Scale Factor* should be changed to 190 when upgrading to version 1.31).
- * All versions of the controller can run this version of the software. Note that for controllers running v 1.21 (or earlier) software it is necessary to use the RC2KD or RC2KE programmable logic device (PLD).
- * A problem with Expert Access which did not allow a user to correct an item that did not contain valid data was corrected.
- * A problem with the computer control routine was corrected; it will now send an NAK (negative acknowledgement) if a command is received that did not contain a valid command code or if the length of the message was not appropriate for the command code contained in the message.
- * The routine which interprets the azimuth and elevation fast and slow deadband CONFIG mode items has been corrected.
- * The software has been modified so that it can be compiled to support either the RC2KPOL polarization control option (version 1.40) or the RC2KHPP polarization control option (version 1.41).
- * The POL SENSOR and POL JAMMED alarm messages have been replaced by the ANTENNA POL alarm message.
- * RESET mode has been modified to display polarization status information (JAMMED, SENSOR (backwards movement of the pot), and DRIVE (over-current)). The DRIVE error will not display for the standard rotating feed drive. Status codes are not displayed in RESET mode.
- * The reply to the REMOTE MODE status poll command has been changed slightly.

2.2.98 v 1.50 / v1.51

Effective S/N 2129

The satellite list has been upgraded.

The controller's keypad/overlay has been changed. The key which was formerly labeled EAST is now labeled CCW and the key which was formerly labeled WEST is now labeled CW. The LIMITS mode prompts have been changed. The user is now prompted to set the CCW and CW limits. The manual has also been changed to replace references to the EAST and WEST keys with CCW and CW, respectively.

The software has been modified to work with digital boards that have the watchdog timer jumper.

9.19.00 v 2.30/ v2.31

Effective S/N 3342

The satellite list has been upgraded.

The user can modify the operation of the runaway alarm sensing system via the values assigned to the Azim Fast Deadband and Elev Fast Deadband CONFIG mode items. Each axis can be configured separately.

01.27.05 v 2.6x

We have added Addendum I to the manual. This addendum addresses the following features;

- * Support added for a signal strength based pickup after automatic moves.
- * Communication protocol enhanced to support ...
 - Upload/download of CONFIG mode and satellite data.
 - Remote front panel emulation via a keystuff command and display reflect command. This allows remote access to all receiver functions.
 - The RC2000A can service a remote Device Status Poll command without switching to REMOTE mode.
- * The Rotating Feed Present CONFIG mode item has been replaced with the Pol Control? CONFIG mode item. The Pol Control? CONFIG item allows the user to specify i) no polarization control device, ii) one port polarization control, iii) two port polarization control, or iv) Chapparral Polarotor type three wire servo.
- * Signal strength can be input to the controller via the AGC1 and AGC2 analog inputs. Signal Strength is displayed in MANUAL, SETUP, LIMITS, and REMOTE modes. In MANUAL mode, the scroll up and Scroll Down allow the user to select either AGC1 or AGC2 for display.
- * The controller supports a Sticky Key Jog. With Sticky Key Jog, in MANUAL mode an az/el jog is initiated by hitting the Az CCW, Az CW, El Down, or El Up keys. Once a sticky key jog is initiated it will continue until the user hits the Stop key or leaves MANUAL mode.
- * The warning messages that the user encounters on entry to POL LIMITS mode has been modified so that 'POL LIMITS' is always displayed in the upper right hand corner of the LCD.
- * A bug that sometimes resulted in erratic display of satellite information in AUTO and SETUP modes when scrolling through a list of satellites with the Scroll Up/Down keys has been fixed. This problem is more prevalent on RC2000C Tracking Controllers.
- * The controller's VONFIG mode has been modified to allow access to a CONFIG mode item anytime the item does not contain valid data and Expert Access Mode is enabled.
- * Bug Fix
- * The reply to the Query ID remote command was modified to include the correct command code.

06.15.09 v 2.7x

We have updated Appendix E for v27x to the manual.

03.10.10 v. 2.32 Effective S/N 8000

Cable length specs and App G were modified to reflect the performance of the replacement transformer.

03.23.11

Added RC1KADP Schematic

Chapter 1 INTRODUCTION

The RC2000A antenna controller is designed to control a dual axis antenna with 36 volt actuators and pulse type position sense feedback. The RC2000A was designed with the requirements of the commercial user of satellite downlink services in mind. Here is a brief listing of the capabilities of the RC2000A.

1. The controller utilizes a solid state drive system capable of providing 8 amps to the antenna actuators. The drive system has built in over current sensing with mechanical relay backup to disconnect the drive from the actuators in the event of a fault.
2. The controller can provide polarization control via a Chaparral type polarotor. The AutoPol feature allows the controller's polarization output to be slaved to a digital input or contact closure obtained from a satellite receiver.
3. The controller also has an internal expansion port that can accept optional daughter boards. Two daughter boards are available which can provide polarization control, designated RC2KPOL and RC2KHPP. The RC2KPOL is designed for use with the Seavey model ESR-124D motorized feed with potentiometer feedback. The Seavey feed requires 24 volts at 500 milliamps. The RC2KHPP option is designed for motorized feeds with potentiometer feedback which require 5 to 40 volts DC at currents up to 3 amps. Version 1.50 of the software supports the RC2KPOL option. Version 1.51 supports the RC2KHPP option.
4. Position sensing feedback can be supplied by any pulse-based sensor - reed switch, Hall effect, or electro-optical. There is no need for special sensors or actuators. The RC2000A keeps track of both rising and falling pulse edges from the pulse sensor for increased accuracy.
5. The non-volatile memory can hold position and polarization data for 50 geostationary satellites.
6. The Adapti-Drive variable speed control system allows the user to specify the desired slow speed for each axis. The Adapti-Drive system will then adjust the actuator voltage (via a pulse width modulation scheme) to maintain the speed selected by the user. This alleviates the problems of poor speed regulation with varying direction along a given axis and environmental conditions associated with constant voltage slow speed systems.
7. The RC2000A is equipped with an RS-422 communications port. This allows the controller to interface with a PC. The communication protocol used is compatible with the popular SA-Bus protocol. Two IBM PC compatible programs are included with the controller. The optional AUTOPILOT software package allows a single PC to control multiple antenna positioners and satellite receivers. An optional RS-232 to RS-422 interface converter, designated RC1KADP, is available to convert the RS-232 interface (which is standard on PC's) over to the RS-422 interface required for the SA-Bus protocol.

1.1 Organization of this Manual

This manual is divided into two broad parts, Installation and Reference. The Installation part of this manual is designed to familiarize the user with the controller and guide him or her through the installation and configuration of the controller. The Reference portion of the manual gives a detailed description of all of the features and capabilities of the controller.

The Installation portion of the manual is comprised of Chapters 2 and 3. Chapter 2 explains the user interface and the basic operation of the unit. Chapter 3 guides the user through the physical installation and wiring of the unit as well as the initial software configuration.

The Reference portion of this manual is comprised of chapters 4, 5, and 6 as well as the appendices which follow. These chapters of the manual describe every field on every screen which the user will ever encounter as well the data which can be entered at any prompt. After the initial installation, when the user has become familiar with the operation of the controller, Chapters 4 and 6 will probably be the only ones consulted by the user to handle the routine chores of adding new satellites and deleting old ones.

1.2 Before You Begin

Please read and understand the manual. Time invested in understanding the installation and operation of the controller will insure satisfactory results. The unit has been tested thoroughly and will work accurately and reliably if it is installed and configured properly. There is an old saying in the controller business - "Garbage in, garbage out". Be sure to follow the procedure described in chapter 3 for installing and configuring the controller.

Chapter 2 BASIC FUNCTION DESCRIPTION

This chapter describes the controller's front panel layout, user interface and basic operation. When the user has completed this chapter, he or she should have a basic understanding of the various operating modes of the unit and be able to use the keyboard and liquid crystal display (LCD) to navigate through those modes.

2.1 Front Panel

The front panel (figure 2.1) of the RC2000A contains an ON/OFF switch, a 2 row by 40 column backlit LCD, and a 4 by 4 matrix keypad with tactile feedback. On the rack mount version of the controller, an AC line fuse is built into the Power Entry Module in the back panel. A 12-amp circuit breaker (located on the back of the unit) protects the controller's 36-volt actuator drive circuits. When a circuit breaker of this type trips, it will protrude from its mounting bezel. To reset the circuit breaker, turn the power switch off, wait a few minutes for the circuit breaker to cool down, then depress the breaker so that it latches and is even with the bezel.

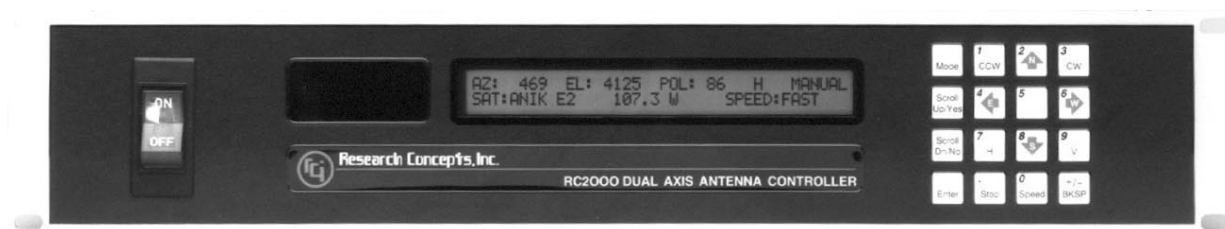


Figure 2.1

The field in the upper right hand corner of the LCD is reserved for the display of the current mode of the controller. The various modes are introduced in the following section. If an error condition is active, an error message will periodically flash across the bottom row of the display. Error messages are discussed in chapter 6. Chapter 4 explains the contents of every field on the display for all of the various controller modes.

An examination of the keyboard in figure 2.2 reveals that many of the keys have 2 or more labels. The function of each key is determined by the current mode of the controller. The various modes are discussed in the following section.

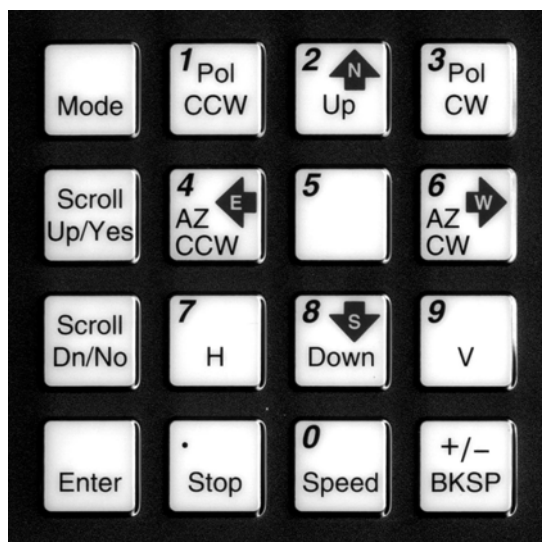


Figure 2.2

MODE

This key is used to select the current mode of the controller. See the description of the various modes in the next section. This key is always active. Depressing this key will always cause a mode change to occur. This key is acted on when it is released. If the key is briefly depressed and released the controller mode will change to the next sequential mode of the mode group which is currently active. If the key is depressed for at least five seconds and then released, the current mode will change to the first mode of the mode group which is not currently active.

SCROLL UP/SCROLL DOWN

These keys scroll up or down through a list of items. These keys are used when selecting a satellite from a list of satellites, selecting a data item to either view or modify, and when selecting alphanumeric characters for a user specified satellite name in SETUP mode.

YES/NO

These keys are used to supply an answer to a YES or NO question.

ENTER

This key is used to select an entry from a list, terminate a prompt for some action by the user, or to complete the entry of numeric data.

0-9/DECIMAL POINT (with the stop key)/BKSP

These keys are used for numeric entry. The BKSP key causes the cursor to move one column to the left writing over the character which was there. In some modes, the BKSP key is used to prompt the user to confirm that a critical parameter is about to be changed.

SPEED

This key toggles the speed from fast to slow and vice versa.

ARROW KEYS - 2/4/6/8

These keys are used to manually jog the antenna in some modes. The AZ CCW and AZ CW arrow keys jog the antenna ccw and cw in azimuth, respectively, while the up and down arrow keys jog the antenna up or down in elevation. Small type within the red arrow indicates compass direction for antennas installed in the northern hemisphere.

E/W/N/S

These direction keys, E east, W west, N north, and S south are used to specify a direction when the user is entering latitude or longitude data. These coincide with the arrow keys above.

POL CCW/ POL CW/ H/ V

These keys control the polarization. The POL CCW and POL CW keys skew the polarotor counterclockwise and clockwise. The H and V keys are used to either select or specify the polarization position associated with a given satellite.

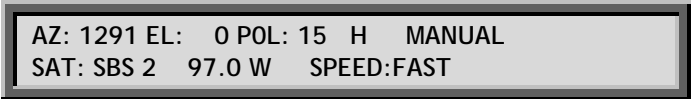
Note that all of these keys are not active simultaneously. The function of each key is dependent on the current mode of the controller. In some modes certain keys are ignored.

2.2 Operating Modes

The mode system on the RC2000A antenna controller resembles the menu system used with many personal computer (PC) programs. On a PC program a menu system allows the user to perform operations or to enter in data. The user must navigate through the menu structure to the particular menu which allows access to the function or data that the user wishes to manipulate.

On the RC2000A, the mode which is currently active is always displayed in the upper right hand corner of the LCD. The MODE key is used to switch between modes. User access to all operations performed by the controller and all data maintained by the controller is governed by the mode system. Here is a summary of the modes implemented on the RC2000A.

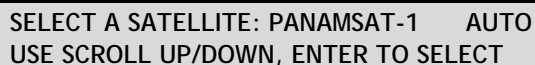
MANUAL



AZ: 1291 EL: 0 POL: 15 H MANUAL
SAT: SBS 2 97.0 W SPEED:FAST

This mode allows the user to jog the antenna in elevation and azimuth using the ARROW KEYS, toggle the speed from fast to slow (and vice versa) with the SPEED key, jog the polarization with the CCW/CW keys, and use the H/V keys to toggle between the preset H and V polarizations of the satellite located closest to the antenna's present position. When MANUAL mode is active, the following information is displayed on the top row of the LCD - azimuth position (AZ), elevation position (EL), and polarization position (POL). The bottom row of the LCD displays the name and longitude of the satellite on which the antenna is currently aligned and either the FAST or SLOW banner to indicate the speed which will be used for jogging the antenna. Note that if the AutoPol feature (described later in this chapter) is enabled, the user will not have control over the polarization functions and the 'POL:' display banner will be replaced with 'RCV:'.

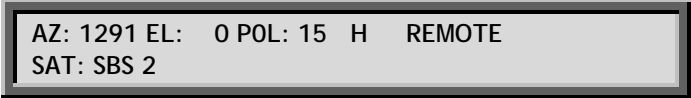
AUTO



SELECT A SATELLITE: PANAMSAT-1 AUTO
USE SCROLL UP/DOWN, ENTER TO SELECT

This mode allows the user to select a satellite which has previously been stored in memory and automatically position the antenna on that satellite. In this mode the SCROLL UP/DOWN keys are used to scroll through the list of satellites which have been programmed in by the user (via SETUP mode). When the name of the desired satellite appears the ENTER key is hit to initiate the automatic move. While movement is in progress the STOP key can be hit to terminate the move. When the antenna reaches the target position the polarization is adjusted to the horizontal polarization position associated with the desired satellite.

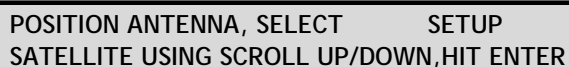
REMOTE



AZ: 1291 EL: 0 POL: 15 H REMOTE
SAT: SBS 2

In this mode, the controller receives and acts on commands received via the communications port. This mode can only receive control if enabled via a CONFIG mode item. The only key which is active is the MODE key, which can be used to switch to a different mode. Note that REMOTE mode will become active if a valid command is received via the serial port.

SETUP



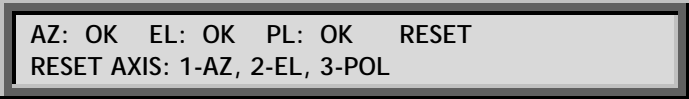
POSITION ANTENNA, SELECT SETUP
SATELLITE USING SCROLL UP/DOWN,HIT ENTER

This mode allows the user to store satellite azimuth and elevation positions and horizontal/vertical polarization values into the controller's non-volatile memory. Once stored in memory, the satellite is available for recall by AUTO mode. When SETUP mode is invoked the user peaks the antenna up on

the desired satellite using the azimuth jog, elevation jog, polarization jog, H/V, and SPEED keys as described for MANUAL mode above. The SCROLL UP/DOWN and ENTER keys are also active at this time. The SCROLL keys are used to scroll through a list of satellite names stored in the controller's EPROM memory. This is the name which will be assigned to the azimuth and elevation positions and the polarization values stored in the non-volatile memory. The ENTER key is used to select a value from the list of satellite names.

When the ENTER key is hit the user is prompted to specify the satellite longitude and the H and V polarization values for the satellite. If the user wishes to assign a name which is not stored in the satellite's EPROM memory, the USER entry in the satellite name list may be selected and the operator will be prompted to enter in an alphanumeric string using the SCROLL UP/DOWN and ENTER keys. When data for one satellite has been stored into non-volatile memory, the user is prompted to position the antenna on another satellite and repeat the process.

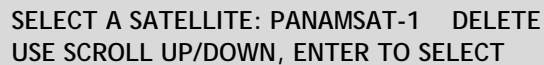
RESET



AZ: OK EL: OK PL: OK RESET
RESET AXIS: 1-AZ, 2-EL, 3-POL

This mode allows the user to examine the error status of the motor drive circuits and reset them if a fault has occurred. The drive systems of each axis are independent. A DRIVE error indicates that the drive circuit detected an over current fault and was disabled. A JAMMED error indicates that the antenna actuators were commanded to move but no movement was detected. A RUNAWAY error indicates that antenna movement was detected when the actuators were not energized. A SENSOR error can occur only on the polarization axis when the unit is configured for a rotating feed. It indicates movement of the polarization sense pot occurred in the opposite direction from that expected. Any error condition can be reset by pressing the key designated on the bottom line of the display. Errors are covered in chapter 6.

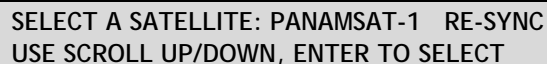
DELETE



SELECT A SATELLITE: PANAMSAT-1 DELETE
USE SCROLL UP/DOWN, ENTER TO SELECT

This mode allows the user to delete satellites from non-volatile memory. The SCROLL UP/DOWN and ENTER keys are active.


RE-SYNC



SELECT A SATELLITE: PANAMSAT-1 RE-SYNC
USE SCROLL UP/DOWN, ENTER TO SELECT

The antenna azimuth and/or elevation position can be corrupted by any number of causes (sensor failure, lightning strike, faulty shield connection, etc). If there is an error in the position counts, the controller cannot properly position itself on the satellites stored in non-volatile memory, and the limits are not valid. In this situation, it is necessary to re-synchronize the controller's internal position counts. To do this, the operator positions the antenna on a known satellite which has previously been stored in the controller's non-volatile memory. The user then activates RE-SYNC mode and selects the satellite with which the antenna is currently aligned using the SCROLL UP/DOWN and ENTER keys. When the ENTER key is hit, the controller's internal position counts are initialized to the positions which were assigned to the satellite name when that satellite was stored in non-volatile memory. This restores the count to the value stored prior to the event that caused the data corruption, and affects all satellites stored in non-volatile memory.

AZIM SLOW



AZ: 1246 SPEED:165 AZIM SLOW
USE SCROLL UP/DOWN, <>, ENTER TO SET

In this mode the antenna can be moved at slow speed about the azimuth axis through the use of the AZ CCW and AZ CW keys and the azimuth slow speed code can be adjusted by using the SCROLL

UP/DOWN keys. The user selects a slow speed code and then jogs the antenna to test the selection. When a satisfactory slow speed has been found the ENTER key may be used to store that slow speed code into non-volatile memory. Note that after the slow speed has been changed through the use of the SCROLL UP/DOWN keys and the antenna is jogged in azimuth to test out the selection, it may take a while for the azimuth slow speed to settle to its final value.

ELEV SLOW

```
EL: 1452 SPEED:160 ELEV SLOW
USE SCROLL UP/DOWN, ^v, ENTER TO SET
```

This mode is similar to the AZIM SLOW mode. It allows the user to specify, test, and set the elevation slow speed. See the description of the AZIM SLOW mode described above.

CONFIG

```
AUTOPOL ENABLE:*          CONFIG
0-DISABLE, 1-ENABLE  ENT,BKSP,SCROLL ^v
```

This mode allows the user to view and enter configuration data into the controller. This data is stored in non-volatile memory and is used to set certain parameters and enable or disable certain controller options. The following parameters and options are controlled or configured via data entered into the controller from CONFIG mode: AUTOPOL (described below), simultaneous azimuth/elevation movement, the communication port parameters, the geo elevation position, azimuth/elevation angle display parameters, polarization options, and az/el drive options.

In CONFIG mode, the SCROLL UP/DOWN and ENTER keys as well as the numeric keypad are active. The SCROLL UP/DOWN keys are used to select the parameter to be viewed or modified. If asterisks are displayed in the parameter field it means that the present value for the parameter is invalid. The parameter can be modified using the numeric keypad to key in a new value. For the modification to take effect, the numeric entry must be terminated with the ENTER key. A message in the lower left hand corner of the display gives the user data entry instructions.

LIMITS

```
AZ: 5000 EL: 5000          LIMITS
7 - SET CCW LIMIT  9 - SET DOWN LIMIT
```

This mode allows the user to jog the antenna to any azimuth or elevation position without regard to any existing limits, and initialize the azimuth clockwise and counter-clockwise and/or down and up limits. Once the limits are set the antenna cannot be moved (except in LIMITS mode) to a position that is not within the region defined by the down, up, azimuth clockwise and azimuth counter-clockwise limits.

To set the azimuth limits, the user would first move the antenna to the desired azimuth counter-clockwise limit, set the limit, then move the antenna to the desired azimuth clockwise limit and set that limit. When the limits for a particular axis are initialized the position count for that axis is also reset. Whenever the azimuth (or elevation) limits are reset the azimuth counter-clockwise (or down) limit is assigned a position count of 30. If the down and up elevation limits have been reset, the user is then prompted to set the GEO ELEV POSITION. This feature is described later in this chapter.

POL LIMITS

```
POL: 745 POL LIMITS
USE CW,CCW - 5 TO SET FIRST POL LIMIT
```

If the optional RC2KPOL or RC2KHPP daughterboards are installed in the RC2000A, the controller can support a rotating feed with potentiometer feedback. In this mode the user can set the polarization limits for the optional polarization motor. The user will be able to access this mode only if the *Rotating*

Feed Present? CONFIG mode item is set to Yes. Before attempting to set the polarization limits for the rotating feed, please consult section 3.3.

More detailed information is available concerning each of the modes described above in chapter 4 of this manual.

2.3 Changing Modes with the MODE Key

The user can switch the current controller mode by use of the MODE key. The MODE key is always active - when the MODE key is depressed, the controller's current mode will change. The various modes are divided into two groups. The Operational mode group consists of the MANUAL, AUTO, and REMOTE modes. The Programming mode group consists of the SETUP, RESET, DELETE, RE-SYNC, AZIM SLOW, ELEV SLOW, CONFIG, LIMITS, and POL LIMITS modes. The Programming modes are typically only used during system installation and configuration. The Operational modes are the ones used in everyday operation of the controller.

The modes are divided into two groups, referred to as mode groups, as part of a scheme to keep the user out of the Programming modes in the course of the normal everyday operation of the controller after the unit has been installed. This scheme is based on the use of the MODE key.

If the MODE key is depressed for 5 seconds and released, the current controller mode will switch to the first mode of the mode group which was NOT active when the MODE key was depressed.

If the MODE key is rapidly depressed and released, the controller mode will switch to the next mode in the mode group that was active when the MODE key was depressed.

For example, if MANUAL mode is active (the active mode is always displayed in the upper right hand corner of the LCD) and the user depresses the MODE key for at least 5 seconds and releases it, SETUP mode will become the active mode. As another example, if MANUAL mode is active and the user rapidly depresses and releases the MODE key, AUTO mode will become the active mode.

2.4 Mode Access

Access to some controller modes is restricted. There are three conditions which can restrict user access to certain modes. The user will not be able to access REMOTE mode (either via the MODE key or the comm port) if the CONFIG mode *Remote Mode Enable* item is set to 0 (DISABLED). Also the user will not be able access the POL LIMITS mode if the CONFIG mode *Rotating Feed Present?* item is set to 0 (NO). The third condition that can limit user access to certain modes is the state of the 'Expert Access Flag'.

2.5 Expert Access

An Expert Access Flag is maintained by the controller. The user can inspect and change the state of this flag via the CONFIG mode 'EXPERT ACCESS' item. When the Expert Access Flag is set (1) the user has access to all controller modes (subject to the state of the *Remote Mode Enable* and *Rotating Feed Present?* flags described in the preceding paragraph). When the Expert Access Flag is reset (0), the user only has access to the MANUAL, AUTO, REMOTE, RESET, and CONFIG modes.

The Expert Access Flag also controls access to CONFIG mode items. When the Expert Access Flag is reset (0), the user only has access to the *AutoPol Enable*, *Simultaneous Az/EI Enable*, and *Expert Access* CONFIG mode items. The user can toggle the state of the Expert Access Flag by entering a 5 digit code at the CONFIG mode *Expert Access* item. This 5 digit code is contained in a removable appendix (Appendix A) at the end of this manual to safeguard from any accidental corruption of operating parameters by inexperienced personnel. Note that the Expert Access Flag is set whenever the controller's memory is cleared via the *Reset System Data* CONFIG mode item.

2.6 AutoPol

The AutoPol feature slaves the RC2000A polarization control to an output derived from a satellite receiver. The RC2000A has an AutoPol input accessible via a connector on the back of the unit. When the controller is operating in MANUAL or REMOTE modes, this input is monitored and the polarotor is controlled according to a digital level present at this input. The AutoPol feature should not be used with feeds that receive both horizontal and vertical polarizations simultaneously.

To configure the controller for AutoPol operation, the user must have a suitable output available on the satellite receiver which is connected properly to the AutoPol input of the RC2000A. Additionally, the polarity of the AutoPol input must be specified (from CONFIG mode), and the AutoPol feature must be enabled (also from CONFIG mode). When the polarity of the AutoPol input is specified, the user is informing the controller that a given AutoPol input level (high or low) corresponds to vertical polarization. Configuring the AutoPol system during installation is covered in more detail in Chapter 3 and the CONFIG mode prompts which enable and specify the polarity of the AutoPol input are described in Chapter 4 in the CONFIG mode section.

Chapter 3 INSTALLATION/SETUP

This chapter guides the user through the installation and the initial software setup. The procedures outlined in this chapter cover the mechanical and electrical installation of the unit, setting the azimuth and elevation limits, determining the azimuth and elevation slow speed parameters, and programming the satellite positions into non-volatile memory.

3.1 Before You Begin

Before installing the unit the installer must ensure that the line voltage is correct, the controller's memory has been cleared, and that he or she is familiar enough with the mode system described in Chapter 2 to place the controller in any desired mode. All units are shipped from the factory with memory cleared and an appropriate line cord for the line voltage requested.

If the line cord received with the unit is not appropriate for the power available at the installation site, the installer should check the controller to ensure that the proper line voltage has been selected.

The RC2000 can be configured to operate on either 115 VAC or 230 VAC. The AC input voltage that the unit is currently configured for is displayed in a window located in the fuse holder. The fuse holder is a component of the power entry assembly located in the back panel. To change the AC input voltage selection, remove the fuse holder, pull out and reverse the jumper assembly (on which the '115' and '230' labels are located). The fuse holder is designed to accommodate 1/4" by 1 1/4" fuses. If the RC2000 is configured for 115 VAC operation or 230 VAC operation, use a 6 amp AGC (fast-blow) fuse. A diagram showing the power entry module is located in Appendix B, Field Upgrading.

When the AC line voltage has been verified, and before any of the antenna wiring has been connected, the installer should become familiar with the controller's user interface. It is not necessary to understand every aspect of the controller's operation to install the unit, but the installer should be familiar with the mode structure of the RC2000 and be able to use the MODE key to place the controller in any of the modes described in Chapter 2.

When the unit is powered up, it should be verified that the controller goes to MANUAL mode ('MANUAL' displayed in the upper right hand corner of the LCD). Before the controller is shipped from the factory, the memory is cleared. If the unit does not power up in Manual mode or if the memory is corrupted, the installer should perform a system reset to place the controller into a known state before proceeding with the installation.

To perform a system reset:

1. Use the MODE key to place the controller into CONFIG mode ('CONFIG' displayed in the upper right hand corner of the LCD).
2. Use the SCROLL DOWN and SCROLL UP keys to bring up the 'Reset System Data' screen. If the 'Reset System Data' item does not appear, the Expert Access Flag (see section 2.5) may need to be reset.
3. To inspect the status of the Expert Access Flag use the SCROLL DOWN key (while still in CONFIG mode) to bring up the Expert Access CONFIG mode item. If a 1 does not appear in the data entry field, enter the 5 digit code described in section 2.5 to toggle the Expert Access Flag on. This will allow access to the Reset System Data CONFIG mode item.
4. At the Reset System Data screen enter the same 5 digit code followed by the ENTER key.

3.2 Mechanical and Electrical Installation

This section covers the mechanical and electrical installation of the unit. For rack mount models, use 4 #10-32 mounting screws to secure the unit to a standard 19" rack. Please refer to figures 3.1, 3.2, and 3.3 for diagrams of the controller back panel and electrical connections.

The following electrical connections must be made:

Azimuth and Elevation Motor Drive - 4 wires (2 for each axis)

These cables connect the controller to the azimuth and elevation motors. The conductors must be sized appropriately so that sufficient voltage is supplied to the motors. The voltage supplied to the motors will be the output voltage from the controller less the voltage drop caused by the resistance of the wires.

The output voltage of the controller is a function of the current supplied to the motors. The voltage drop in the wires connecting the controller to the antenna is determined by the wire size, the wire length, and the current supplied to the motors. Figure A-1 in the back of this manual shows the relationship between the controller output voltage and load current.

The following tables show the separation between the controller and the antenna which will result in 22 and 18 volts being applied to the antenna drive motors as a function of motor current and wire gauge. The tables take into account the controller output loading and resistive losses in the conductors.

Separation (in feet) between controller and antenna which will result in 28 volts being applied to the motors:

Motor Current	16	14	12	10
2 Amps	1100	1744	2777	4411
3 Amps	611	968	1543	2402
4 Amps	366	581	925	1470
6 Amps	122	193	308	490
8 Amps	45	72	115	183

Separation (in feet) between controller and antenna which will result in 18 volts being applied to the motors:

Motor Current	16	14	12	10
2 Amps	1589	2519	4012	6372
3 Amps	937	1484	2364	3754
4 Amps	611	968	1543	2450
6 Amps	285	449	716	1137
8 Amps	168	266	246	392
10 Amps	97	155	246	392

A typical 36 volt actuator will draw 2 to 4 amps and will run at voltages down to about 12 volts.

Research Concepts, Inc. can supply cable for installation. RCI part number CBL-2_16-3_22A contains 2 16 gauge conductors for carrying the motor drive current and a shielded triple with a drain wire in a single UV resistant-direct burial jacket. Contact RCI for details.

Polarotor™ - 3 wires in a shielded cable.

The Polarotor™ is commonly supplied with a 3-wire interface using red, white, and black wires. If no other documentation exists from the device manufacturer, the red wire should be connected to 5.7V (J1 pin 11), the white wire to pulse (J1 pin 10) and the black wire to return (J1 pin 9).

NOTE: A SHIELDED CABLE IS REQUIRED FOR THE POLAROTORTM TO MINIMIZE NOISE PICKUP. THE SHIELD MUST BE CONNECTED TO J1-9 ON THE BACK OF THE CONTROLLER AND MUST NOT BE CONNECTED AT THE ANTENNA.

Azimuth and Elevation Position Sense

If reed switch sensors are used, each axis requires 2 wires in a shielded cable. If Hall effect sensors are used, each axis requires 3 wires in a shielded cable. Shielded cables are required to minimize noise pickup which can result in antenna positioning errors. Please refer to figure 3.2 for reed sensor connections and figure 3.3 for Hall Effect sensor connections.

NOTE: SHIELDED CABLES ARE REQUIRED FOR THE POSITION SENSORS. THE SHIELDS BE MUST CONNECTED TO PINS J1-4 OR J1-6 ON THE BACK OF THE CONTROLLER AND MUST NOT BE CONNECTED AT THE ANTENNA.

Position count errors due to improper use of the shield on the position sense lines is one of the most frequent problems encountered during the installation of the RC2000A. Here are the problems that are encountered.

1. A shielded cable was not used for the position sense wires.
2. The shield is not connected at the connector on the rear panel of the RC2000A.
3. The shield is connected to earth ground at the antenna. This results in ground currents flowing in the shield. The shield must not be connected to anything at the antenna.
4. The insulator on the sensor cable is broken and the shield is grounded to something. As in #3, this results in ground currents.
5. The sensor cable is spliced but the shield has not been spliced or the shield is spliced but is also shorted to earth ground.

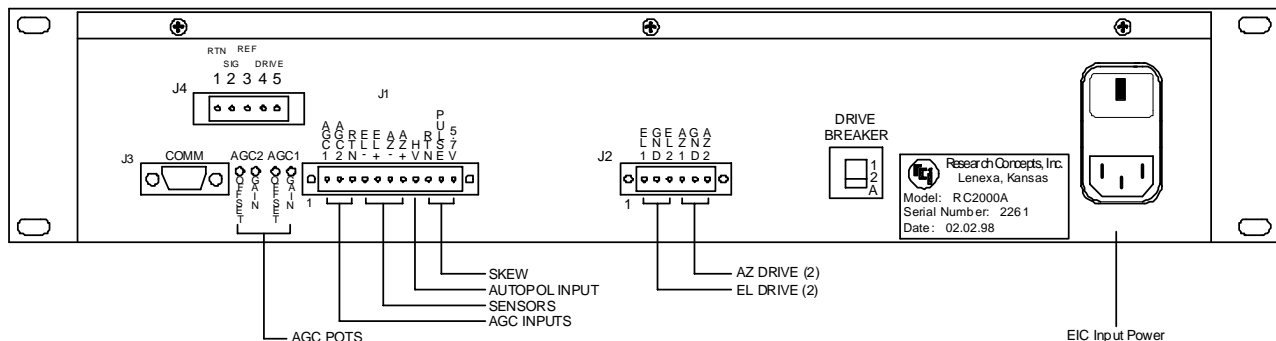


Figure 3.1 RC2000A Back Panel

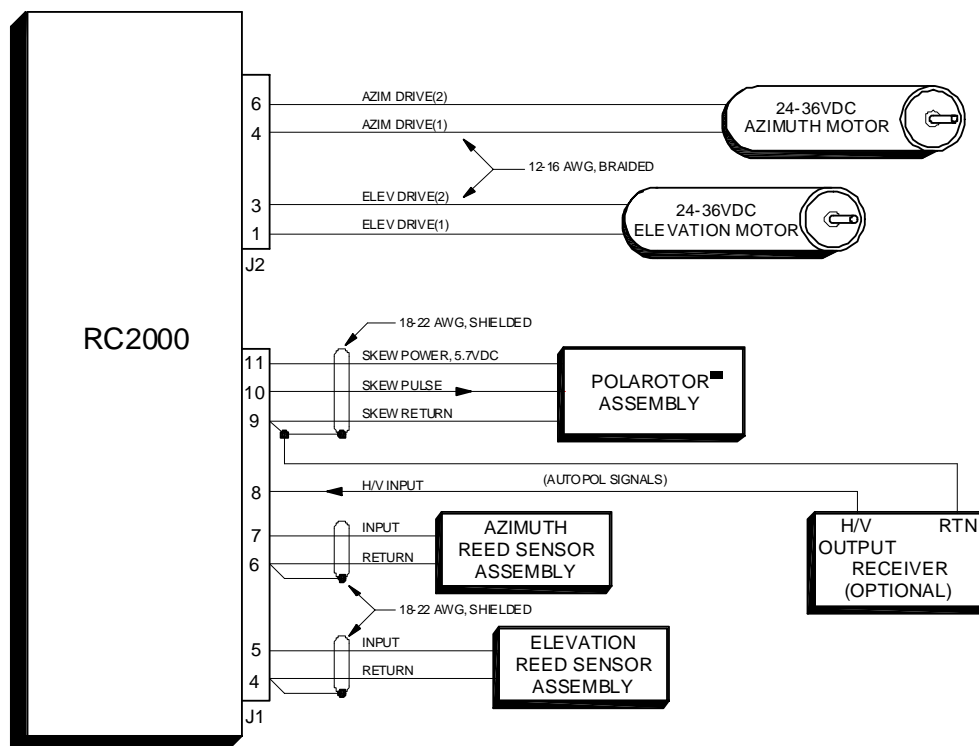


Figure 3.2 Reed Sensor Diagram

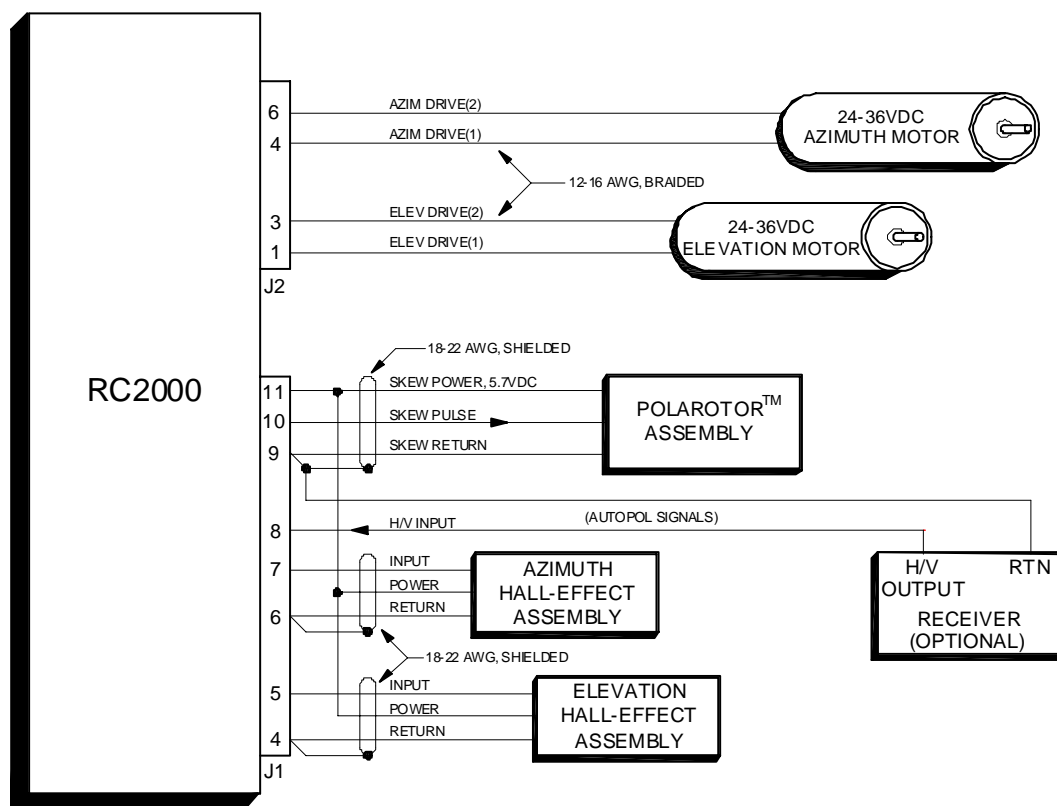


Figure 3.3 Hall Effect Diagram

3.3 Optional Polarization Control

This section describes how to configure the RC2000A to control motorized feeds with potentiometer feedback. If this installation uses a Chaparral type polarotor servo, or has no polarization adjustment, proceed to section 3.4.

The controller has an internal expansion port which can accept optional daughter boards. Two daughter boards are available which can provide polarization control: RC2KPOL and RC2KHPP. The RC2KPOL is designed for use with the Seavey model ESR-124D motorized feed with potentiometer feedback. The Seavey feed requires 24 volts DC at 500 milliamps. The RC2KHPP option is designed for motorized feeds with up to 3 amps. Version 1.50 of the software supports the RC2KPOL option. Version 1.51 supports the RC2KHPP option. If either of these options is installed in the unit, a 5 position connector labelled J4 will be present on the back panel of the unit above the pots labelled AGC1 and AGC2.

*** CAUTION ***

Before using a Seavey rotating feed with the RC2000, it is recommended that the user verify that the feed's range of mechanical movement is within the position sense potentiometer's range of mechanical movement. If the mechanical limit of the pot is reached before the mechanical limit of the feed is reached, the torque of the motor can destroy the pot. The pot used with the Seavey feed is a Spectrol model 533 (1K ohm, 3 turn). To see if the potentiometer is centered properly, the following procedure may be performed on a workbench.

Verifying Potentiometer Center Position

1. Verify the total resistance of the potentiometer. This may be done by either reading the value written on the side of the pot, or by measuring between the two non-wiper terminals of the pot. For the Spectrol pot this will be terminals 1 and 3.
2. Connect an ohm meter between the wiper of the pot (terminal 2 on the Spectrol) and one of the other two terminals. Note that when the shaft position of the pot is near one of the pot's mechanical limits, the ohm meter will read either less than 25 ohms, or the value found in step 1.
3. With a bench power supply, automobile battery charger, or some other voltage source, carefully apply power to the feed's DC motor to move it towards one mechanical limit or the other. (Note that the feed motor for the Seavey feed nominally requires 24 volts DC at approximately 150 ma. The feed motor should move with an applied voltage of 6 to 12 volts DC.)

While movement is in progress monitor the ohm meter to insure that the pot's mechanical limit is not reached. If the ohm meter indicates that the pot's mechanical limit is being approached, quickly disconnect the power source and perform the procedure outlined in the section entitled "Centering the Pot".

4. If the feed can safely move to one of its mechanical limits, reverse the power supply leads and move the pot towards the other mechanical limit. Once again, monitor the ohm meter to insure that the pot's mechanical limits are not exceeded. If the feed cannot be moved to its mechanical limit without approaching the pot's mechanical limit, perform the procedure outlined in the section entitled "Centering the Pot".

Centering the Potentiometer

The procedure outlined here may be used to center the feed's range of travel within the pot's mechanical limits.

1. Find the total resistance of the pot. See step (1) above.
2. Loosen up the allen screw which holds the shaft of the pot to the gear.
3. Apply power to the feed motor (as in step (3) above) to center the feed in the middle of its range of travel. As the feed rotates, make sure that the shaft of the pot does not turn.

4. When the feed has been centered in its range of travel, connect the ohm meter between the wiper and one of the other terminals of the pot. Rotate the shaft of the pot until the resistance read from the ohm meter is one half of the value of the pot's total resistance (obtained in step (1)).
5. Tighten the allen screw and verify that the pot is properly centered by performing the procedure above entitled "Verifying Pot Center Position".

Replacement Potentiometer

The biggest problem encountered when using potentiometers in an outdoor application is moisture. When moisture gets past the shaft seal on the pot, it will cause inaccurate readings and can eventually lead to failure. The Contelec model PD2205, 5K ohm, 5 turn device has excellent environmental characteristics. It is available from Novotechnik, Marlborough, MA, (508) 485-2244.

When replacing a pot on an existing feed (controlled via either the RC2KPOL or RC2KHPP options), the resistance value of the potentiometer is not that important. It is necessary that the replacement pot have either the same number of turns or a greater number of turns than the original pot. If the replacement pot has a greater number of turns, there will be somewhat less resolution available in the measurement of polarization position. When a potentiometer is replaced, the sensed polarization positions which correspond to the satellite's horizontal and vertical positions will change.

Configuring the Controller for Optional Feed Drives

Use the following procedure to configure the RC2000A for use with a 5-40V DC polarization motor.

1. Connect the polarization/sensor assembly as shown in figure 3.4. Note that shielded cable is required for the sensor and that the shield MUST be connected to the GROUND terminal (1) at the back of the controller and MUST NOT be connected to anything at the antenna. Research Concepts, Inc. can supply cable for installation. RCI part number CBL-2_16-3_22A contains 2 16 gauge conductors for carrying the motor drive current and a shielded triple with a drain wire in a single UV resistant-direct burial jacket. Contact RCI for details.
2. The CONFIG mode item *Rotating Feed Present?* must be set to YES (1). Activate CONFIG mode and use the SCROLL DOWN key to bring up the *Rotating Feed Present?* item and key in a 1 followed by the ENTER key. (If the *Rotating Feed Present?* item is not accessible in CONFIG mode, the Expert Access Flag has been reset. If this occurs, set the Expert Access Flag (1) as described in section 2.5.)
3. When the controller is configured to work with a 24 volt polarization motor, the polarization position may be optionally displayed in an angle format. For this part of the installation procedure, the angle display feature must be disabled. To verify that the angle display feature is disabled, go to the CONFIG mode *Pol Angle Display* item. If this feature is not disabled, key in a 0 at the *Pol Angle Display* prompt followed by the ENTER key.

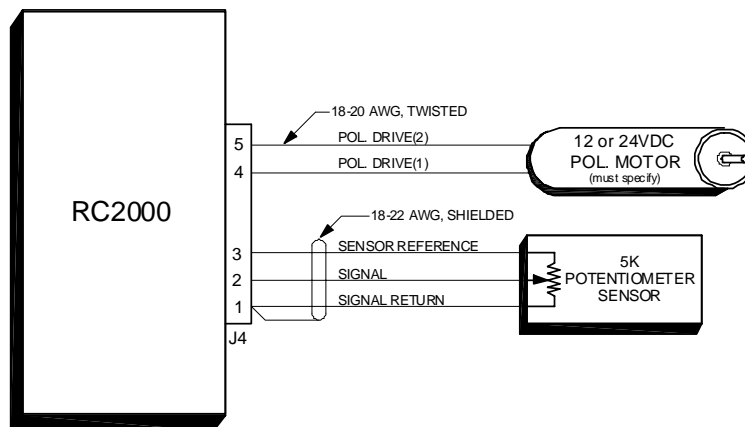


Figure 3.4 Polarization Control

When polarization angle display is disabled, the polarization position has a maximum possible range of movement of 0 to 1023. Note that some potentiometers will not move over the entire range. When moving the polarization motor (in the steps that follow) be very careful not to exceed the potentiometer's mechanical limits - potentiometers are very susceptible to damage when moved past their mechanical limits.

4. In this step the polarity of the polarization motor and sensor wiring is checked. This step of the procedure is performed in the POL LIMITS mode.

The motor polarity is somewhat arbitrary. The polarization jog keys are labeled CW and CCW. The user is free to define the direction sense as he or she wishes. The important thing to remember is that when the polarization motor is jogged CCW (by hitting the CCW key) the position count **MUST INCREASE**. If this is not the case, the 5 VOLT REF and GROUND wires must be swapped. Note that shield must always be connected to the GROUND terminal.

The motor may be jogged in POL LIMITS mode. Note that in this mode there are no limits on polarization movement. The user must be careful to not move the polarization motor past a limit. Damage to the antenna feed, polarization motor, or potentiometer may occur if the limits are exceeded. If the user attempts to move the polarization motor and no movement is detected on the position sense lines, or movement is in the wrong direction, the ANTENNA POL alarm will activate. Remember, when the polarization is jogged counter-clockwise (with the CCW key), the count **MUST** increase. If a polarization alarm is active, an error message will flash on the bottom row of the display and the polarization drive will be disabled. The alarm can be de-activated via RESET mode.

5. Once the polarity of the motor drive and sense lines have been verified, the polarization limits may be set. This is done from the POL LIMITS mode. To set the limits, the user positions the polarization motor at each limit (through the use of the CW and CCW keys) and hits the 5 key. Note that in POL LIMITS mode there are no restrictions on polarization motor movement. It is recommended that an assistant be stationed at the antenna to ensure that the polarization motor's (or sensor's) mechanical limits are not exceeded. Damage to the antenna feed, polarization motor, or sensor may occur if the limits are exceeded.
6. This section describes how to enable and calibrate the angle display of polarization position. Angle display is enabled by setting the CONFIG mode 'Pol Angle Display' item to 1.

To calibrate the angle display, the user must initialize the CONFIG mode 'POL DISPLAY 0 DEG CNT' and 'POL DISPLAY 90 DEG CNT' items. The position entered at the 'POL DISPLAY 0 DEG CNT' will display 0.0 degrees and the position entered at the 'POL DISPLAY 90 DEG CNT' prompt will display as 90.0 degrees. All intermediate positions are scaled appropriately. The maximum possible range of displayed angles is from -99.9 degrees to 999.9 degrees.

It is not necessary to enable and calibrate the angle display at this time. These CONFIG mode items may be initialized after some satellites have been entered into the controller's non-volatile memory.

3.4 Setting Azimuth and Elevation Limits

The next step in the installation procedure is to ensure that the polarity of the motor drive wiring is correct, the position sensors and polarotor function properly, and then to set the azimuth and elevation limits. All of the operations outlined in this section can be carried out with the controller in LIMITS mode.

IN LIMITS MODE THE USER HAS UNRESTRICTED MOVEMENT OF THE ANTENNA, THERE ARE NO SOFTWARE AZIMUTH OR ELEVATION LIMITS, AND ANTENNA JAMMED SENSING DOES NOT TAKE PLACE. WHEN MOVING THE ANTENNA IN LIMITS MODE AN ASSISTANT SHOULD BE STATIONED AT THE ANTENNA TO INSURE THAT THE ANTENNA DOES NOT MOVE PAST A PHYSICAL LIMIT. NOTE ALSO THAT THE CW AND CCW POLARIZATION ADJUSTMENT KEYS ARE ACTIVE.

3.4.1 Motor Drive Polarity

The polarity of the azimuth motor drive is checked by depressing the AZ CCW (AZ CW) ARROW key and verifying that the antenna moves in the proper direction. The sense of azimuth movement is

defined as seen by an observer located above the antenna looking down on the antenna. If the antenna does not move in the proper direction, connector J2 pins 4 and 6 need to be reversed. The polarity of the elevation motor drive is checked in a similar fashion. The UP ARROW key corresponds to up elevation movement.

The azimuth and elevation position sensor operation can be checked by jogging the antenna about the appropriate axis and verifying that the position count changes for that axis. Note that the position count will always decrease for azimuth counter-clockwise and down movement, and will always increase for azimuth clockwise and up movement. Also the count will not decrement lower than 1 or increment higher than 65535.

Polarotor operation is checked by using the POL CW and POL CCW keys to skew the polarization.

3.4.2 Setting Limits

The azimuth counter-clockwise and/or down limits are set first. The bottom row of the display prompts the user to set the limits for each axis. To set a limit, position the antenna at the desired limit, and hit either the 7 key to set an azimuth limit or the 9 key to set an elevation limit. When the counter-clockwise azimuth limit or down elevation limit is set, the position count for the axis is reset to 30. The limits should be specified so that there is adequate clearance between the antenna and any obstacles when the antenna is positioned at any azimuth/elevation combination within the limits.

3.4.3 Geo Elev Position

After the upper antenna limit has been set the installer is prompted to 'SET GEO LIMIT'. This refers to the Geo Elevation Position. This quantity should be specified for modified polar antenna mounts. For az/el mounts this quantity has no meaning and the user can exit LIMITS mode by depressing the MODE key. It is not necessary to set the Geo Elevation Position at this time because this quantity can be specified via CONFIG mode at any time.

A properly adjusted polar mount can track the geostationary satellites with movement of the antenna about the polar axis. A modified polar mount is a polar mount whose elevation angle (sometimes also referred to as latitude angle) adjustment has been motorized. The Geo Elevation Position is the elevation position where it is possible to nominally track the geostationary satellites with movement about the polar axis.

When system memory is cleared, the Geo Elevation Position is reset to zero. Whenever the Geo Elevation Position is zero the elevation position which is displayed will be the actual elevation position count, the down limit is 30 and the up limit will be some value greater than 30. Once the Geo Elevation Position has been set, all elevation position values are displayed relative to the Geo Elevation Position. When the antenna is located at the Geo Elevation Position (assuming it has been set), the displayed elevation position will be 0.

A simple example will illustrate the interaction between the Geo Elevation Position and the elevation display. The user enters LIMITS mode and sets the CCW limit. After the down limit is set the displayed elevation position is 30. The user then moves the antenna to a position of 175 and sets the upper limit. At this point the displayed elevation position is 175. The user then moves the antenna to an elevation position of 100 and sets the Geo Elevation Position. The displayed elevation position is then 0. After the Geo Elevation Position has been set, when the antenna is at the down elevation limit the displayed elevation position is -70 ($30 - 100$), and when the antenna is at the up elevation limit the displayed value will be 75 ($175 - 100$).

When LIMITS mode is entered, if a non-zero Geo Elevation Position exists, it is temporarily reset to zero so that the actual elevation position count is displayed. If the user resets the down and up elevation limits without resetting the Geo Elevation Position, the Geo Elevation Position is permanently reset to zero when LIMITS mode is exited. If the user exits LIMITS mode without changing the down and up elevation limits, the Geo Elevation Position which existed on entry is restored.

3.5 Slow Speed Adjustment

The Adapti-Drive slow speed control system allows the user to specify a desired slow speed. When the antenna is moving at slow speed the controller will vary the voltage to the drive to maintain the actual antenna slow speed at the value specified by the user. Other slow speed drive systems in use reduce the voltage to the drive to a constant value whenever slow speed movements occur. This results in poor speed regulation as the load on the motor varies or as friction in the drive system changes with temperature.

For the RC2000A the user sets the slow speed for each axis independently by entering a slow speed code via the AZIM SLOW and ELEV SLOW modes. This section outlines the procedure for selecting the appropriate slow speed code. When the system memory is reset the azimuth and elevation slow speed codes are initialized to 254. This code value effectively disables the slow speed system by making slow speed equal to the maximum possible speed.

When slow speed movement occurs, the RC2000A determines the speed at which the actuator is moving by measuring the rate at which position feedback pulses are received for the axis which is being moved. The controller adjusts the voltage to the drive by using a Pulse Width Modulation (PWM) scheme, which essentially turns the 36 volt drive voltage off and on very rapidly. Whenever the antenna is manually jogged at slow speed (in MANUAL, SETUP, AZIM SLOW or ELEV SLOW modes) an indication of the voltage delivered to the drive is displayed in the lower right hand corner of the display. This quantity, referred to as a 'voltage code', varies from 1 to 24. The drive voltage associated with a voltage code of 1 is the minimum voltage which can be delivered to the actuators. A voltage code of 24 is associated with the maximum voltage which can be delivered to the drive.

The azimuth slow speed is set in AZIM SLOW mode. In this mode the SCROLL UP and SCROLL DOWN keys are used to change the speed code, the LEFT and RIGHT arrow keys can be used to jog the antenna in azimuth at the selected slow speed, and the ENTER key is used to store the selected speed code in non-volatile memory.

When jogging the antenna in the AZIM SLOW mode after the speed code has been changed through the use of the SCROLL UP/DOWN keys, note that it may take 5-10 seconds for the speed to settle out to a steady state value. Watch the voltage code displayed in the lower right hand corner of the display. When the steady state condition is reached it should slowly toggle back and forth between a pair of adjacent voltage codes.

After the voltage code settles to a steady state range of values, check the rate of movement to make sure that it is slow enough to be useful but not so slow that the motor stalls or moves in a jerky fashion. If the movement is not satisfactory, increase or decrease the speed code using the SCROLL UP and SCROLL DOWN keys. Increasing the speed code will result in a faster slow speed. For most 36 volt motors, an appropriate slow speed code will be in the range of from 140 to 175.

The elevation slow speed is set in ELEV SLOW mode. Note the values for the azimuth and elevation slow speed codes may be set via the CONFIG mode *Azim Slow Speed* and *Elev Slow Speed* prompts. Note that if the speed code for a given axis is set to 254 (the maximum speed code) the slow speed system is disabled and full voltage is applied to the axis whenever slow speed is selected. If the speed code is set to 254 and slow speed is selected, the SLOW banner and a voltage code will be displayed, but the drive will move at fast speed and the voltage code will not change.

3.6 Programming Satellites

After the limits have been set and the slow speed code determined, satellites can be programmed into the controller's memory. If the controller is used with an elevation over azimuth type of antenna mount, the user should review this section along with the following section before programming in any satellites. The following section discusses the display of azimuth and elevation position data in an angle format and explains the use of the IBM PC programs found on the disk included with the controller. Displaying the azimuth and elevation position in an angle format can be a great aid in locating satellites.

All satellites are programmed into memory via SETUP mode. In SETUP mode the user can jog the antenna in azimuth and elevation to peak up on a satellite, specify the satellite name and jog the polarization to assign H and V polarization values. This information is retained in the controller's non-

volatile memory. The user can automatically position the antenna on a satellite which has previously been programmed into memory by invoking the AUTO mode and using the SCROLL UP and SCROLL DOWN keys followed by the ENTER key to select the satellite.

SETUP mode is straightforward. If the user wishes to assign a satellite name which is not in the list, the USER entry in the satellite name list may be selected. The user is then prompted to enter an alphanumeric string using the SCROLL UP, SCROLL DOWN, and ENTER keys.

After the satellite name has been selected the user is prompted to enter in the satellite's longitude position. If the satellite name came from the controller's internal list, the user is presented with a longitude value also from the controller's internal list. The range of longitude values accepted by the controller ranges from 0 to 180 West and 0 to 180 East. Satellites located over North America have West longitude values. Satellites located over Asia have East longitude values. Some Intelsat literature gives satellite longitude values in a range of 0 to 359. In this scheme, values from 0 to 180 correspond to East longitudes. Values from 180 to 359 correspond to West longitudes. To convert from the Intelsat scheme to the scheme used by the controller, a simple example is presented. If the satellite longitude is specified as 325 degrees in the Intelsat scheme, to convert to the value needed for entry into the controller, calculate $360 - 325 (= 35)$. The value entered into the controller would then be 35.0 West.

The user also has an option in specifying the H/V polarization data. After at least one satellite has been programmed into non-volatile memory, the user can specify that the horizontal and vertical position data for a satellite which is about to be entered into non-volatile memory can be copied from the satellite in non-volatile memory closest to the antenna's present position. With an elevation over azimuth type mount, however, it is recommended that the user always manually peak up the H and V polarization values for each satellite.

If a modified polar antenna mount is used (see section 3.4.3 - Geo Elevation Position for a discussion of modified polar mounts) the option of using H/V data from the nearest satellite may be a time saver. For C band satellites H and V polarities are well coordinated from one satellite to the next (i.e. the H polarization position for Galaxy 5 are nearly the same as the H polarization position for Galaxy 6 - both are C band satellites). For Ku band satellites, however, the H and V polarities are not well coordinated from one satellite to the next. Using the 'H/V polarization data from the nearest satellite' option should be selected only for the case where the user is using a modified polar mount in a C band only system.

It is recommended that the user first program in a pair of satellites and then use the AUTO mode to repeatedly position the antenna on one satellite and then the other. This will exercise the controller, actuators, mount, and position sensors. If the antenna does not return to the peak for each satellite make sure that the position sensors are properly wired. After the operation of the system has been verified by testing with two geostationary satellites, the rest of the satellites may be programmed in.

3.7 Angle Display of Az/EI Position Data

The RC2000A antenna controller has the capability to display its azimuth and elevation position in an angle format. This capability can facilitate the process of locating satellites during system setup for systems that employ an elevation over azimuth type of antenna mount. This section describes the procedure for enabling, calibrating, and using the angle display feature. The procedure outlined in this section makes use of the programs (designed to run on an IBM compatible PC) found on the floppy disk included with the controller.

The controller can display azimuth and elevation position in a degrees format. When this feature is enabled, the azimuth position is displayed as a true heading (in degrees - 0 to 360) and the elevation position is displayed as an angle above the horizon (0 to 90 degrees). This feature is controlled by parameters specified by the user via CONFIG mode. The scale2.exe program on the floppy disk can be used to determine these parameters once a pair of satellites has been found.

Another program included on the floppy disk is antenna.exe. This is a general purpose program which aids the user in locating any satellite. This program prompts the user to enter the antenna longitude and latitude, the satellite longitude and the satellite inclination angle and calculates the magnetic heading, true heading and elevation angle above the horizon needed to intercept the satellite. For geostationary satellites, the satellite inclination angle is 0.

The following step by step procedure can be used to locate geo-stationary satellites. In the process, the parameters needed to display azimuth and elevation parameters in an angle format will also be determined.

1. Determine the antenna latitude and longitude. Obtain a satellite guide and identify the pair of satellites which will be located initially and used to calibrate the angle display. A reasonable selection would be a pair of satellites with many readily identifiable active transponders that are located 10 to 15 degrees apart (in longitude) placed somewhere in the middle of the arc.
2. Invoke the antenna.exe program to determine the magnetic heading and elevation angle needed to intercept each satellite. To run the antenna.exe program, simply type ANTENNA followed by the enter key at the prompt. Position the antenna on each satellite. A magnetic compass and an inclinometer can be used to help point the antenna in the proper direction. For each satellite, record the longitude and the antenna azimuth and elevation count values where the satellite was located.
3. After the two satellites have been found, invoke the scale2.exe program to calculate the AZIMUTH SCALE, AZIMUTH OFFSET, ELEVATION SCALE, and ELEVATION OFFSET parameters which will be entered into the controller via CONFIG mode.
4. With the controller, go to CONFIG mode and enter in the values for those parameters determined in step 3. At the CONFIG mode *Angle Display Enable* item, enter 1 to enable the angle display feature. The antenna longitude and latitude values must also be specified via CONFIG mode. A latitude or longitude entry is performed in two parts. The numerical value is entered first (followed by the ENTER key). Next the direction is specified, either E (East) or W (West) for longitude or N (North) or S (South) for latitude (followed by the ENTER key).

Be sure to terminate all CONFIG mode numeric entries with the ENTER key. When all of the parameters have been entered, scroll back through the list to make sure that each entry is correct.

5. To locate additional satellites, invoke the antenna.exe program to determine the true heading and the elevation angle required to intercept the satellite. Note that when the controller's angle display feature is enabled, the azimuth position is displayed as a true heading. Simply jog the controller until the displayed azimuth position matches the true heading value predicted by the antenna.exe program and the displayed elevation position matches the elevation value predicted by the program.

For mounts which employ linear actuators, there will be an error in the controller's displayed values for true heading and elevation. The error will be negligible when the antenna is located near the satellites used to calibrate the angle display (the satellites found in step 2). The error will be greater as the antenna is moved away from those satellites. This occurs because the controller uses a linear mapping of position counts to display angle. For a mount which uses a linear actuator, the actuator forms one side of a triangle and as that side gets shorter or longer, the opposite angle changes. For this case the mapping of position counts to antenna pointing angle is described by trigonometry and will be non-linear. To minimize the error try to choose a pair of satellites in the middle of arc to perform the calibration with.

3.8 AutoPol

This section covers the installation and software configuration required to use the AutoPol feature. The AutoPol function allows the antenna polarization to be controlled via a digital input to the controller. The AutoPol feature, when enabled, is active whenever the controller is in MANUAL and REMOTE modes. Note that the H, V, and SKEW keys do not work when AutoPol is enabled. The AutoPol input of the RC2000A is driven by a digital output from a satellite receiver. The AutoPol input responds to a digital level, with a high level being one polarity and a low level the other polarity. The mapping of a high level on the digital input to either H or V polarization is referred to as the AutoPol polarity and is controlled via a CONFIG mode item. It is not necessary to use the AutoPol feature with 2 port feeds that receive horizontal and vertical polarizations simultaneously.

The AutoPol input on the controller has an internal pull-up resistor which means that the input will float high when it is not driven by the receiver. This allows the receiver to use a relay contact closure to drive the AutoPol input. One side of the relay can be connected to ground and the other side connected to the AutoPol input. When the relay is active the AutoPol input is connected to ground - a low level input, and when the relay is open the AutoPol input floats high due to the pull-up in the RC2000A.

Here is the procedure for installing and configuring the AutoPol feature:

1. Identify an output on the receiver, which can be used to drive the AutoPol input on the RC2000A. Note if a high level output corresponds to V polarization or H polarization.
2. Connect the AutoPol input as shown in figures 3.2 or 3.3.
3. Go to CONFIG mode, use the SCROLL UP and SCROLL DOWN keys to bring up the '*AutoPol Enable*' prompt, and key in 1 followed by the ENTER key to enable the AutoPol function.
4. While in CONFIG mode, use the SCROLL UP and SCROLL DOWN keys to bring up the '*AutoPol Vpol Level*' item. If a high level corresponds to vertical polarization, key in 1 followed by the ENTER key. If a high level corresponds to horizontal polarization, key in 0 followed by the ENTER key.
5. Go to MANUAL mode and verify that the AutoPol feature works properly. In MANUAL mode, when the AutoPol feature is active the polarization display banner reads 'RCV:' rather than 'POL:'.

3.9 Simultaneous Azimuth and Elevation Movement

The RC2000A has the capability to move the azimuth and elevation axis actuators simultaneously during AUTO mode moves. The use of this feature is subject to a limitation in that the total current draw for both 36 volt actuators combined cannot exceed 8 amps. If this requirement is satisfied over all operating conditions, simultaneous azimuth and elevation movement can be enabled by going to the CONFIG mode '*Simultaneous Az/El Enable*' item and keying in 1 followed by the ENTER key.

3.10 Installation and Setup Checklist

This section gives a summary of the installation and configuration procedure outlined in this chapter. The summary is presented in the form of a checklist.

1. Before power is applied verify that the line voltage is correct. Check the displayed voltage in the fuse holder window.
2. Make sure that the memory has been cleared. The controller should come up in LIMITS mode.
3. Make the required electrical connections. A shielded cable must be used for the position sensors and the shield must be connected at the back of the controller and not at the antenna. Refer to figures 3.1, 3.2, and 3.3.
4. If the RC2KPOL or the RC2KHPP option is installed (which allows the RC2000A to interface to a motorized feed with potentiometer feedback), make the required electrical connections for the motor and sensor, verify the polarity of the motor and the position feedback sensor, and set the polarization limits. Make sure that when the CCW key is depressed to jog the polarization motor counter-clockwise, the displayed position count INCREASES. Use caution to avoid damaging the potentiometer.
5. Go to LIMITS mode and verify the motor drive polarity. Set the azimuth ccw, azimuth cw, down, and up limits. If a modified polar antenna mount is used, get the mount to track the Clarke Belt and set the GEO ELEV POSITION.
6. Use the AZIM SLOW and ELEV SLOW modes to set the azimuth and elevation slow speed codes.
7. Go to SETUP mode and program in the satellites. If an az/el mount is used, review section 3.6 which describes a procedure for locating satellites that makes use of the RC2000A's ability to display azimuth and elevation position in an angle format.
8. If desired, enable the AutoPol feature to slave the controller's polarization control output to a satellite receiver. A digital output on the receiver must be connected to the AutoPol input of the controller and the AutoPol feature must be enabled via CONFIG mode.

9. Enable simultaneous azimuth and elevation movement in AUTO mode if the total combined current draw from both actuators is less than 8 amps over all operating conditions////////.

Chapter 4 MODES IN DEPTH FUNCTION DESCRIPTION

The Operational Mode Group consists of three modes: MANUAL, AUTO, and REMOTE. Programming Mode Group consists of several modes: LIMITS, SETUP, RESET, AZIM SLOW, ELEV SLOW, DELETE, RE-SYNC, POL LIMITS and CONFIG. Access to certain modes is controlled by the state of certain CONFIG mode items and the Expert Access Flag. See section 2.4 for more information on access to the various modes.

4.1 MANUAL Mode

```
AZ: 1291 EL: 0 POL: 15 H  MANUAL
SBS 2      97.0 W  SPEED:FAST
```

This mode allows the user to manually jog the antenna in azimuth and elevation using the AZ CCW, AZ CW, DOWN, and UP keys and adjust the polarization using the POL CW and POL CCW keys. The SPEED key is used to toggle the azimuth and elevation jog speed from fast to slow and vice versa. The H and V keys will select the preset H and V polarizations for the satellite closest to the antenna's present position. Polarization control is available in this mode only if the AutoPol feature is disabled. When AutoPol is enabled, the polarization will be set according to the level present on the H/V input, and 'RCV:' will be displayed before the polarization position field (instead of 'POL:').

When the antenna is within 45 counts of an azimuth position AND 20 counts of an elevation position of a satellite, which has been stored in non-volatile memory via SETUP mode, the satellite name will appear in lower case letters. If the antenna is within 15 azimuth counts and 10 elevation counts of a stored satellite position, the satellite name will be displayed in capital letters.

The polarization code is displayed to the right of the polarization position display field. When a polarotor is present in the system, a lower case 'h' or 'v' will be displayed if the polarotor is positioned within 40 degrees of the horizontal or vertical positions, respectively, of the satellite located closest to the antenna's present position. An upper case 'H' or 'V' will be displayed if a satellite name is displayed in upper case letters and the polarotor is positioned within 10 degrees of the preset polarization positions of that satellite.

If the RC2KPOL or RC2KHPP options are installed (which allow the RC2000A to interface to a motorized feed with potentiometer feedback), the lower case 'h' and 'v' display window is 160 polarization position counts and the upper case 'H' and 'V' display window is 40 polarization position counts.

4.2 AUTO Mode

```
SELECT A SATELLITE: PANAMSAT-1  AUTO
USE SCROLL UP/DOWN, ENTER TO SELECT
```

Satellites which have been stored in the controller's non-volatile memory (via SETUP mode) can be recalled with AUTO mode. Azimuth, elevation, and H/V polarization data for up to fifty (50) satellites may be stored in non-volatile memory. When AUTO mode is activated, the SCROLL UP and SCROLL DOWN keys may be used to scroll through the list of satellites. Depressing the ENTER key initiates an automatic move to the selected satellite.

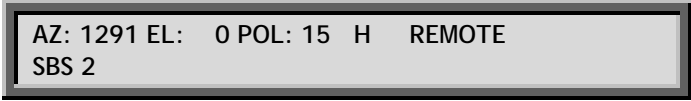
When the antenna is moving to the azimuth or elevation position associated with the selected satellite, the STOP key may be used to stop the antenna's movement. When this occurs the user is prompted to select another satellite with the SCROLL UP and SCROLL DOWN keys. If the automatic move continues to completion and the AutoPol feature is disabled, the polarization will be set to the horizontal position of the satellite which was the target of the automatic move and the mode will change to manual.

If simultaneous azimuth and elevation movement (see CONFIG mode) is enabled, the antenna will move about the azimuth and elevation axis simultaneously when performing automatic moves.

Simultaneous azimuth and elevation movement should only be enabled if the total current draw of the two axes is less than 8 amps under all operating conditions.

NOTE: WHEN THE POWER IS TURNED OFF, THE POLAROTOR PROBE MAY SLIGHTLY SHIFT POSITIONS. WHEN THE POWER IS RE-APPLIED, THE POLAROTOR PROBE WILL MOVE BACK TO THE POSITION IT WAS AT BEFORE POWER WAS REMOVED. FOR THIS REASON, ALWAYS LEAVE THE CONTROLLER ON.

4.3 REMOTE Mode



```
AZ: 1291 EL: 0 POL: 15 H REMOTE
SBS 2
```

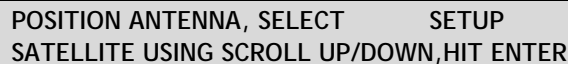
In REMOTE mode the controller will respond to commands received via the built-in RS-422 port. REMOTE mode can only become active if the '*Remote Mode Enable*' CONFIG mode item is enabled (see CONFIG mode, section 4.10). If REMOTE is enabled via CONFIG mode, it can become active either in response to the user manipulating the MODE key or upon the reception of a valid command at the communications port.

Refer to the appendices for a description of the communications protocol. If the AutoPol feature is active, the 'POL:' banner on the display is replaced with 'RCV:'. When the controller is in REMOTE mode the only key that is active is the MODE key.

4.4 SETUP Mode

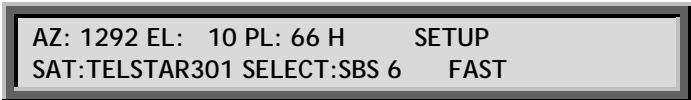
SETUP mode allows a user to store a satellite name, azimuth and elevation antenna positions, and horizontal and vertical polarization positions into non-volatile memory. Once stored in non-volatile memory, a satellite position may be recalled via AUTO mode. SETUP mode is only accessible when the Expert Access Flag is set. See section 2.5 for more information on the Expert Access Flag.

When SETUP mode is activated the following screen is displayed for approximately 5 seconds.



```
POSITION ANTENNA, SELECT SETUP
SATELLITE USING SCROLL UP/DOWN,HIT ENTER
```

The initial screen is replaced by the following screen.



```
AZ: 1292 EL: 10 PL: 66 H SETUP
SAT:TELSTAR301 SELECT:SBS 6 FAST
```

When this screen is displayed, the ARROW keys may be used to jog the antenna in elevation and azimuth, the SPEED key may be used to toggle the azimuth and elevation jog speed, and the CW, CCW, H and V keys may be used to adjust the polarization. (The H and V keys are active only if at least one satellite has been previously stored in non-volatile memory.). The SCROLL UP and SCROLL DOWN keys may be used to select the satellite name (in the 'SELECT:' field) which will be stored in non-volatile memory. If the user selects the 'USER' entry from the satellite list, he or she will be prompted to enter in a string of characters (after the ENTER key) is depressed. The entry of user defined satellite names is described in section 4.4.1. While this screen is active the user peaks up the antenna on the satellite which is to be stored in non-volatile memory. When the ENTER key is depressed the user is usually prompted to specify the satellite longitude.

If the satellite name present in the 'SELECT:' field when the ENTER key was depressed is already stored in non-volatile memory, the user is presented with the following screen.



```
SELECT:SBS 6 DUPLICATE ENTRY SETUP
OVERWRITE EXISTING DATA, USE YES/NO KEYS
```

If the user selects NO the initial screen is displayed and the selection process is repeated.

The user is next prompted to specify the satellite longitude with the following screen.

```
SELECT:SBS 6          SETUP
ENTER SAT LON LLL.L: 99.0 W 0-9.ENT,BKSP
```

If the satellite name was not user defined, a value will be present in the longitude field. The longitude is specified in degrees.tenths_of_degrees. This information is not used in any way by the controller. It is displayed beside the satellite name in MANUAL mode.

After the longitude has been specified, the user is presented with the following screen (if at least one satellite has been stored in non-volatile memory).

```
SELECT:SBS 6   H/V POL DATA?  SETUP
1-H/V DATA FROM NEAREST SAT,2-USER ENTRY
```

This screen prompts the user to specify the source of the horizontal and vertical polarization data, which will be stored in non-volatile memory. If the 1 key is depressed the polarization positions will be obtained from the satellite in non-volatile memory which is closest to the antenna's present azimuth position. Please refer to section 3.6 for more information concerning this option.

If the user selects the USER ENTRY option, the following screen is displayed.

```
SELECT:SBS 6   POL: 75   SETUP
USE CW, CCW TO ADJUST - H, V KEYS TO SET
```

When this screen is displayed the CW and CCW keys may be used to adjust the polarization and the H and V keys may be used to set each polarization.

When all data has been specified, the user is presented with the 'DATA ACCEPTED' message. Control then is transferred to the initial screen and the process may be repeated. Note that the MODE key may be depressed at any time to exit any mode, which is currently active.

4.4.1 User-Defined Satellite Names

If the desired satellite name is not in memory, you can assign a new name of up to ten (10) alphanumeric characters (A-Z, 0-9, hyphen (-), or space) by accessing the USER entry mode as follows.

From the screen, which allows the user to jog the antenna in azimuth and elevation, use the SCROLL UP and SCROLL DOWN keys to bring up the 'USER' entry in the list. Use the ENTER key to select the entry.

When the ENTER key is depressed, the user will be presented with the following display.

```
SELECT:*        KEY IN SAT NAME  SETUP
USE SCROLL UP/DOWN, BKSP & ENTER KEYS
```

Note that the cursor will be displayed under the '*' character. The SCROLL UP and SCROLL DOWN keys may be used to select alpha-numeric characters (A-Z, 0-9, hyphen (-), and space). The BKSP key may be used to delete the character to the left of the cursor. During alpha-numeric data entry, the ENTER key has two functions. If the ENTER key is depressed while the '*' character is displayed, the alpha-numeric data entry session is terminated. If the ENTER key is depressed when the '*' character is not displayed, the cursor will advance to the right one space and the user will be prompted again with the '*' character.


4.4.2 Preset Satellite Names

A list of satellite names is maintained in the controller's EPROM memory. The user is prompted to select one of these names to assign to non-volatile memory. RC2000A antenna controllers may be

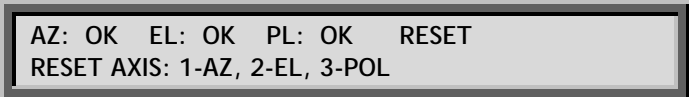
ordered with either of the satellite lists. The west set of satellites is appropriate for antenna sites with western longitudes and the east set is appropriate for eastern longitudes.

4.5 RESET Mode

The RESET mode is used to display azimuth and elevation drive fault conditions and re-enable the drive outputs in the event the microcontroller has disabled an axis. When RESET mode is activated, one of the following screens will be displayed.



AZ: OK EL: OK RESET
RESET AXIS: 1-AZ, 1-E



AZ: OK EL: OK PL: OK RESET
RESET AXIS: 1-AZ, 2-EL, 3-POL

The first screen will be displayed if a polarotor is present in the system and the second screen will be displayed if the RC2KPOL or RC2KHPP options are installed to control motorized feeds with potentiometer feedback.

The status of each axis is displayed after the appropriate banner (AZ:, EL:, or PL:) on the top line of the LCD. If a fault exists for an axis, no movement may occur about that axis until that axis is reset. Use the 1 key to reset the azimuth axis, the 2 key to reset the elevation axis, and the 3 key to reset the polarization axis. Note that polarization status is displayed and polarization resets are possible only if the optional rotating feed interface is installed.

Here are the status messages which may be displayed:

OK

Indicates that no fault conditions are active for the axis (azimuth, elevation, or polarization).

JAMMED

Indicates that the antenna was commanded to move about the axis and no movement was detected by the controller. This indicates either that the antenna did not move when commanded to do so, or the sensor failed and the controller was not able to detect any movement (azimuth, elevation, or polarization).

RUNAWAY

The drive was deactivated because the processor sensed movement for a drive which was not commanded to move. This error is rarely caused by an actual runaway condition (the antenna moving on its own). This error is usually due to a faulty sensor or noise pickup due to the sensor shield not being connected properly. See Chapter 3 for proper shield connection instructions (azimuth and elevation).

DRIVE

The axis was deactivated due to an over-current condition (azimuth, elevation, and high current polarization axis). This error condition can be detected only if the RC2KHPP option is present in the system (software version 1.51). It will not be detected for the RC2KPOL option (software version 1.50).

SENSOR

This error will occur if the antenna commands a polarization movement, and movement is detected in the wrong direction. Note that a polarization jammed condition will occasionally

register as a sensor error. Polarization movement in the wrong direction should only occur during setup (polarization axis only).

Note that the azimuth, elevation, and high power polarization axis are also protected from over-currents by a circuit breaker located on the back of the controller. If the circuit breaker opens, the controller will report a JAMMED condition. Note that if simultaneous azimuth and elevation movement is enabled, the total current draw for both axes cannot exceed 8 amps. If the total current draw for both axis exceeds 8 amps, disable simultaneous azimuth and elevation movement.

4.6 DELETE Mode

SELECT A SATELLITE: PANAMSAT-1 DELETE
USE SCROLL UP/DOWN, ENTER TO SELECT

This mode is used to delete a satellite entry. This mode can only be activated if the Expert Access Flag is set. Refer to section 2.5 for more information on the expert access system. To delete a satellite from the controller's non-volatile memory:

1. Proceed to DELETE mode.
2. Scroll through the ASSIGNED satellite names.
3. When the desired satellite name is shown, press ENTER. The system will display the message

A SAT DATA DELETION HAS BEEN REQUESTED
BKSP TO CONFIRM, ANY OTHER KEY TO EXIT

Pressing BKSP will automatically delete this satellite from memory.

4.7 RE-SYNC Mode

SELECT A SATELLITE: PANAMSAT-1 RE-SYNC
USE SCROLL UP/DOWN, ENTER TO SELECT

The RE-SYNC feature allows the controller to make a graceful recovery from sensor failure or in the unlikely event of an errant pulse count. By using this feature, the user simply has to correct for one satellite location, and the RC2000A automatically will correct all others.

1. While in MANUAL mode, jog the antenna to a satellite whose location was previously stored in memory. (NOTE: Do not re-sync using an inclined orbit satellite!) Use a K band satellite if possible.
2. Proceed to RE-SYNC mode.
3. Scroll through the list of assigned satellites (in alphabetical order) until the correct satellite name is displayed.
4. Press the ENTER key. The system will respond with the message

AN AZ/EL RE-SYNC HAS BEEN REQUESTED
BKSP TO CONFIRM, ANY OTHER KEY TO EXIT

5. Press BKSP to recalibrate all stored satellite locations. The system will confirm with the message



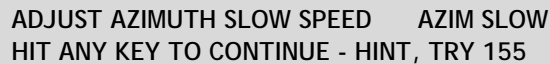
RE-SYNC ACCOMPLISHED

and will return to MANUAL mode.

6. With an assistant out at the antenna, validate the accuracy of the limits by moving the antenna to all four limit positions (azimuth counter-clockwise, azimuth clockwise, down, and up).


4.8 AZIM SLOW Mode

This mode allows the user to interactively adjust the azimuth slow speed code. When this mode is activated, the user is presented with the following screen:



ADJUST AZIMUTH SLOW SPEED AZIM SLOW
HIT ANY KEY TO CONTINUE - HINT, TRY 155

When any key is depressed, the user is presented with the following screen:



AZ: 700 SPEED:175 AZIM SLOW
USE SCROLL UP/DOWN, <>, ENTER TO SET

At this point, the SCROLL UP and SCROLL DOWN keys can be used to increment or decrement the speed code, the LEFT and RIGHT ARROW keys can be used to jog the antenna in azimuth at slow speed, and the ENTER key stores the currently displayed speed code into non-volatile memory. When the user jogs the antenna, a voltage code appears in the lower right hand corner of the screen, and the slow speed code which is displayed is used to control the speed of the antenna. When the speed code is changed and the user jogs the antenna, the voltage code will slowly settle to a steady state range of values. Make sure that the voltage code has settled before using the ENTER key to store the speed code in non-volatile memory. Please see section 3.5 for more information on setting the slow speed.

4.9 ELEV SLOW Mode

This mode is similar to the AZIM SLOW mode. Please refer to sections 4.8 and 3.5 for information.

4.10 CONFIG Mode

The CONFIG mode allows the user to view and/or modify various controller parameters and to enable or disable certain features. When this mode is active, the SCROLL UP and SCROLL DOWN keys may be used to select various items for either viewing or modification. To change the value of a parameter the user can simply key in a new value. The BKSP (backspace) KEY is active. If a new value is keyed in, for the change to take effect and update the parameter's value in the controller's non-volatile memory, the entry must be terminated with the ENTER key. If the present value of the parameter is invalid, '*' characters will be displayed in the item's data field. If the user terminates a data entry with the ENTER key and the value is accepted, the next CONFIG mode item will be displayed. If the user terminates a data entry with the ENTER key and the data is not accepted, the CONFIG mode item will not change. The MODE key can be depressed at any time to exit CONFIG mode.

Access to certain CONFIG mode items can be restricted depending on the status of the Expert Access Flag and by the values currently assigned to certain CONFIG mode items. When the Expert Access Flag is reset (see section 2.5), the only CONFIG mode items which will be accessible will be the *AutoPol Enable*, *Simultaneous Az/EI Enable*, and *Expert Access Enable*. When the Expert Access Flag is set, access to the other CONFIG mode items can be restricted by the value of a controlling CONFIG mode item.

An example will clarify the concept of a controlling CONFIG mode item. Three CONFIG mode items related to access to the controller via its serial port are *Remote Mode Enable*, *Comm Port Address*, and *Comm Baud Rate*. The *Remote Mode Enable* CONFIG item is the controlling item for the *Comm Port Address* and *Comm Baud Rate* items. If the *Remote Mode Enable* CONFIG mode item has a value of 0

(disabled) then the other two items will not appear in the list of CONFIG mode items. In the descriptions which follow the controlling items and the items, which are controlled by other items will be clearly delineated.

4.10.1 AutoPol

The AutoPol system allows the controller's polarization control function to be slaved to the level of a digital input derived from a satellite receiver. Please refer to sections 2.5 and 3.8 for more information on the AutoPol system.

The AutoPol system is disabled and enabled via the *AutoPol Enable* CONFIG mode item.

AUTOPOL ENABLE:0	CONFIG
0-DISABLE, 1-ENABLE	ENT,BKSP,SCROLL ^v

The *AutoPol Vpol Level* CONFIG mode item specifies the polarity of the AutoPol digital input signal. A value of zero implies that a low on the AutoPol digital input specifies vertical polarization and a value of one implies that a high level on the AutoPol input selects vertical polarization. Access to this item is only allowed when the Expert Access Flag is set.

AUTOPOL VPOL LEVEL:1	CONFIG
0-LOW, 1-HIGH	ENT,BKSP,SCROLL ^v

4.10.2 Simultaneous Azimuth and Elevation Movement

The *Simultaneous Az/El Enable* CONFIG mode item is used to enable simultaneous azimuth and elevation movement when moving to a satellite selected via SETUP mode.

SIMULTANEOUS AZ/EL ENABLE:0	CONFIG
0-DISABLE, 1-ENABLE	ENT,BKSP,SCROLL ^v

NOTE: If the total current draw from both motors exceeds 8 amps, it is not possible to utilize this feature. Trying to enable it in this case will cause a breaker to open, which will disable the drive and generate an antenna jammed error.

4.10.3 Remote Communication Parameters

The following items are used to enable and configure the remote RS-422 communications capability. Access to these parameters is allowed only when the Expert Access Flag is set. The *Remote Mode Enable* item is the controlling item for the *Comm Port Address* and *Comm Baud Rate* items.

The *Remote Mode Enable* item is used to enable access to REMOTE mode. If this item is enabled, REMOTE mode will activate whenever a valid command is received via the serial port or in response to MODE key manipulations.

REMOTE MODE ENABLE:0	CONFIG
0-DISABLE, 1-ENABLE	ENT,BKSP,SCROLL ^v

The *Comm Port Address* item selects the address of the communications port. See the Appendix covering the communications protocol. Valid values for this parameter are 49 to 111.

COMM PORT ADDRESS: 50	CONFIG
49 - 111	ENT,BKSP,SCROLL ^v

The *Comm Baud Rate* item selects the baud rate that the controller's serial port will be initialized to. Valid values for this parameter are 3 (300 baud), 6 (600 baud), 12 (1200 baud), 24 (2400 baud), 48 (4800 baud) and 96 (9600 baud).

```
COMM BAUD RATE (HUNDREDS):96    CONFIG
3, 6, 12, 24, 48, 96  ENT,BKSP,SCROLL ^v
```

4.10.4 Geo Elevation Position

The Geo Elevation Position is defined for modified polar type antenna mounts. For a modified polar mount this is the elevation position where the antenna will track the geo-stationary satellite arc with only azimuth movements. See section 3.4.3 for more information on this feature. This value is normally set via LIMITS mode. If the value of this item is set to zero, display of elevation position relative to the Geo Elevation Position is disabled. The Expert Access Flag must be set to obtain access to this parameter via CONFIG mode.

```
GEO ELEV POSITION: 0    CONFIG
0-DISABLE        ENT,BKSP,SCROLL ^v
```

To assign a meaningful value to this parameter, use the following procedure:

1. Adjust the mount so that it will track the geostationary arc with only azimuth movement.
2. Go to CONFIG mode and set this parameter to zero (0).
3. In MANUAL mode, determine the elevation value at which the mount will track the geostationary satellites with only azimuth movement.
4. Go to CONFIG mode and set the Geo Elev Position to the elevation value found in step 3.

4.10.5 Azimuth and Elevation Slow Speed Codes

These CONFIG items can be used to set the azimuth and elevation slow speed codes. Normally, these parameters are adjusted interactively via the AZIM SLOW and ELEV SLOW modes. Please refer to sections 3.5 and 4.8 for more information on the slow speed system. The range of values for these parameters is from 1 to 254. Higher numbers give faster speeds. (For a given axis, a slow speed code of 254 will disable the slow speed system for that axis - all movement will occur at fast speed.) For most motor/sensor combinations, a slow speed code in the range of 140 to 175 is appropriate. If the slow speed codes are changed, test the slow speed system to insure that the selected values yield reasonable results. Access to these CONFIG mode items are allowed only when the Expert Access Flag is set.

```
AZIM SLOW SPEED 0-254:253    CONFIG
ENT,BKSP,SCROLL ^v
```

```
ELEV SLOW SPEED 0-254:253    CONFIG
ENT,BKSP,SCROLL ^v
```

4.10.6 Azimuth and Elevation Angle Display

The RC2000A has the ability to display azimuth and elevation position in an angle format. This feature can greatly facilitate the process of locating satellites for systems which use an elevation over azimuth type antenna mount. Please see section 3.7 for more information on how to enable and calibrate this feature. Access to these CONFIG mode items allowed only when the Expert Access Flag is set.

Briefly, to calibrate the angle display feature, the user locates two satellites and records their azimuth and elevation position count values. The scale2.exe PC program (for IBM compatibles - shipped with each controller) is then used to calculate azimuth and elevation scale factors. These scale factors are entered into controller via the CONFIG mode items described in this section. The scale2.exe program

prompts for the antenna latitude and longitude, and the longitude, azimuth position count, and elevation position count values for a pair of satellites which have been located with the controller.

The *Angle Display Enable* item is the controlling item for the other items described in this section. When this parameter is set to 1 (enabled), azimuth and elevation positions are displayed in an angle format using the other items described in this section.

ANGLE DISPLAY ENABLE:0	CONFIG
0-DISABLE, 1-ENABLE	ENT,BKSP,SCROLL ^v

The *Azim Scale Factor* and *Azim Offset* items are used to calibrate the display of azimuth position according to the following formula:

Display_Angle = 180.0 +

((100 * (Azim_Position_Cnt - Azim_Offset)) / Azim_Scale_Factor)

(Northern Hemisphere)

Display_Angle = 360.0 -

((100 * (Azim_Position_Cnt - Azim_Offset)) / Azim_Scale_Factor)

(Southern Hemisphere - Note the displayed angle is adjusted by adding or subtracting 360.0 so that the result is in the range of 0 to 360.0 degrees.)

The range of values that the user must specify for the '*Azim Offset*' CONFIG mode item is 0 to 65535. Values in the range of 32768 to 65535 are converted to negative offset values for Azim_Offset in the above equations according to the following relationship:

Azim_Offset = Azim Offset (CONFIG mode item entered by user) - 65536

This is necessary because it is not possible to enter negative values via the keypad on the RC2000A.

AZIM SCALE FACTOR: 1	CONFIG
ENT,BKSP,SCROLL ^v	

AZIM OFFSET: 0	CONFIG
ENT,BKSP,SCROLL ^v	

The *Elev Scale Factor* and *Elev Offset* items are used to calibrate the display of elevation position according to the following formula:

Display_Angle = (100 * (Elev_Position_Cnt + Elev_Offset)) / Elev_Scale_Factor

The range of values that the user must specify for the '*Elev Offset*' CONFIG mode item is 0 to 65535. Values in the range of 32768 to 65535 are converted to negative offset values for Elev_Offset in the above equations according to the following relationship:

Elev_Offset = Elev Offset (CONFIG mode item entered by user) - 65536

This is necessary because it is not possible to enter negative values via the keypad on the RC2000A.

ELEV SCALE FACTOR: 1	CONFIG
ENT,BKSP,SCROLL ^v	

ELEV OFFSET: 0	CONFIG
ENT,BKSP,SCROLL ^v	

The *Hemisphere* CONFIG mode item is used to calibrate the azimuth display angle (see the formula above for the displayed azimuth angle). North America, Europe, Asia, and the Northern half of Africa lie in the northern hemisphere. Australia and most of South America lie in the southern hemisphere.

HEMISPHERE:1	CONFIG
0-SOUTH 1-NORTH ENT,BKSP,SCROLL ^v	

4.10.7 Polarization Motor Option

The controller has an internal expansion port, which can accept optional daughter boards. Two daughter boards are available which can provide polarization control. The daughter boards are designated RC2KPOL and RC2KHPP. The RC2KPOL is designed for use with the Seavey model ESR-124D motorized feed with potentiometer feedback. The Seavey feed requires 24 volts DC at 500 milliamps. The RC2KHPP option is designed for motorized feeds with up to 3 amps. Version 1.50 of the software supports the RC2KPOL option. Version 1.51 supports the RC2KHPP option. If either of these options is installed in the unit, a 5-position connector labeled J4 will be present on the back panel of the unit above the pots labeled AGC1 and AGC2.

The CONFIG mode items described in this section are used to enable the controller to interface with one of the motorized feed options described above, and to calibrate the display of the polarization motor position in an angle format. Access to these CONFIG mode items is allowed only if the Expert Access Flag is set. The *Rotating Feed Present?* item is the controlling item for access to the other items described in this section.

The *Rotating Feed Present?* CONFIG mode item is used to inform the controller whether or not a polarotor is present in the system. If one of the motorized feed options is installed, this parameter should be set to YES and the POL LIMITS mode should be invoked to set the polarization limits (see section 3.3).

ROTATING FEED PRESENT?:1	CONFIG
0-NO 1-YES ENT,BKSP,SCROLL ^v	

The *Pol Angle Display* CONFIG mode item determines the display format of polarization positions when one of the motorized feed options is installed in the controller. If this item is enabled the polarization position will be displayed in an angle format.

POL ANGLE DISPLAY:0	CONFIG
0-DISABLE, 1-ENABLE ENT,BKSP,SCROLL ^v	

When the *Pol Angle Display* item is enabled, the calibration of the angle display feature is controlled by the Pol Display 0 Deg Cnt and Pol Display 90 Deg Cnt items. When the polarization position is equal to the value which is entered for the Pol Display 0 Deg Cnt item, the angle displayed will 0.0. In a similar fashion, when the polarization position is equal to the value, which is entered for the Pol Display 90 Deg Cnt, the displayed angle will be 90.0. All other polarization positions are scaled in a linear fashion.

POL DISPLAY 0 DEG CNT: 500	CONFIG
1-1023	ENT,BKSP,SCROLL ^v

POL DISPLAY 90 DEG CNT: 750	CONFIG
1-1023	ENT,BKSP,SCROLL ^v

The Pol Motor Jog Duration CONFIG mode item controls the length of time (in milliseconds) that the polarization motor drive signals are applied when a polarization jog command is received via the serial communications port. The setting of this parameter determines the accuracy with which the polarization can be adjusted via remote control.

POL MOTOR JOG DURATION:1000	CONFIG
175-3000 MSEC	ENT,BKSP,SCROLL ^v

4.10.8 Azimuth and Elevation Drive Options

The CONFIG mode items described in this section set the movement parameters for the azimuth and elevation axis. The default values of these parameters (as initialized upon system reset) are adequate for use with 36 volt linear actuators. For systems employing linear actuators, it is recommended that these values not be changed from the default values. The provision to modify these parameters is included for those customers who use the azimuth and elevation drive outputs from the RC2000A to drive a pair of 36 volt relays (equipped with steering diodes) which in turn activate AC motors. More information about using the RC2000A in this fashion may be found in the appendix entitled "Controlling Antennas Powered by AC or Large DC Motors with the RC1000 or RC2000 Antenna Controllers". Access to the CONFIG mode items described in this chapter is permitted only when the Expert Access Flag is set.

The *Az/El Drive Options Enable* CONFIG mode item is the controlling item for the other CONFIG mode items described in this chapter. When this item is disabled the user does not have access (via CONFIG mode) to the other items described in this section. Note that when this item is disabled, the current values of the other items described in this section are used to control azimuth and elevation movement. In other words, disabling this item does not reset the other items described in this section to their default values.

AZ/EL DRIVE OPTIONS ENABLE:0	CONFIG
0-DISABLE, 1-ENABLE	ENT,BKSP,SCROLL ^v

During an automatic move in AUTO mode, the 'Fast Slow Threshold CONFIG mode items are used to set the number of counts before a target position is reached that the controller switches the speed of the drive from fast to slow. There is a separate value for each axis.

AZIM FAST SLOW THRESHOLD: 80	CONFIG
0-400 COUNTS	ENT,BKSP,SCROLL ^v

ELEV FAST SLOW THRESHOLD: 80	CONFIG
0-400 COUNTS	ENT,BKSP,SCROLL ^v

During an automatic move in AUTO mode, the 'Coast Threshold CONFIG mode items set the number of counts 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 counts 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 counts of the target position.

AZIM COAST THRESHOLD: 4	CONFIG
1-40 COUNTS	ENT,BKSP,SCRLL ^v

ELEV COAST THRESHOLD: 4	CONFIG
1-40 COUNTS	ENT,BKSP,SCRLL ^v

The '*Max Position Error* CONFIG mode items set the maximum acceptable error between the final resting position and a target position for an automatic move which occurs in AUTO mode.

AZIM MAX POSITION ERROR: 1	CONFIG
0-10 COUNTS	ENT,BKSP,SCRLL ^v

ELEV MAX POSITION ERROR: 1	CONFIG
0-10 COUNTS	ENT,BKSP,SCRLL ^v

The '*Auto Retry Attempts* CONFIG mode items set the maximum number of attempts which will be made to hit a target position (within 'Max Position Error counts - described above) during an automatic move initiated from AUTO mode.

AZIM AUTO RETRY ATTEMPTS:3	CONFIG
2-5	ENT,BKSP,SCRLL ^v

ELEV AUTO RETRY ATTEMPTS:3	CONFIG
2-5	ENT,BKSP,SCRLL ^v

The '*Fast Deadband* and '*Slow Deadband* CONFIG mode 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 a pulse-train. 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, counter-clockwise (down), the azimuth (elevation) position count is decremented. If the antenna is moving, or last moved, clockwise (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 4 different '*Deadband* values specified - there are unique fast and slow speed values for each speed and each axis. 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. All '*Deadband* values are given in milliseconds.

Configuring the Runaway Sensing System

The user can modify the operation of the runaway alarm sensing system via the values assigned to the Azim Fast Deadband and Elev Fast Deadband CONFIG mode items. Each axis can be configured separately.

If the value assigned to the Azim Fast Deadband CONFIG mode item ends in '40' the controller will only accumulate azimuth position counts when the antenna is moving about the azimuth axis or is in a coast interval immediately proceeding an azimuth move. This effectively disables the runaway alarm for the azimuth axis. The operation of the elevation runaway sensing system is configured via the Elev Fast Deadband CONFIG mode item in a manner similar to that of the azimuth axis. Examples of 'Fast Deadband values that disable runaway sensing are 2040 and 940.

If the value assigned to the Azim Fast Deadband CONFIG mode item ends in '41' through '49' the azimuth runaway count threshold will be assigned a value of 1 through 9, respectively. The azimuth runaway count threshold is defined as the number of runaway counts that must be exceeded before an azimuth runaway alarm is triggered. For example, if the Azim Fast Deadband CONFIG mode item has a value of 1845 six runaway position counts must be accumulated before an azimuth runaway alarm is triggered. The elevation axis is configured in a similar manner using the Elev Fast Deadband CONFIG mode item.

Note that to obtain access to the Azim Fast Deadband and Elev Fast Deadband CONFIG mode items the controller's Az/EI Drive Options Enable CONFIG mode item must be set to 1 and the Expert Access Flag must be set.

Compatibility

This version of the software can be installed in controller's currently running software versions 1.40 through 1.50 without upsetting the contents of the controller's non-volatile memory. Note that whenever IC's are replaced there is a slight chance that the contents of non-volatile memory will be corrupted. For this reason we recommend that the user make a record of the contents of the controller's non-volatile memory as listed in the upgrade instructions. It is also recommended that the user position the controller at the antenna's east (azim ccw) and down limit before powering the controller down to replace the EPROM.

AZIM FAST DEADBAND:2000 CONFIG 175-5000 MSEC ENT,BKSP,SCRLL ^v

ELEV FAST DEADBAND:2000 CONFIG 175-5000 MSEC ENT,BKSP,SCRLL ^v

AZIM SLOW DEADBAND: 800 CONFIG 175-5000 MSEC ENT,BKSP,SCRLL ^v

ELEV SLOW DEADBAND: 800	CONFIG
175-5000 MSEC	ENT,BKSP,SCROLL ^v

4.10.9 Expert Access Flag

This CONFIG mode item is used to toggle the state of the Expert Access Flag. When the Expert Access Flag is set (ON), the user has access to all controller modes and all CONFIG mode items. When the Expert Access Flag is reset (OFF), the user is locked out of several modes and most CONFIG mode items. This purpose of this feature is to keep an operator away from the modes and CONFIG mode items which can allow an operator to change the contents of the controller's non-volatile memory.

When the Expert Access screen is displayed, the present state of the Expert Access Flag is displayed in the data entry field. A display value of 1 indicates that the Expert Access Flag is set, and a value of 0 indicates that the flag is reset. To toggle the state of the flag, either from set (1) to reset (0) or reset (0) to set (1), the user must key in a 5 digit code at the prompt followed by the ENTER key. This code is found in a removable appendix (Appendix A) at the end of this manual. If the information is lost, call the factory for assistance.

EXPERT ACCESS (0-OFF, 1-ON): 1	CONFIG
ENTER CODE TO TOGGLE	ENT,BKSP,SCROLL ^v

4.10.10 Reset System Data

This CONFIG mode data item is used to reset the controllers non-volatile memory. When this occurs, the azimuth and elevation limits are invalidated and each of the various CONFIG mode items are initialized to a default value. This operation is usually performed at the factory. Access to this item is allowed only when the Expert Access Flag is set. To reset the system memory, the user must key in the same 5 digit code, followed by the ENTER key.

RESET SYSTEM DATA: 0	CONFIG
ENTER CODE	ENT,BKSP,SCROLL ^v

Here are the default values which are assigned to non-volatile memory.

Azimuth Position Count:	5000
Azimuth CCW Limit:	4999
Azimuth CW Limit:	5001
Azimuth Limit Checksum:	Invalid - So the 'AZIM LIMITS ERROR' alarm is displayed.
Elevation Position Count:	5000
Elevation Down Limit:	4999
Elevation Up Limit:	5001
Elevation Limit Checksum:	Invalid
AutoPol Enable:	0
AutoPol Vpol Level:	1 (Vertical)
Simultaneous Az/EI Enable:	0 (Disabled)

Remote Mode Enable:	0 (Disabled)
Comm Port Address:	50
Comm Baud Rate:	9600
Geo Elev Position:	0
Azim Slow Speed:	253
Elev Slow Speed:	253
Angle Display Enable:	0 (Disabled)
Azim Scale Factor:	1
Azim Offset:	0
Elev Scale Factor:	1
Elev Offset:	0
Hemisphere:	1 (Northern Hemisphere)
Rotating Feed Present?:	0 (No)
Pol Angle Display:	0 (Disabled)
Pol Display 0 Deg Count:	500
Pol Display 90 Deg Count:	750
Pol Motor Jog Duration:	1000 milliseconds (1 second)
Az/EI Drive Options:	0 (CONFIG mode prompts disabled)
Azim Fast Slow Threshold:	80 position counts
Azim Coast Threshold:	4 counts
Azim Max Position Error:	1 count
Azim Auto Retry Attempts:	3
Azim Fast Deadband:	2000 milliseconds
Azim Slow Deadband:	800 milliseconds
Elev Fast Slow Threshold:	80 position counts
Elev Coast Threshold:	4 counts
Elev Max Position Error:	1 count
Elev Auto Retry Attempts:	3
Elev Fast Deadband:	2000 milliseconds
Elev Slow Deadband:	800 milliseconds

Expert Access Flag: 1 (on - flag set)

4.11 LIMITS Mode

In this mode the user can jog the antenna in any direction, set the azimuth and/or elevation limits, adjust the polarization, and specify the Geo Elevation Position. If the azimuth or elevation limits are corrupted on power-up, the system will come up in LIMITS mode, prompting the user to re-enter the LIMITS before using the controller. The Expert Access Flag must be set (see section 2.5) to allow access to LIMITS mode via the MODE key. The entry screen for LIMITS mode is shown below.

SET CCW/CW AND-OR UP/DOWN LIMITS
HIT ANY KEY TO CONTINUE

NOTE: To set limits, there MUST be someone outside at the antenna location to let the programmer know when the antenna has reached its physical limits of travel, because in LIMITS mode no software precautions are taken to protect the antenna from jammed conditions. It is critical that as the antenna is jogged using the direction keys, the antenna moves in the corresponding direction. If it does not, pins on J2 are reversed. Recheck Figure 3.1 and correct.

***** **WARNING** *****
THERE ARE NO RESTRICTIONS ON ANTENNA MOVEMENT
WHEN IN THE LIMITS MODE - USE CAUTION!

1. Go to LIMITS mode and press ENTER to advance past the opening screen. The screen will prompt the user to set the CCW azimuth limit and the DOWN elevation limit. The CCW azimuth limit must be set before the CW limit, and the DOWN limit must be set before the UP limit. The left, right, down and up arrow keys can be used to jog the antenna in azimuth and elevation. The CW and CCW keys can be used to adjust the polarization.

AZ: 5000 EL: 5000 POL: 69 LIMITS
7 - SET CCW LIMIT 9 - SET DOWN LIMIT

2. With an assistant at the antenna to notify you that the antenna is near its physical limit, move the antenna to the CCW limit and press the 7 key. The AZ count will reset to 30.
3. Repeat step 2, but with the CW limit this time. Upon pressing the 7 key, the controller will ask the user to be sure of the selection. If limits are indeed to be set, press the BKSP key, else press ENTER. The controller will confirm a limit set with * AZIM LIMITS SET *. Position the antenna on a satellite near the center of the arc.
4. Move the antenna to the DOWN limit, again with an assistant to monitor the physical limit, and press 9 to set the limit. The counter will be reset to 30.
5. Move the antenna to the UP limit, press 9, then BKSP to confirm the selection. Note that if the antenna actuators are equipped with mechanical limit switches those switches should be adjusted so that damage to the antenna cannot occur. The software limits (those set by this mode) should be within the mechanical limits.

The controller now prompts the user to 'SET GEO POSITION'. This refers to the Geo Elevation Position (see section 3.4.3) and is the elevation position where the antenna tracks the geostationary satellites. Note that this position is only defined for modified polar antenna mounts. If the user does not wish to set the Geo position simply hit the MODE key to exit from LIMITS mode. Note that the Geo Elevation Position can also be specified via CONFIG mode.

6. To specify the Geo Elevation Position for an antenna equipped with a modified polar mount, adjust the mount declination, mount heading, and the elevation actuator so that the antenna tracks the geo-synchronous satellites with only azimuth movement. Move the antenna to the GEO position and carefully peak up the antenna on the satellite. Press 9 to store the position and BKSP to confirm the entry.

NOTE: If LIMITS mode is exited before both endpoints of a limit are set, the RC2000A will ignore the partial limits and retain the previous values. If the controller powers down while LIMITS mode is active, all limit data will be lost.

4.12 POL LIMITS Mode

This mode allows the user to set the limits for the optional motorized feed with potentiometer feedback. To enter this mode the Expert Access Flag must be set (1), and the '*Rotating Feed Present?*' CONFIG mode item must be set to 1 (YES). When this mode is activated, the initial display presented to the user is:

SET CW AND CCW POL LIMITS - SEE MANUAL
HIT ANY KEY TO CONTINUE

If the user hits any key (other than the MODE key), the following screen is displayed:

CAUTION!!! - THERE IS UNRESTRICTED POL
MOVEMENT HIT ANY KEY TO CONTINUE

At this point the user should stop and think about what this screen means. In this mode there are no limits to polarization movement - extreme caution should be exercised to insure that the physical limits of the potentiometer's movement are not exceeded. MANY POTENTIOMETERS HAVE BEEN DESTROYED IN THIS MODE.

When the user hits any key (other than the MODE key), the following screen is displayed:

POL: 455 POL LIMITS
USE CW,CCW - 5 TO SET FIRST POL LIMIT

At this point the CW and CCW keys are active. When the CW key is depressed, the polarization position **MUST** decrease. If this does not occur, the sensor REF and ground connections need to be reversed. The user should position the polarization motor at a limit and then hit the 5 key. When this occurs the user will be prompted with the following screen:

POL: 153 POL LIMITS
USE CW,CCW - 5 TO SET SECOND POL LIMIT

The user should position the polarization motor at the other limit and then hit the 5 key. The user is next prompted to verify the selection with the following screen:

THE POL LIMITS ARE ABOUT TO BE RESET
BKSP TO CONFIRM, ANY OTHER KEY TO EXIT

The selection can be confirmed with the BKSP key. Note that this mode (or any mode) can be exited at any time by depressing the MODE key. Please see section 3.3 before using this mode to set the polarization limits when the optional polarization control motor is present in the system.

Chapter 5 SPECIFICATIONS

Inspect unit for any damage caused during shipping. If any exists, notify shipper immediately.

A. PHYSICAL

Size:	19.0" x 3.5"H x 9.0"D (Rack) 15.0"W x 3.5"H x 9.0"D (Desk)
Weight:	12.5 lbs.
Temperature:	0-50°C
Input Power:	115/230 VAC, 50/60 Hz., 48 W

B. DRIVE

Output:	12-36VDC, 8.0 Amps 280VA
Sensor Input:	Reed, Hall Effect, Optical
Standard Polarization Interface:	Chaparral type polarotor servo
Optional Interfaces for Motorized Feeds with Potentiometer Feedback:	
RC2KPOL:	20 volts DC at 500 milliamps (the RC2KPOL option requires software version 1.50)
RC2KHPP:	5-40 volt DC output (output voltage set by potentiometer (P2) on the RC2KHPP board), 3 amps at 40 volts DC, 400 milliamps at 5 volts DC (the RC2KHPP option requires software version 1.51)

C. Azimuth and Elevation Drive Transfer Function (current vs. voltage)

See Figure A1 in Appendix.

D. Non-Volatile Memory Battery

Duracell DL2450

E. Drive supply lines are protected by circuit breakers. The AC input is protected by a 6 amp AGC (fast-blow) fuse at both 115 VAC and 230 VAC.

Chapter 6 TROUBLESHOOTING/ALARM CODES

The alarm system monitors important system 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.

6.1 SYSTEM ERROR CODES

LOW BATTERY

The RC2000A constantly monitors the level of the lithium battery. 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 power before removing the cover to change the battery. Take care to hold the battery tab away from the battery housing while replacing the battery, and it will not be necessary to reprogram the memory. Since there is a chance that the non-volatile memory will be corrupted when the battery is changed, please refer to the appendix entitled 'Restoring the Non-Volatile Memory' before changing the battery.

AZIM LIMITS, ELEV LIMITS

One of the antenna software limits has been corrupted. Go into LIMITS mode and reset the software limits. See Section 4.11

POL LIMITS

This error indicates that the polarization motor limits have been corrupted when either the RC2KPOL or RC2KHPP option is installed (allowing the RC2000A to interface to a motorized feed with potentiometer feedback). The limits for the polarization motor are set via POL LIMITS mode. See sections 3.3 and 4.10.12.

ANT AZIM, ANT ELEV, ANT POL

These alarm messages indicate that an error has been detected for the axis referenced in the alarm message. When one of these alarms are detected, the axis is disabled. Go to RESET mode (section 4.5) to view the actual fault condition which was detected and to clear the fault.

A Reset mode JAMMED indication may mean that the drive breaker is open. This can occur if simultaneous movement is enabled, and the total current draw from both motors exceeds 8 amps. Reset the breaker by pressing it back into place, and disable Simultaneous AZ/EL movement via CONFIG mode. See Section 4.10.2

NOTE: The following alarm conditions are cleared by going into CONFIG mode and re-initializing the applicable CONFIG mode items. Access to certain items is controlled by other CONFIG mode items - these controlling items can sometimes make it difficult to clear a CONFIG mode data related alarm. Please review the explanation of the role of these controlling CONFIG mode items in section 2.4.

AZIM COUNT, ELEV COUNT

The internal position count has been corrupted. Manually find a satellite and go into RE-SYNC mode to update positions. See Section 4.7

AZIM SLOW SPEED, ELEV SLOW SPEED

The code entered by the user for the azimuth or elevation slow speed has been corrupted. Go to the corresponding speed mode and reenter the slow speed code. See Section 4.8

AUTOPOL CONFIG DATA

The user has the option to configure the system for AutoPol ON or OFF, and to denote a HI or LO level for the vertical polarization. If either of these values is corrupted, this error will appear. Go to CONFIG mode and reenter the correct values. See Section 4.10.1

SIMULTANEOUS AZIM/ELEV

This error indicates that the value for the *Simultaneous Az/El Enable* CONFIG mode item has been corrupted. See section 4.10.2.

GEO POSITION

The checksum associated with the GEO COUNT value does not agree with geo position in memory. Move the antenna to the proper GEO POSITION and reenter the GEO ELEV POSITION in the CONFIG mode. Section 4.10.4

COMM PORT

This alarm indicates that the checksums associated with the CONFIG mode *Remote Mode Enable*, *Comm Port Baud Rate*, and *Comm Port Address* items indicate that at least one of these items is invalid. See section 4.10.3.

AZ/EL ANGLE DISPLAY

This alarm indicates that the CONFIG mode items associated with the display of azimuth and elevation position in an angle format have been corrupted. Please see section 4.10.6.

POL OPTIONS

This error indicates that at least one of the CONFIG mode items associated with the polarization control and display options is invalid. If the system uses a polarotor, these items must still be initialized properly to avoid this error. Please see section 4.10.7.

AZIM OPTIONS, ELEV OPTIONS

This error indicates that at least one of the CONFIG mode items associated with the azimuth or elevation drive options are invalid. Note that all of the config mode items associated with these options must be properly initialized even if the *Az/El Drive Options Enable* CONFIG mode item is disabled. If this item is disabled and these errors occur, the *Options Enable* item should be enabled to gain access to the other CONFIG mode items associated with these options. These other items can then be initialized to their default values. See section 4.10.10 for default values.

6.2 OPERATIONAL TROUBLESHOOTING TIPS

THE CONTROLLER DOES NOT RETURN TO THE PROPER SATELLITE LOCATION (AND IS NOT EVEN CLOSE)

When this occurs the controller is generally losing or gaining position counts for a given axis as the antenna moves about that axis. Please review the items mentioned in Section 3.2 - Azimuth and Elevation Position Sense.

If the cause of the problem is not found and only one axis is affected, consider replacing the position sense module and/or magnets in the actuator. If both axis are affected the motor drive wires may have

to be shielded. This is seldom necessary, but if it is, follow the rules for connecting the shields as outlined in Section 3.2.

THE CONTROLLER RETURNS TO APPROXIMATELY THE CORRECT POSITION BUT MUST BE PEAKED MANUALLY TO ACHIEVE A GOOD SIGNAL

This is generally an indication of mechanical hysteresis (slop) in either the actuator or the mount. When this occurs the antenna will peak up at one position when approaching the satellite from the azimuth clockwise direction and another when approaching the satellite from the azimuth counter-clockwise direction. To test for this, move the antenna well past the satellite in the azimuth clockwise direction and then manually move the antenna counter-clockwise at slow speed until the peak is reached. Repeat the procedure approaching the satellite from the opposite direction. The difference in azimuth position between the 2 peaks is the mechanical hysteresis. If mechanical hysteresis exists try to eliminate the it. If this is not possible, always approach each satellite from the same direction as it was approached when the satellite was originally programmed into memory.

THE ANTENNA AZIM ERROR or ANTENNA ELEV ERROR OCCUR

To determine the cause of this error, go the RESET mode. One of the following error messages will be displayed: JAMMED, RUNAWAY, or DRIVE. Here are the likely causes of each of these errors:

JAMMED

This error indicates that the drive was commanded to move, but movement was not sensed. This can be caused by an mechanical jam at the antenna, or the antenna may be moving but position feedback pulses are not getting back to the controller. Determine which condition exists.

If the antenna is not moving there may either be a faulty motor, a wiring problem, a mechanical limit switch has been encountered, or the breaker in the drive circuit has tripped (the breaker may be reset from the back of the unit). If the antenna is moving but position pulses are not reaching the controller, check the sensor wiring of the sensor module in the antenna actuator.

RUNAWAY

This error occurs when position pulses are recorded but the antenna has not been commanded to move. Check the items listed in Section 3.2 - Azimuth and Elevation Position Sense. If this error occurs just after the antenna has been moving and the drive signals are released, review the 'Deadband CONFIG mode items described at the end of section 4.10.8. Also see the paragraph in this section entitled 'CONFIGURING THE RUNAWAY SENSING SYTEM'.

DRIVE

This error indicates that the controller's electronic over-current sensing has detected an over-current condition and has shut the drive down. There are pots which control the level at which the electronic over-current sensing trips. These pots may have to be adjusted. Please consult the factory. Under no circumstances should the load current supplied by the controller be allowed to exceed 8 amps for more than several seconds.

THE AUTOPOL SYSTEM DOES NOT SEEM TO WORK PROPERLY

This error is usually caused by the horizontal and vertical polarizations for a given satellite being programmed at the same position. If you turn off the AutoPol function and the controller does not toggle the polarization position as the H and V keys are depressed in MANUAL mode, the polarization positions have probably been programmed at the same value. Other AutoPol problems result from not having a ground wire connected between the satellite receiver and the controller. Please refer to figures 3.2 and 3.3. The AutoPol system should not be enabled when the controller is used with feeds that receive both polarizations simultaneously.

WHEN A SATELLITE IS SELECTED VIA AUTO MODE THE CONTROLLER DISPLAYS THE MESSAGE 'ENTRY SELECTED HOLDS INVALID DATA'.

Before the controller executes an automatic move it checks to see if the azimuth, elevation, horizontal polarization, and vertical polarization are within their respective limits. If they are not, the error message is displayed. This error can occur if the limits were reset after the satellite position was programmed into memory via SETUP mode. This error can also occur if the state of the *Rotating Feed Present?* CONFIG mode item was changed after the satellite was programmed into non-volatile memory.

Recovering From Unexpected Memory Upsets

The key to restoring the non-volatile memory is getting the azimuth and elevation limits and position counts right. The position counts are initialized to 30 when the azimuth counter-clockwise and down limits are set. If the antenna can be unambiguously placed at the counter-clockwise and down limits, non-volatile memory can be restored quite easily. It is probably a good idea to use a punch or a waterproof magic marker to mark the antenna and mount assembly so that the azimuth counter-clockwise and down limit positions can be identified. In addition, it may be useful to identify and mark other places on the mount where slippage could occur. This would allow the mount to be restored to its original configuration. The procedure for restoring non-volatile memory is outlined in Appendix B *Field Upgrading*.

Note that the procedure for restoring non-volatile memory only works if the count characteristics of the actuators are not changed. If the actuator count characteristics are changed, the count values that correspond to the west and up limit will change, as will the positions of all of the satellites.

Appendix A - EXPERT ACCESS / RESET SYSTEM DATA CODE

To clear the system memory or toggle the expert access, the user must enter the five-digit code **41758**, then press enter. This code has been printed in this removable appendix only, so that management can choose to remove the information to eliminate the possibility of inexperienced users entering the code and clearing the memory inadvertently. USE CAUTION!

For a discussion of expert access, see section 4.10.9. RESET SYSTEM DATA is covered in section 4.10.10

The Code is:

41758

Appendix B - Field Upgrading

This appendix outlines a procedure that allows the user to restore the contents of non-volatile memory. The controller firmware is contained in an EPROM memory chip. Firmware upgrades may also require the replacement of a programmable logic device (PLD). Changing the EPROM and PLD may sometimes corrupt the data stored in the non-volatile memory of the controller. Other procedures performed on the controller may require a restoration of non-volatile memory such as:

- i. changing the battery which powers the non-volatile memory and allowing the center tab of the battery holder to touch the base of the battery holder,
- ii. performing maintenance on the controller,
- iii. swapping one controller out for another,

This procedure ensures that this data is valid after the upgrade. Following the firmware upgrade procedure, the system reset and operating voltage change procedures are listed.

Updating In-Service RC2000 Firmware

1. With your current controller, enter into CONFIG mode and verify that Expert Access is enabled. (See manual section 4.10.9 for enabling instructions) Verify that REMOTE MODE is enabled. (See manual section 4.10.3 for enabling instructions) Scroll through the config mode item list with the SCROLL UP and SCROLL DWN keys. Log every item on the included worksheet.
2. Verify that the ANGLE DISPLAY ENABLE feature is disabled. (Section 4.10.6) Verify that the POL ANGLE DISPLAY is disabled. (Section 4.10.7)
3. Using AUTO mode, position the antenna on each of the geostationary satellites stored in memory. Record the name, longitude, and azimuth/ elevation count values for each on the bottom half of the Config mode items worksheet at the end of this section. While positioned on each satellite, use the H and V keys to move to horizontal and vertical polarization. Record these values on the worksheet.
4. Jog the Antenna to the CW and Up limits, record the values displayed just prior to the limit on the worksheet.
5. If a rotating feed is present (Section 4.10.7), manually rotate the feed to the CW and CCW limits. Record the displayed position just prior to the limits on the worksheet.
6. Position the Antenna at the CCW and DOWN limits.
7. Turn the unit off and disconnect it from the remaining components of the antenna system. Move the unit to a static-free workstation for chip replacement. Remove the lid and position the unit on the bench facing toward you. Make sure proper grounding straps are used to avoid static discharge damage to the processor section.
8. Locate the RC2000 digital board (RC2KDIG2) located on the right side of the unit. Remove the existing EPROM chip (U4) from its socket and replace it with the upgrade EPROM. If necessary locate and remove the PLD chip (U2) from its socket and replace it with the upgrade PLD.
9. Make sure the chip (or chips) is oriented properly in its socket. The notch or dot should line up with the notch of the outline silk-screened onto the PCB under the socket. Make sure that the legs of the EPROM package fit into each pin socket and do not bend up under the IC upon insertion.
10. Replace the lid, reinstall the 2000 into the rack, and reconnect the other components of the antenna system.

11. Power-up the RC2000 and verify the start-up banner and subsequent manual mode. If the unit comes up in LIMITS mode or is flashing an error message, the non-volatile memory has been corrupted and the following steps must be performed to restore memory. If the unit comes up normally, go to step 16.
12. Go to Limits Mode. WITHOUT MOVING THE ANTENNA, set the down and east limits. AFTER THE CCW AND DOWN LIMITS HAVE BEEN SET, jog the antenna to the position count values for the CW and up limits recorded in step 4 above. After the limits have been set exit the limits mode by hitting the mode key.
13. If the optional rotating feed is installed, go to POL LIMITS mode and restore the worksheet values recorded in step 5.
14. Go to CONFIG mode and key-in the data recorded in Step 1. Each entry must be terminated with the ENTER key. After the data has been entered, scroll through the CONFIG mode items and verify correct data entry. See Section 4.10 for a description of the CONFIG mode.
15. Go to SETUP mode. Position the antenna on each of the satellites that were recorded in Step 2. Select the satellite name, enter the longitude and move the polarization to the recorded H and V positions in response to the SETUP mode prompts. Return to MANUAL mode.
16. Using Auto mode, recall each of the geostationary satellites stored in memory. Verify that the antenna moves to each satellite correctly. If the angle display feature for Az/EI or Pol was enabled previously, modify those config mode items now. This completes the procedure.

To Perform a Complete RC2000 System Reset

1. This procedure should be followed only in the case of the requirement to bring the unit software to its factory shipped condition. (e.g. in the event of changing antenna sites) Resetting the RC2000 has the effect of deleting all satellites in memory and returning all CONFIG mode items to their factory state.
2. If any data from the previous installation is required, be sure to log it on the RC2000 Non-Volatile Memory Items Worksheet. (See Steps 1 through 5 above.)
3. From CONFIG Mode, scroll to the RESET SYSTEM DATA item. Key in the 6 digit code "41758" followed by the ENTER key. The Controller will return in Manual Mode. All CONFIG mode items will be reset to their factory state. All stored satellites will be deleted from memory. The Date and Time will remain unchanged. You may now follow Steps 12 through 16 above to restore the non-volatile memory.

To Convert the RC2000 from 115VAC to 230VAC Operation:

Switch the power off at the front panel. Remove the IEC power cord from the back panel power entry module. Refer to the diagram below when converting the operating voltage.

With a small straight-blade screwdriver, remove the fuse drawer from the power entry module. With the same tool, remove the small plastic circuit card. Rotate the card so that the desired operating voltage will be displayed through the front of the fuse drawer and reinsert the card so that it firmly seats into the power entry module. Replace the fuse with one of the appropriate size for the new operating mains voltage (fuse ratings may be found in the manual and on a back panel placard)

Appendix C - RS-422 Serial Interface

The RC1000A, RC2000A, RC2000C, and RC2500 antenna controllers support an RS-422 serial interface. The communications protocol employed by RCI is compatible with the SABUS standard originally developed by the Scientific Atlanta Corporation. The protocol is described in appendix D - RS-422 Communications Protocol. The aspects of the communications interface which are unique to the RC2500 antenna controller are described in Appendix E RC2500-RS-4-22 Command Set.

RS-232 to RS-422 Protocol Converter

The RS-422 signal levels are not directly compatible with the RS-232 serial ports available on personal computers. RS-232 is a point to point protocol - a PC can only communicate with one peripheral connected to the PC via an RS-232 interface. The RS-422 interface employed by the RC2000 allows a single PC to communicate with up to 63 devices. An RS-232 to RS-422 protocol converter (designated RC1KADP) is available from Research Concepts, Inc. The diagrams and schematics at the end of this appendix document the connection of a PC to an RC2500 via an RC1KADP protocol converter.

Software

Software to control the RC2000 is available from a number of sources. The diskette included with the manual includes a program which allows a PC to control an RC2000 (a protocol converter is required). The RC2KA.EXE program is designed primarily for use by software developers or by integrators during installation. This program features a crude user interface which displays each byte of data sent to the controller and each byte received from the controller in an ASCII format and hex format. We recommend that this program be used to verify the operation of the system during initial installation and checkout of the RC1KADP and the associated cabling. A second program, called RC2KDEMO.EXE has a more user-friendly interface and may be used for day-to-day operations with the controller.

The Autopilot 2/16 and 4/16 software packages are produced by Broadcast Automation Systems (905) 822-7935 and are available from Research Concepts. This program can control the RC2500, RC2000 and the RC1000A antenna controllers as well as the Standard Agile Omni model 830BR or the DX657 satellite receivers. This program runs under Windows 95 and NT and gives the user the ability to schedule antenna and receiver events. Contact Research Concepts for more information on these products.

Here are other suppliers of software products which are compatible with the RC1000/RC2000/RC2500.

Alamar Electronics: (408) 866-9373
Broadcast Automation Systems: (905) 822-7935
Crystal Computer Corporation: (404) 263-0555
Drake Automation:
Florical Systems: (904) 372-8326
Image Communications: (408) 335-2141
Industrial Logic Controls (ILC): (404) 504-7400
Link Research: 01923 244233 (England)
Louth Automation: (415) 329-9498
M & C Systems: (408) 454-0396

Appendix D - The RCI RS422 Interface Specification

Introduction

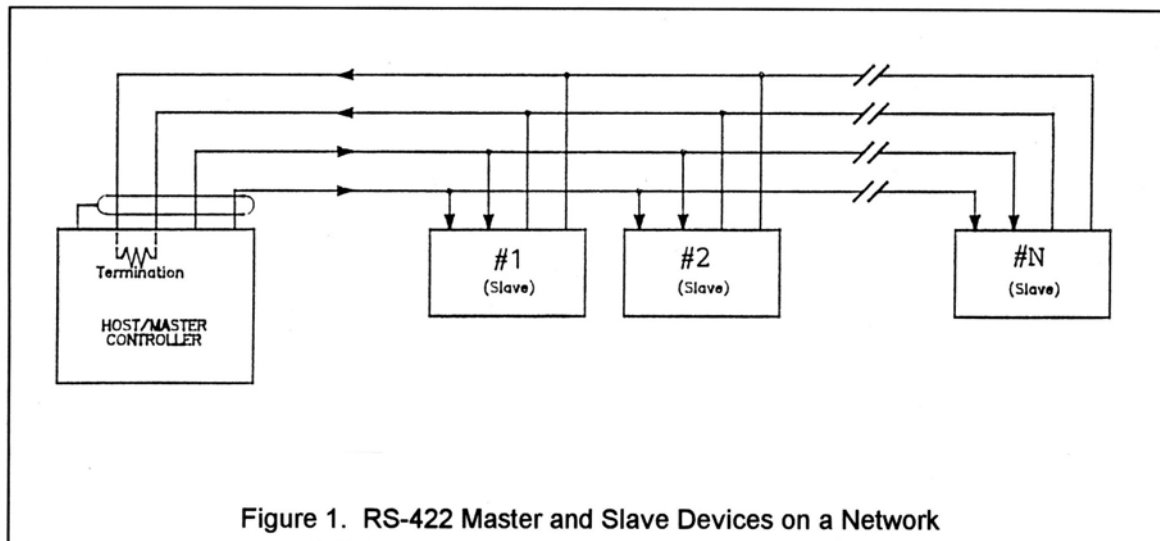
The purpose of this document is to explain the key parameters needed by a user to interface to the RCI RS422 Interface. This interface is compatible with the SABus and can be readily integrated into an existing SABus network. A few query and control commands are all that are needed to control the equipment and fetch all data from it. The user should refer to RCI document 'Communications Protocol' for the specific program commands and descriptions of their functions.

Electrical Specifications

RS-422 is a unipolar, balanced 5-volt serial interface designed to connect equipment which must exchange data over considerable distances with high-noise immunity and high speed. Standard IC drivers and receivers are available for RS-422 that convert to and from TTL logic levels. The RS-422 drivers/receivers in the controllers allow up to 32 devices to be connected in parallel with up to 1,500 feet between the master and group of controllers.

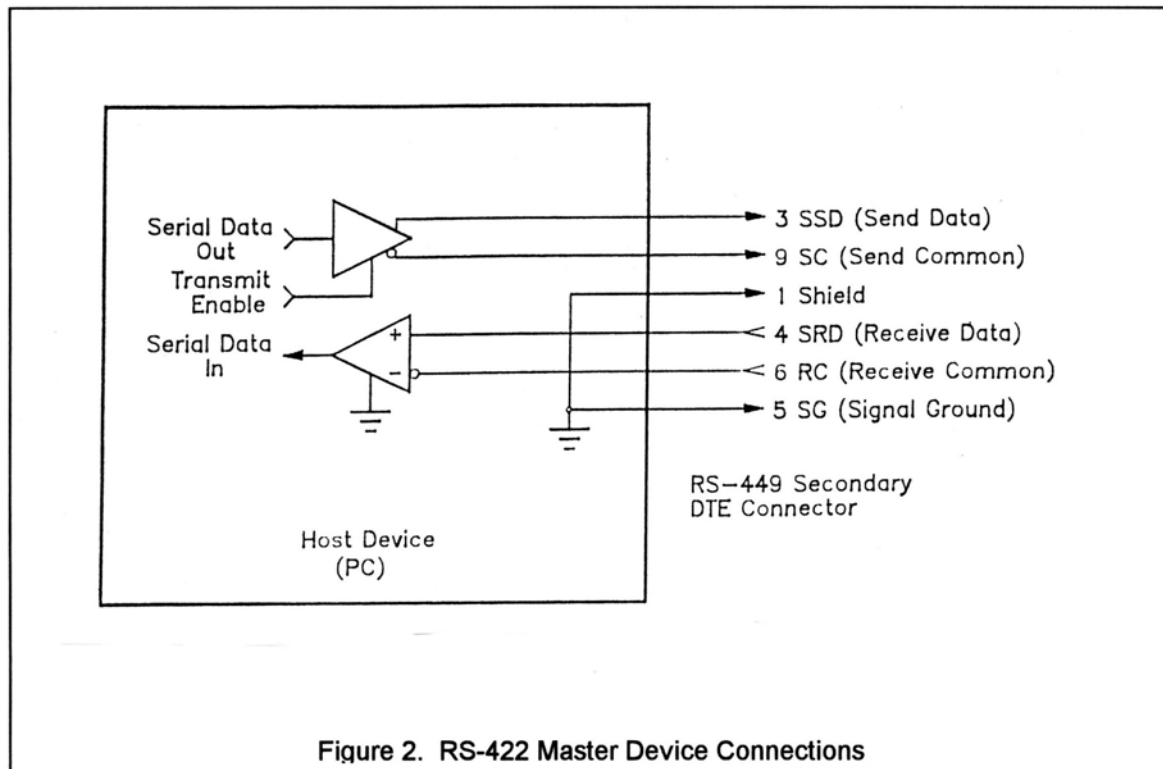
Physical Specifications

The physical implementation of the interface takes the form of a 9-pin "D" connector located on the rear panel of the controller. This connector and its wiring is compatible with EIA RS-449, which is the mechanical specification for RS-422/423-compatible equipment. The 9-pin connector chosen is described as the secondary interface in RS-449 and has only the four data lines and shield. No hardware handshaking is used in the protocol, so all the control lines specified for the standard 37-pin connector are not needed. The controller operates as a slave only and has a female connector, whereas master devices have male connectors. Multiple controllers, connected in a daisy chain fashion, can operate in electrical parallel with only a single 5-conductor cable required to connect all devices controlled by a master. Figure 1 illustrates the connection of a master and multiple controllers.



RS-422 Protocol

The interface is a multi-drop, balanced line, asynchronous, full-duplex communications link designed to interconnect equipment for remote control and switching applications. Products that are compatible can be linked together over a parallel-connected 4-wire circuit without regard to their particular function.



Each network configuration can have one master and up to 32 slave devices. Each controller is internally configured to respond to a unique address. A master could be a protection switch, earth station controller, or any micro- or mini-computer that is electrically and operationally compatible with RS-422. Since the electrical specifications are very similar to EIA standards RS-422 and RS-449, virtually any computer that meets these standards is capable of controlling remote devices.

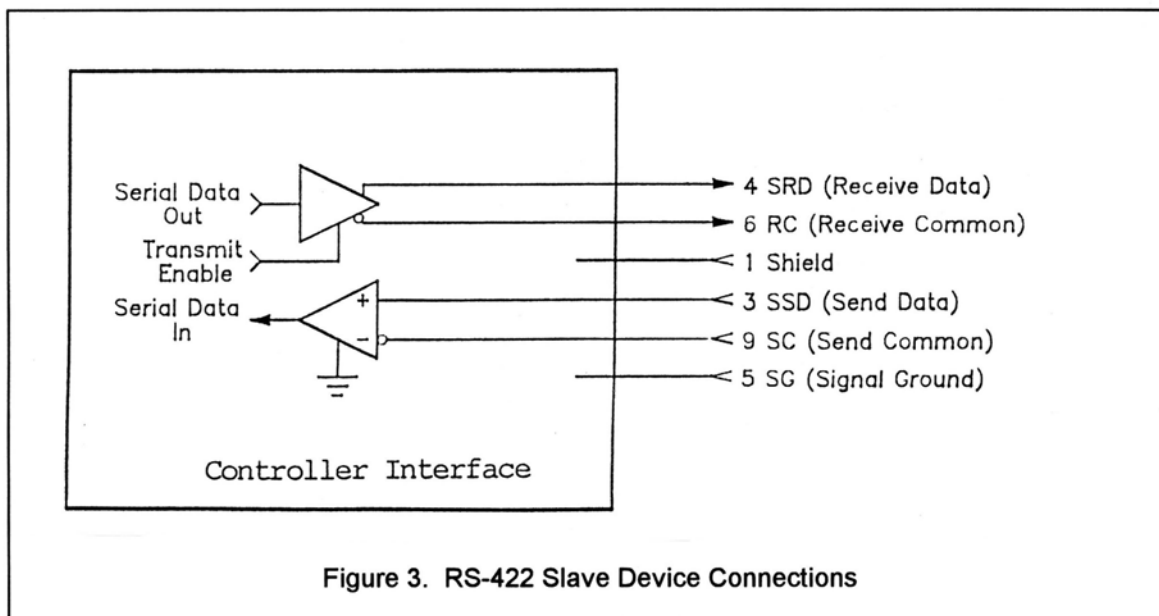


Figure 2 and 3 show RS-422 Master and Slave connections respectively.

Data Format

The data format supports the industry's standard asynchronous ASCII format with one start bit, eight data bits (7-bit ASCII with the 8th bit sent as even parity), and one stop bit. The ASCII control character subset 00-1F (hex) is reserved for message control. The printable ASCII characters 20-7F (hex) are used for address, command and data characters. The standard bus data rate via direct connect (up to 1,500 ft.) is 9,600 BAUD; the data rate for devices connected to a master via modem is 1,200 BAUD, typically.

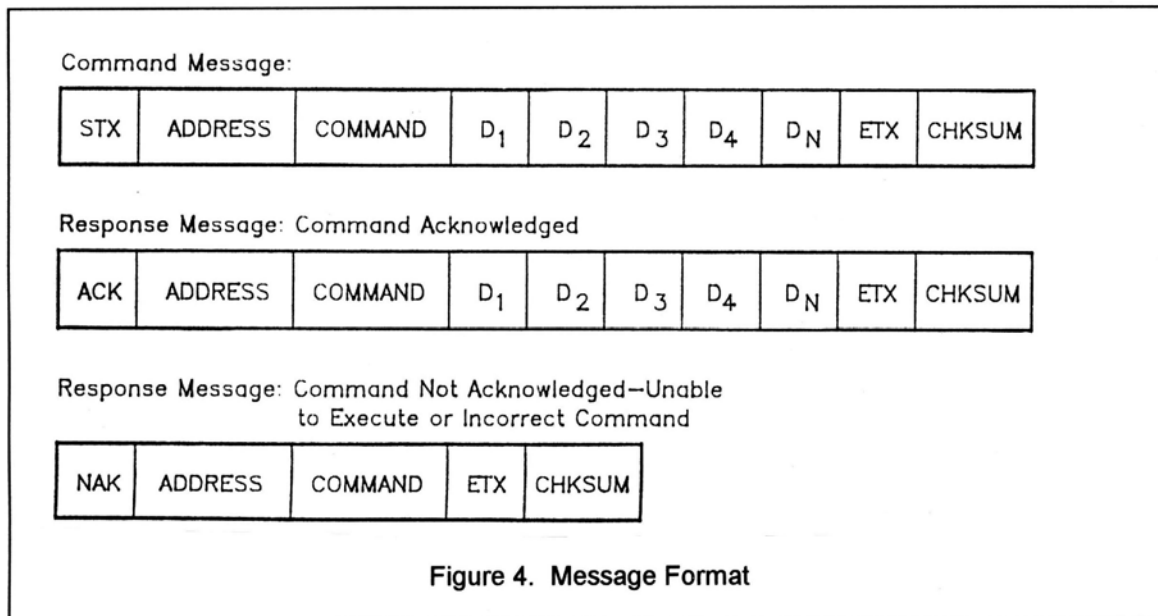
Message Protocol

Message format and protocol over the bus is a derivative of IBM's binary synchronous communications protocol (BISYNC). The master station sends a command over the bus to all remote stations. The station whose address is contained in the second byte of the command message carries out the requested commands, and then replies with a response message containing its own address and status information relating to its present condition. A remote station only sends a response following a command containing its unique address from the master. This prevents bus contention caused by more than one remote device communicating over the bus at the same time.

A remote device ignores all commands that contain parity or checksum errors, protocol errors, a wrong address, or message overrun errors. A remote device replies with a not-acknowledged (NAK) character, 15 hex, if it receives an invalid command or data.

Message Format

Command messages (see Figure 4) begin with Start-of-text byte, STX, followed by a remote address, a command byte and multiple data bytes. The End-of-text byte, ETX, is sent following the last data byte, and the message is terminated by a checksum character. Response messages are identical to command messages in format (but not content) with the exception of the ACK (Acknowledge) or NAK (Not Acknowledge) character at the start of the message instead of STX. Figure 4 illustrates the format of the command and response messages. A command or reply message may have a variable length.



Message Delimiters

A command message begins with STX (02 hex), the ASCII Start-of-text control character. A message-acknowledged reply begins with ACK (06 hex), the ASCII Acknowledge control character, and a

message-not acknowledged reply begins with NAK (15 hex), the ASCII Not Acknowledge control character. All messages end with the ETX (03 hex), the ASCII End-of-text control character, followed by the checksum byte.

Address Character

The device address must be a valid ASCII printable character between 31 and 6F in hex; thus, 63 addresses are possible. These are set in the controller in decimal format, or 49-111.

Command Character

The command character (CMD) immediately follows the device address and specifies one of several possible commands for a particular device. See RCI 'Communication Protocol' document for a complete description of these commands.

Check Character

The last character of any message is the check character (CHK). This character is simply the bit-by-bit exclusive OR of all characters in the message starting with the STX character through the ETX character. This forms a Longitudinal Redundancy parity check over the entire message.

Message Timing

The NAK or ACK reply does not signify that a function has actually taken place, but only that the message was received and understood. The user should query the controller later to see if the command was actually carried out, or is still in progress. Figure 5 shows the controller state diagram.

Command Restrictions

All slaves will respond to a command "0", 30 (hex), with 6 data bytes of ASCII characters in the following form:

ACK ADDR 30 *type* D5 D6 ETX CHSUM

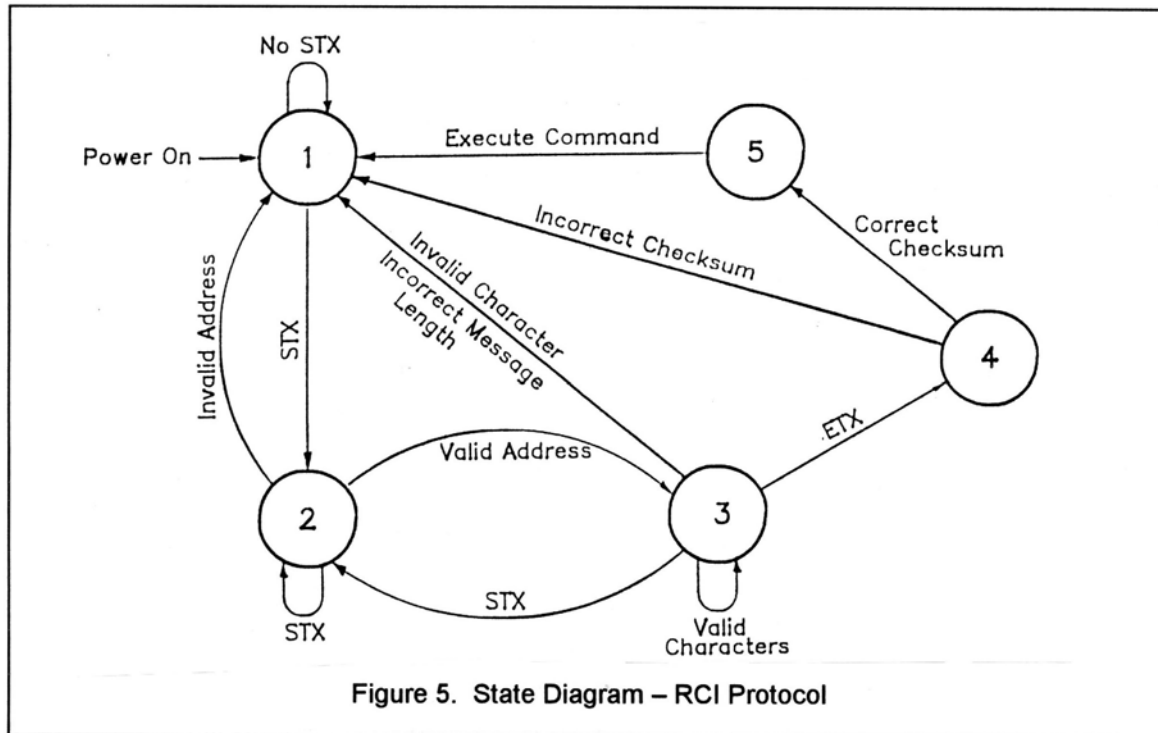
Where *type* is RC2K for an RC2000A, RC1K for an RC1000A, 2KCA for an RC2000C for EI-over-Az mounts, 2KCP for an RC2000C for polar mounts, 2KCE for Az-over-EI mounts, 2500 for the RC2500A, 25CA for an RC2500B for EI-over-Az mounts, 25CP for an RC2500B for polar mounts, and 25CE for Az-over-EI mounts.

Slave State Diagram: Introduction

General Description: The slave State diagram (see Figure 5) presents the required protocol implementation at the slave device that guarantees the proper transfer and processing of communication messages sent by a Master controller.

State Diagram Notation. Each state that a slave can assume is represented graphically as a circle. A single-digit number is used within the circle to identify the state.

All permissible transitions between states are represented graphically by arrows between them. Each transition is qualified by a condition that must be true in order for the transition to occur. The device will remain in its current state if conditions, which qualify transitions leading to other states, are false, or conditions that qualify pseudo-transitions are true. A pseudo-transition is a transition that occurs within the same state and is represented graphically by arrows leaving from and arriving at the same state. Table 1 describes mnemonics used to identify transitions in the state diagram.

**Table 1. State Diagram Mnemonics****Mnemonics Description**

STX	Start-of-Text ASCII control character, used as a header in command messages to identify the beginning of a new message.
ETX	End-of-Text ASCII control character, used as a termination character in messages to identify the end of data.
Checksum LRC byte	(Longitudinal Redundancy Check) is a last byte in the message data block. The value of LRC byte is the exclusive OR of all message bytes including the STX and the ETX bytes and is used to detect errors during transmission of data.

States Description

State 1 (Slave Idle State). In State 1, a slave is ready to receive a new message, and therefore, must complete any previous message reception. A slave always powers on in State 1.

A slave will exit State 1 and enter State 2 (Slave Addressed State) only if STX byte is received.

State 2 (Slave Addressed State). In State 2, a slave is waiting to receive the address byte, the second byte of a command message.

A slave will exit State 2 and enter:

- State 3 (Slave Data State) if received address byte equals a slave's address.
- State 1 (Slave Idle State) if received address byte does not equal a slave's address.
- State 2 (remain in current state) if STX byte is received, which may be the beginning of a new message data block.

State 3 (Slave Data State). In State 3, a slave is engaged in receiving the command and associated data bytes sent by a master-controller.

A slave will exit State 3 and enter:

- State 4 (Slave Data Error State) if ETX byte is received signifying the end of data in the message.
- State 1 (Slave Idle State) if invalid command, or data character, or incorrect number of data bytes is received.

State 4 (Slave Data Error State). In State 4, a slave is waiting to receive a Checksum byte that tests the transmitted message for errors.

A slave will exit State 4 and enter:

- State 5 (Command Execute State) if a Checksum byte is true -received LRC value of Checksum byte equals the LRC value computed by a slave during message reception.
- State 1 (Slave Idle State) if a Checksum byte is false -- received LRC value of Checksum byte does not equal the LRC value computed by a slave during message reception.

State 5 (Command Execute State). In State 5, a slave, having completed reception of a message, executes a function specified by a command byte. A slave will send an appropriate response message to a master-controller after receiving the last character of the message.

A slave will always exit State 5 and enter Device Idle State, State 1.

Appendix E - RC2000A Communications Protocol

REVISION HISTORY

1.22.92 - Original communications protocol for the RC2000A derived from the RC1000A sabusext.inc file.

4.6.93 - Revised to document the new Auto Move to a target az/el position command in the RC2000A version 1.30 software.

1.2.95 - Revised to document the new Auto Move to a target polarization position command and the new byte 32 function of the device status poll command reply in the RC2000A version 1.31 software.

3.21.95 - Revised for the RC2000A version 1.32 software which provided support for the high power polarization option. The POL JAMMED and POL SENSOR alarm messages have been replaced with the ANT POL alarm. The drive error status field of bytes 27 and 28 has been removed.

4.1.02, Version 2.6x, a major revision of the protocol to support the AutoPeak function and upload/download of all controller configuration/satellite data.

12.16.03, Version 2.7, modify the remote SAT_DATA_WRITE command to support deletion of a single satellite in non-volatile memory and all satellites in non-volatile memory.

Command Modifications ...

Miscellaneous Command – ‘Q’ sub command initiates an immediate pickup, the ‘K’ sub command can be used to stuff a keystroke into the controller’s key buffer.

Auto Move Command – Form 1 of the Auto Move Command (32 hex) allows a user to specify a satellite from non-volatile memory as well as an optional polarization code (‘H’ or ‘V’). This command has been modified to also accept ‘D’ (C band) or ‘K’ (K band) if the antenna is equipped with a dual band feed.

Az/El Jog Command – the direction field of this command can accept an ‘X’ character to stop az/el movement. This command has been modified to also stop polarization movement when the direction field contains an ‘X’ and a rotating feed is present. Note that if a rotating feed is present and AutoPol is enabled, rotating feed movement is stopped and the AutoPol CONFIG mode item is disabled.

Polarization Command – now accepts ‘D’ or ‘K’ if the Pol Control? CONFIG mode item specifies that a Two Port feed is present. ‘D’ causes the rotating feed to move to the position associated with C band and ‘K’ causes the feed to move to the position associated with Ku band.

Status Query Reply modifications ...

Pol Position, bytes 24-25, modified to accommodate No Polarization Control device.

Polarization Code, byte 26, modified to indicate display of a pol character associated with a User Remote Auto Move command.

Alarm Code, bytes 30-31, supports the alarms associated with the CONFIG mode items required to support the pickup function.

Pol Equipment/Position, byte 32, modified to include the information contained in the Pol Equipment Code CONFIG mode item, namely, the type of polarization control device present in the system. There is now direct support for a Two Port Pol Motor device (Seavey ESA 124D simultaneous C/Ku and H/V feed).

Pickup Status and Signal Strength, bytes 33 – 35, these bytes were added to give the status of pickup operations and indicate signal strength, formerly reserved bytes.

New Commands

The following commands are supported in this version of the software ...

Reflect Display – transfers the contents of the controller's LCD to the host PC.

Config Read/Write Commands – Download/upload CONFIG mode data.

Sat Data Read/Write Commands – Download/upload non-volatile satellite data.

User Auto Move – Supports auto moves to target az/el/pol target positions.

Bugs Fixed

Query ID Command – in past versions of the software, the command field of the reply to this command did not contain the correct command code.

OVERVIEW

The RC2000C command set conforms to the SA Bus protocol originally defined by Scientific Atlanta. This file describes the commands used to implement the SA bus remote interface for the RC2000 antenna controller. See the RS-422 Serial Interface Addendum included with RC2000 manual for a complete description of the protocol.

RC 2000 BAUD RATE - ADDRESS SPECIFICATION

The baud rate and address must be set before communication with a host is possible. These quantities can be specified in the CONFIG mode. The range of acceptable addresses is 49 to 111. The possible baud rate values are 300, 600, 1200, 2400, 4800, or 9600. The usual SA Bus baud rate is 9600. For completeness, the transmission parameters are repeated here: 7 data bits, even parity, 1 stop bit.

RC 2000 ONLINE/OFFLINE

To enable REMOTE mode on the RC2000, the internal remote\$mode\$enable\$flag must be set. This flag is set at the 'Remote Mode Enable' prompt in CONFIG mode. When this flag is set, REMOTE mode can be entered in two ways. One way REMOTE mode can be activated by depressing the mode button. REMOTE mode can be found just after AUTO mode. The second way REMOTE mode can be activated is if certain serial commands are received by the serial port. Currently the Miscellaneous Keystuff, Display Reflect, and Device Status Poll commands can be processed with transferring control to REMOTE mode.

If the remote\$mode\$enable\$flag is FALSE and a valid command arrives via the serial port, the offline reply is sent to the host. Here is the format of the offline reply...

byte 0:	ACK	
byte 1:	A	where A is the RC2000 address
byte 2:	'CC'	the command code of the message which triggered this reply.
byte 3:	'F'	ASCII 'F', for offline.
byte 4:	ETX	
byte 5:	checksum	The checksum character is simply the bit-by-bit exclusive OR of all characters in the message starting with the STX character through the ETX character.

RC2000 UNRECOGNIZED COMMANDS - NAK REPLY

If an unrecognized command arrives (one whose command code is either unknown or whose length is not compatible with the given command code, but which has the correct address and checksum), a NAK reply is sent to the host. The format of the NAK reply is ...

byte 0:	NAK
---------	-----

byte 1:	A	where A is the RC2000 address
byte 2:	'CC'	the command code of the unrecognized message.
byte 3:	ETX	
byte 4:	checksum	

DEVICE TYPE QUERY COMMAND

The SA Bus specifications requires that command character 30h must trigger the return of the six character device type string. The message format for this query will be ...

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	30h	30 hex - the device type query command code
byte 3:	ETX	
byte 4:	checksum	

The reply to this query will consist of 11 bytes ...

byte 0:	ACK	
byte 1:	A	where A is the RC2000 address
byte 2:	30h	the device type query command code
bytes 3-6:	'RC2K'	
bytes 7,8:	'XX'	where XX is the version number, for example if the current software version number were 2.65, XX would be '26'.
byte 9:	ETX	
byte 10:	checksum	

DEVICE STATUS POLL COMMAND

The SA Bus specification requires that command character 31h cause a device to return its status information. The reply to this command includes azimuth, elevation and polarization position, current satellite name, as well as limit, alarm and drive status information. The status poll command message consists of 5 bytes and the format is;

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	31h	the status poll query command code
byte 3:	ETX	
byte 4:	checksum	

The response to this command will consist of 38 bytes, which will be a combination of ASCII and binary data fields. The binary data will be placed in the lower nibble of a byte whose higher nibble will be initialized to a value which will make the result an ASCII character. The idea with this response is to be able to reproduce the information presented on the LCD to the user when MANUAL mode is active. The format of the response will be;

byte 0:	ACK	
byte 1:	A	where A is the RC2000 address
byte 2:	31h	the status poll query command code
bytes 3-12:	sat_name	This field will contain the satellite name in upper case letters. If the name does not occupy the entire field the name will be left justified and the string will be right padded with blanks. If a satellite name is not currently displayed, this field will contain blanks.
byte 13:	sat_name	status - binary data

```

7 6 5 4   3 2 1 0
0 0 1 0 $ 0 0 _ _

```

	0 0	displayed in upper case letters
	0 1	displayed in lower case letters
	1 0	sat_name not displayed
bytes 14-18:	az position	This field will contain the current azimuth position, formatted in a manner identical to how the position is displayed on the front of the unit, '0' to '65535'. If an azimuth limit is active, the field will contain either 'CCW' or 'CW'.
bytes 19-23:	el position	This field will contain the current elevation position, formatted in a manner identical to how the position is displayed on the front of the unit, '0' to '65535'. If an elevation limit is active, the field will contain either 'DOWN' or 'UP'.
bytes 24-25:	pol position	If a polarotor is present in the system this field will contain the current polarization position, formatted in a manner similar to how the position is displayed on the front of the unit, '0' to '98', or 'CC' or 'CW' if a limit is active. As the polarotor moves counter clockwise (as viewed looking into the feed horn), the displayed numbers get greater.

If a rotating feed is present in the system, this field will contain a value in the range of 0 to 92, 'CW' or 'CC'. The value in this field will be related to the value displayed on the user interface of the controller by the following formula ...

$$\text{byte_24_25_position} = \text{user_interface_position} / 11.$$

where

byte_24_25_position ... is the value returned in bytes 24 and 25.

user_interface_position ... is the polarization position displayed on the display of the user interface.

Note that the division defined above is an integer division. The result is rounded DOWN to the closest integer.

Please see byte 32 of this command's reply message for more information on polarization position representations.

If a polarization control device is not present in the system bytes 24 and 25 will contain blank characters (20 hex).

byte 26: polarization code and AutoPol status - binary data

```

7 6 5 4   3 2 1 0
0 0 1 0 $  _ _ _ _
           0 x x x
           1 x x x

```

* auto pol disabled (AutoPol flag FALSE)
 auto pol enabled (AutoPol flag TRUE) Note
 that if a two port rotating feed is present
 the state of the auto pol flag has no effect
 on system operation.

x 0 0 0 'H' polarization code displayed

x 0 0 1	'h' polarization code displayed
x 0 1 0	'V' polarization code displayed
x 0 1 1	'v' polarization code displayed
x 1 0 0	no polarization code displayed
x 1 0 1	polarization code passed as part of a User Remote Auto Move command is displayed

* Note, 'x' means don't care

byte 27: azimuth movement/alarm status - binary data

7 6 5 4	3 2 1 0	
0 0 1 0	\$	— — — —
	0 0 0 0	no alarms or movement
	0 0 1 0	east movement pending
	0 0 1 1	west movement pending
	0 1 0 0	east movement in progress
	0 1 0 1	west movement in progress
	0 1 1 1	an auto move is in progress
	1 0 0 0	runaway alarm active
	1 0 0 1	jammed alarm active
	1 1 0 0	drive alarm active. This is triggered by an overcurrent condition.

Note - Higher value status codes have priority over lower value ones, i.e. if as part of an auto move command the antenna is moving west the status will be reported as 'auto move in progress' rather than 'west movement in progress'.

byte 28: elevation movement/alarm status - binary data

7 6 5 4	3 2 1 0	
0 0 1 0	\$	— — — —
	0 0 0 0	no alarms or movement
	0 0 1 0	down movement pending
	0 0 1 1	up movement pending
	0 1 0 0	down movement in progress
	0 1 0 1	up movement in progress
	0 1 1 1	an auto move is in progress
	1 0 0 0	runaway alarm active
	1 0 0 1	jammed alarm active
	1 0 1 0	limit alarm active
	1 1 0 0	drive alarm active. This is triggered by an overcurrent condition.

byte 29: polarization movement status - binary data

7 6 5 4	3 2 1 0	
0 0 1 0	\$ 0 0	— —
	0 0	no polarization movement
	0 1	cw jog in progress
	1 0	ccw jog in progress
	1 1	go to H or V in progress

byte 30: least significant nibble of alarm status - binary data

7 6 5 4	3 2 1 0
0 0 1 0	\$ a3 a2 a1 a0

a3 – a0 represent the least significant nibble of the alarm code

byte 31: most significant nibble of alarm status - binary data

```

7 6 5 4   3 2 1 0
0 0 1 0 $ a7 a6 a5 a4

```

a7 – a4 represent the most significant nibble of the alarm code

Alarm codes - See the system error codes in chapter 6 of the RC2000A manual.

a	a	a	a	\$	a	a	a	a		
7	6	5	4		3	2	1	0		
0	0	0	0		0	0	0	0	0	0 - no alarm active
0	0	0	0		0	0	0	1	1	1 - low battery alarm
0	0	0	0		0	0	1	0	0	2 - azimuth alarm
0	0	0	0		0	0	1	1	1	3 - elevation alarm
0	0	0	0		0	1	0	0	0	4 - azim count alarm
0	0	0	0		0	1	0	1	1	5 - elev count alarm
0	0	0	0		0	1	1	0	0	6 - azim limit corrupt alarm
0	0	0	0		0	1	1	1	1	7 - elev limit corrupt alarm
0	0	0	0		1	0	0	0	0	8 - autopol data alarm
0	0	0	0		1	0	0	1	1	9 - simultaneous az/el alarm
0	0	0	0		1	0	1	0	0	10 - azim slow speed alarm
0	0	0	0		1	0	1	1	1	11 - elev slow speed alarm
0	0	0	0		1	1	0	0	0	12 - comm port data alarm
0	0	0	0		1	1	0	1	1	13 - geo elev position alarm
0	0	0	0		1	1	1	0	0	14 - peakup config data alarm
0	0	0	1		0	0	0	1	0	17 - az/el ang display alarm
0	0	0	1		0	0	1	0	0	18 - pol limits alarm
0	0	0	1		0	0	1	1	1	19 - pol options alarm
0	0	0	1		0	1	0	0	0	20 - polarization alarm
0	0	0	1		0	1	0	1	1	21 - azim drive options alarm
0	0	0	1		0	1	1	0	0	22 - elev drive options alarm

byte 32:

This byte gives information which allows the user to 1) determine the type of polarization control equipment interfaced to the controller, and 2) determine the exact value of the controller's internal polarization position representation. This may be used with the automove command to position the polarization control device at a specific value.

The RC2000's Pol Equipment Code CONFIG mode item allows the user to specify what type of polarization control equipment is interfaced to the controller. The RC2000 supports the following polarization control devices ...

1) No Polarization Control Device

2) A Polarotor type polarization control device.

3) A single port motorized (or rotating) feed with potentiometer position feedback.

4) A two port motorized (or rotating) feed with potentiometer position feedback. A two port feed receives horizontal and vertical polarizations simultaneously.

```

7 6 5 4   3 2 1 0
0 p p p $ s s s s

```

- - - -	- - - -	
0 1 0 0		No polarization control device is present in this system.
0 0 1 0		The system is configured for a Polarotor type polarization control device.
0 1 1 1		A single port rotating feed device is present in this system.
0 0 1 1		A two port rotating feed is present in this system.
	s s s s	The usage of these bits is dependent on the type of polarization control device present in the system as described in the next section.

The definition of the ssss bits is dependent on the type of polarization control device. For No Polarization Control device these bits will be zeroes. These bits will also be zeroes if a Polarotor or rotating feed control device is present and the polarization position is at or beyond a limit.

If a polarization control device is present and the polarization position is not at or beyond a limit the usage of these bits are as defined below ...

For the POLAROTATOR, the polarization position value reported via the user interface and the comm port (bytes 24 and 25 of the device status pol command reply) is a value in the range of 0 to 98, 'CW' (for clockwise limit) or 'CC' (for counter clockwise limit). The controller's internal polarization position representation, however, is a value in the range of 0 to 661. An internal position of 0 corresponds to the CW limit and an internal position of 661 corresponds to the CC limit. Internal position values in range of 1 to 660 are scaled to display as a value of 0 to 98 on both the user interface and via bytes 24 and 25 of the device status poll reply. To obtain the internal position from this byte and bytes 24 and 25, use the following formula ...

$$\text{internal_position} = ((\text{byte_24_25_position} * 661) / 99) + \text{ls_nibble_byte_32}$$

where ...

internal_position ... is the controller's internal polarotor position representation.

byte_24_25_position ... is the polarotor position reported via byte 24 and 25 of the device status poll reply and displayed on the user interface (a value in the range of 0 to 98).

ls_nibble_byte_32 ... is the least significant nibble (lower 4 bits) of this byte.

Note that in the above equation the division is an integer division which means that the result of the division should be rounded DOWN to the closest integer value (i.e. $(39 * 661) / 99 = 260$).

For the ROTATING FEED, the internal polarization position and the polarization position displayed via the user interface are the same and will be a value in the range of 0 to 1023. For the rotating feed the user is prompted to set CW and CC limits. When the polarization position is less than or equal to the CW limit specified by the user the 'CW' banner will be displayed. When the polarization position is greater than or equal to the CC limit specified by the user, the CC banner will be displayed.

The polarization position given by bytes 24 and 25 of the device status poll reply will be a value in the range of 0 to 92. When the rotating feed is at a limit (or beyond) the byte 24,25 values will be 'CW' or 'CC'. To obtain the internal polarization position for the rotating feed from this byte and the value in bytes 24 and 25, use the following formula ...

$$\text{internal_position} = (\text{byte_24_25_position} * 11) + \text{ls_nibble_byte_32}$$

where the variables are as defined for the polarotor case.

Byte 33 Peakup Status

```

7 6 5 4 3 2 1 0
0 e2 e1 p $ s s s s
- - - - - - - -

```

0 1

This version of the software does not support peakups.

1 0

This version of the software supports peakups but peakups are not enabled.

1 1

This version of the software supports peakups and peakups are enabled.

```

0 e2 e1 p $ s s s s
- - - - - - - -

```

0 x x x x

peakup system idle

1 x x x x

peakup in progress

1 1 x x x

auto or manual move preceding peakup in progress

1 0 0 0 0

peakup init state (transient)

1 0 0 0 1

peakup settle state, if a non-zero CONFIG mode Peakup Holdoff Interval is specified the controller will wait for 5 seconds before starting the wait interval.

1 0 0 1 0

peakup wait state, the controller is waiting for agc to begin a peakup.

1 0 0 1 1

an azimuth peakup is in progress

1 0 1 0 0

an elevation peakup is in progress

1 0 1 0 1

the peakup failed, either agc went away of a peak limit error (the antenna moved too far from the nominal position looking for a peak) occurred, the antenna is returning to the nominal az/el position (transient)

1 0 1 1 0

the peakup failed, either agc went away or a peak limit error (the antenna moved too far from the nominal position looking for a peak) occurred, the antenna is returning to the nominal az/el position

```

0 e2 e1 p $ s s s s
- - - - - - - -

```

0 x x x x

peakup system idle, the ssss field indicates the error status of the last peakup

0 0 0 0 0

no error

0 0 0 0 1

1, The stop key was hit during a peaking operation

The following error codes are active if an axis error is detected during the peaking operation.

0 0 0 1 0

2, Azimuth Drive, Jammed, or Runaway Error

0 0 0 1 1

3, Elevation Drive, Jammed, or Runaway Error

0 0 1 0 0

4, Polarization Drive, Jammed or Sensor Error

The following error codes activate if the peakup routine determines that the next azimuth or elevation movement will result in a limit.

0 0 1 0 1

5, Azimuth CCW Limit

0 0 1 1 0

6, Azimuth CW Limit

0 0 1 1 1

7, Elevation Down Limit

0 1 0 0 0

8, Elevation Up Limit

0	1 0 0 1	9, Lost AGC Error. Signal Strength was lost during a peaking operation.
0	1 0 1 0	10, Peak Limit Error. The controller took too many steps looking for a peak (initially 4 steps).
0	1 0 1 1	11, AGC Timeout Error. The controller waited for PEAKUP HOLDOFF INTERVAL seconds and AGC was not detected.
The following errors indicate that a remote movement command (Az, El, or Pol) was received by the controller while a peaking operation was in progress.		
0	1 1 0 0	12, Remote Auto Move occurred during a peaking operation.
0	1 1 0 1	13, Remote Jog Command occurred during a peaking operation.
0	1 1 1 0	14, Mode Change. The controller's operational mode was changed during a peaking operation.
0	1 1 1 1	15, Invalid Peakup Params. A peaking operation was specified but at least one of the peakup related parameters in non-volatile memory is corrupt.

Bytes 34 and 35 contain signal strength information.

Byte 34 contains the least significant 5 bits of the signal strength and indicates which AGC channel has the greatest signal strength.

7	6	5	4	3	2	1	0	
0	c2	c1	L	\$	L	L	L	L
-	-	-	-	-	-	-	-	-
0	1							
1	0							

AGC channel 1 has the greatest signal strength
AGC channel 2 has the greatest signal strength

Byte 35 contains the most significant 5 bits of the signal strength.

7	6	5	4	3	2	1	0	
0	x	x	M	\$	M	M	M	M
-	-	-	-	-	-	-	-	-
x	x							
1	0							

x x are reserved bits
initialized to 1 0 in this version of the software

The signal strength is a 10 bit value (0 to 1023) – M M M M M L L L L L where L L L L L are the 5 least significant bits of byte 34 and M M M M M is the 5 least significant bits of byte 35.

byte 36: ETX
byte 37: checksum

AUTO MOVE COMMAND

This command causes the controller to automatically position the antenna in either azimuth and elevation and/or polarization. The command has 3 forms.

Form 1. If the sat_name/position field contains the name of a satellite saved via the controller's SETUP mode the controller will position the antenna at the azimuth and elevation positions associated with that satellite. The satellite name should be in capital letters, left justified and padded on the right with blanks in the sat_name/position field. Note that the satellite name must exactly match one in the controller's non-volatile memory for the auto move to occur.

With this form of the command, the polarization field may contain either 'H', 'V', 'D', 'K', or ' ' (a blank, 20 hex or 32 decimal). If an 'H' or a 'V' is specified, in addition to positioning the antenna in azimuth and elevation, the polarization control device will be commanded to go to the position associated with either the horizontal ('H') or vertical ('V') polarization specified for the satellite. If a dual band feed is present, 'D' or 'K' can be specified to select the polarization associated with either C or Ku band, respectively. If the field contains a blank the polarization is not changed. For example, this command with 'H' in the polarization field and 'SBS 6' in the sat_name/position field will specify an auto move to SBS 6 and the polarization will be adjusted to horizontal for the SBS 6 satellite.

Form 2. If the sat_name/position field contains a valid pair of azimuth and elevation positions the antenna will move to the position specified. The first 5 characters of the sat_name/position field specify the azimuth position (azimuth sub-field) and the last five characters specify the elevation position (elevation sub-field). Within each of the sub-fields the position must be right justified and left padded with zeroes. For example, a sat_name/position field value of '0152500750' specifies an azimuth position of 1525 counts and an elevation position of 750. For the command to be accepted these positions must be within their respective limits for each axis. For this form of the auto move command, only the blank character is accepted in the polarization field. Note that the position must be specified in position counts and not in an angle format.

Form 3. If the polarization field contains the 'P' character, the command is interpreted as a go_to_polarization command. For this form of the command, the first 5 characters of the sat_name/position field specify the target polarization position in the controller's internal polarization position representation (polarization sub-field). See byte 32 of the device status poll reply for more information on the internal polarization position representations for the different types of polarization control devices. The polarization position in the polarization sub-field must be right justified and left padded with zeroes. The second 5 characters of the sat_name/position field must contain '00000'. For example, if the sat_name/position field contains '0050000000' the polarization control device is commanded to adjust the polarization to a position of 500.

The command contains 16 bytes. Here is the format;

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	32h	the auto move command code
byte 3:	polarization	This field can specify 'H', 'V', ' ' (blank), 'P', 'D', or 'K'.
byte 4-13:	sat_name/position	This field specifies the satellite name or a target azimuth and elevation or polarization position.
byte 14:	ETX	
byte 15:	checksum	

The normal reply to this command will be the same as the reply to the status poll query except that the command code field will be '32h'. Note that if the satellite name is not found, the auto pol system is enabled and a polarization is specified within the command, or if a position specified in the sat_name/position field is outside of the limits for the relevant antenna axis a NAK reply will be sent to the host.

AZIMUTH/ELEVATION JOG COMMAND

This command jogs the antenna in azimuth or elevation. The command contains 11 bytes. Here is the format of the command;

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	33h	the command code

byte 3:	direction	This field can specify 'E', 'W', 'D', 'U' or 'X'. 'E' refers to counter clockwise, 'W' to clockwise, 'D' refers to down, and 'U' refers to up. An 'X' specifies that the antenna stop moving. Note that if a rotating feed is present the rotating feed movement will terminate when this command is received. Note that if the Auto Pol feature is enabled when a stop command is received, the Auto Pol feature will be disabled.
byte 4:	speed	This field specifies the jog speed, either 'F' (Fast) or 'S' (Slow). Note that this field must contain a valid value even if the direction field specifies 'X' (Stop).
bytes 5-8:	duration	This field specifies the duration of the azimuth/elevation jog command in milliseconds. The valid range of values for this field is '0000' to '9999'. As a practical matter, the resolution of the timer used to time the move is approximately 150 milliseconds, so any move will be for a time interval equal to a multiple of approx. 150 milliseconds. Note that this command must contain a valid value even if the direction field specifies 'X' (Stop).
byte 9:	ETX	
byte 10:	checksum	

The reply to this command will be the same as the reply to the status poll query except that the command code will be '33h'.

POLARIZATION COMMAND

The following command specifies a polarization jog. The command contains 6 bytes. Byte 3 can contain one of the following values...

'C'...	jog the polarization clockwise.
'W'...	jog the polarization counter clockwise. Note that there is not a duration or a speed associated with these commands. The duration is fixed and the speed increases as the polarization continues its movement without being interrupted. An interruption occurs if another command does not arrive before the previous polarization command terminates.
'H'...	move the polarotor to the preset horizontal position of the satellite closest to the antenna's present azimuth position.
'V'...	move the polarotor to the preset vertical position of the satellite closest to the antenna's present azimuth position.
'D'...	moves the feed to position associated with C band if a Two Port rotating feed is specified in the Pol Control? CONFIG mode item.
'K'...	moves the feed to position associated with Ku band if a Two Port rotating feed is specified in the Pol Control? CONFIG mode item.

The format of the command is as follows;

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	34h	the command code
byte 3:	'X'	the polarization movement code

byte 4: ETX
 byte 5: checksum

The reply to this command will be the same as the reply to the status poll query except the command code will be '34h'. Note that the NAK reply will be sent back to the host if AutoPol is enabled or if 'H' or 'V' is specified and there are no satellites available in the RC2000 memory.

QUERY NAME COMMAND

This query command instructs the RC2000 to send back to the host computer an indexed satellite name from the list of satellites stored in non-volatile memory. This list is comprised of those satellites that were saved via SETUP mode in the RC2000. A maximum of 50 can be in the list. This query command contains 7 bytes and the format is;

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	35h	the query name command code
bytes 3,4:	'XX'	where XX is the index of the satellite name being requested. Normally this would be '01' the first time through and then incremented until the 'YY' (YY being the last entry in the list) satellite name is read. The maximum possible range for XX and YY is 1 through 50.
byte 5:	ETX	
byte 6:	checksum	

The normal response to this query command contains 19 bytes and the format is as follows;

byte 0:	ACK	
byte 1:	A	where A is the RC2000 address
byte 2:	35h	the query name command code
bytes 3,4:	'XX'	where XX is the index of the satellite name being requested.
bytes 5,6:	'YY'	where YY is the total number of satellite names contained in the list.
bytes 7-16:	This field will contain the satellite name.	
byte 17:	ETX	
byte 18:	checksum	

Note that if entry 'XX' does not exist in the list (or the list has no entries) the NAK reply will be sent back to the host.

MISCELLANEOUS COMMAND

This command performs miscellaneous functions. Here is the format of the command.

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	36h	the miscellaneous command code
byte 3:	'X'	the sub-command code
byte 4:	'Y'	the sub-command parameter
byte 5:	ETX	
byte 6:	checksum	

The sub-command code 'X' can have the following values ...

'X' = 'R'	This code specifies the azimuth, elevation, or polarization drive reset command. This accomplishes the same function as the RESET mode of the RC2000: it allows the user to reset the solid state drive circuits if an azimuth or elevation alarm has
-----------	---

been detected. When the sub-command code is 'R', the sub-command parameter 'Y' must be either 'A', 'E', or 'P' (for azimuth, elevation, or polarization respectively) to specify which axis will be reset. If the 'P' command is specified, the command will be accepted only if the RC2000A is configured for use with the optional rotating feed.

'X' = 'P'	This sub-command allows the host to enable or disable the AutoPol mode. If the sub-command is 'P' the sub-command parameter 'Y' must either be 'N' or 'F' (for AutoPol on or off, respectively).
'X' = 'Q'	This sub-command can initiate an immediate peakup operation. A sub-command parameter of 'C' initiates a C band peakup. A sub-command parameter of 'K' initiates a Ku band peakup. This command will be accepted if the controller supports peakups, if the controller's Peakup Enable CONFIG mode item is enabled, the Peakup related parameters in non-volatile memory are valid, and a peakup is not currently in progress. Otherwise, a NAK reply will be sent to the host.
'X' = 'K'	This sub-command sends a keypad value to the RC2000 (this is referred to as key-stuffing). The RC2000 will react to the keypad value as if the corresponding key on the RC2000's front panel was pushed. The command is implemented using the miscellaneous command format.

The sub parameters are and the corresponding keys are given below.

Parameter	Key
30h	0/Speed
31h	1/Pol CCW
32h	2/N/EL UP
33h	3/Pol CW
34h	4/E/AZ CCW
35h	5
36h	6/W/AZ CW
37h	7/H
38h	8/S/EL DN
39h	9/V
3A-3Fh	-- unused --
41h	Stop/decimal pt.
42h	+/-/BKSP
43h	Mode
44h	Scroll Up/Yes
45h	Scroll Dn/No
46h	Enter
47h	Mode Group Change

Antenna jog operations are controlled by the length of time that a jog key is depressed by the user. To emulate this characteristic when jogging the controller with the Miscellaneous keystuff command, the reception of a Miscellaneous keystuff command initiates a timer. The key

sent will remain 'depressed' until the timer expires. The default timer interval is one second. The user can alter this via the Pol Motor Jog Duration CONFIG mode item. If the last two digits of the 'Jog Duration' parameter are between 2 and 25 the jog interval will be the value specified by the last two digits multiplied by 100 milliseconds. For example, a 'Jog Duration' value of 1015 will result in a timer interval of 1500 milliseconds or 1.5 seconds.

The resolution of the timer is approximately +/- 150 milliseconds.

The reply to this command will be the same as the reply to the status poll query except the command code will be '36h'.

REFLECT DISPLAY COMMAND.

This command causes the RC2000 to report 1) the contents of the controllers display (80 characters in a 2 row by 40 column format), 2) the position of the cursor (row and column), and 3) any active alarms.

The command contains 5 bytes ...

byte 0	STX	
byte 1	A	the RC2000's address
byte 2	37h	reflect display command code
byte 3	ETX	
byte 4	checksum	

The response contains 91 bytes ...

byte 0	ACK	
byte 1	A	where A is the RC2000's address
byte 2	37h	reflect display command code
byte 3-42	row 1	40 ASCII characters displayed on row 1 of the LCD
byte 43-82	row 2	40 ASCII characters displayed on row 2 of the LCD
byte 83	cursor row	cursor row position, ASCII '1' or '2'
byte 84,85	cursor column	ASCII '1' through '40', byte 84 contains the most significant digit
byte 86	cursor status	ASCII '0' or '3' => cursor off, '1' => cursor on and blinking, '2' => cursor on but not blinking.
byte 87,88	alarm code	ASCII '1' through '22', byte 87 contains the most significant digit of the alarm code, byte 88 contains the least significant digit of the alarm code. The alarm codes are as defined for bytes 30 and 31 of the Device Status Poll Command.
byte 89	ETX	
byte 90	checksum	

CONFIG WRITE COMMAND

This command writes CONFIG mode data to the controller's non-volatile memory. The command contains 13 bytes. Here is the format of the command

byte 0	STX	
byte 1	A	where A is the RC2000 address
byte 2	38h	the command code

bytes 3,4 data index This field specifies the data item that will be written to non-volatile memory. The data index is specified in an ASCII format. The data index is right justified and padded on the left with a blank, if necessary. The indices are defined below. Byte 3 is the most significant digit.

- 0 - Auto Pol Enable
- 1 - Auto Pol Vpol Level
- 2 - Simultaneous Azim Elev
- 3 - Comm Port Baud Rate
- 4 - Comm Port Address
- 6 - Remote Mode Enable
- 7 - Geo Position
- 8 - Azim Cw Limit
- 9 - Elev Up Limit
- 10 - Peakup Cband Azim Step
- 11 - Peakup Cband Elev Step
- 12 - Agc Polarity
- 13 - Agc Cband Threshold
- 14 - Agc Kband Threshold
- 15 - Peakup Kband Azim Step
- 16 - Peakup Kband Elev Step
- 17 - Azim Position Cnt
- 18 - Peakup Enable
- 19 - Peakup Holdoff Interval
- 20 - Azim Tach Slow Speed
- 21 - Elev Tach Slow Speed
- 22 - Ang Disp Enable
- 23 - Ang Disp Azim Scale
- 24 - Ang Disp Azim Offset
- 25 - Ang Disp Elev Scale
- 26 - Ang Disp Elev Offset
- 27 - Ang Disp Northern Hemi
- 28 - Pol Equipment Code
- 29 - Pol Ang Disp Enable
- 30 - Pol Disp 0 Degree Cnt
- 31 - Pol Disp 90 Degree Cnt
- 32 - Drive Options Enable
- 33 - Azim Fast Slow Threshold
- 34 - Azim Coast Threshold
- 35 - Azim Max Position Error
- 36 - Azim Max Retry Cnt
- 37 - Azim Fast Deadband
- 38 - Azim Slow Deadband
- 39 - Elev Fast Slow Threshold
- 40 - Elev Coast Threshold
- 41 - Elev Max Position Error
- 42 - Elev Max Retry Cnt
- 43 - Elev Fast Deadband
- 44 - Elev Slow Deadband
- 45 - Pol Motor Jog Duration
- 46 - Expert Mode
- 47 - Elev Position Cnt
- 48 - Pol CCW Limit **
- 49 - Pol CW Limit **

** The Pol CCW Limit value should be greater than or equal to the Pol CW Limit value. Both limit values should be less than 1024. Note that the controller maintains a single checksum value that validates both the Pol CCW and CW limits. Inputting one of the pol limit values causes the checksum to be recalculated using the value which was input and the other pol limit value.

Bytes 5-10	data field	This field specifies the data value. In general, data values are specified in an ASCII format. The data values are right justified and left padded with blanks. Please refer to Chapter 4 – CONFIG mode for the range of acceptable values for each field. Data field formatting information unique to certain data indices are described below. Byte 5 is the most significant digit of the field.
Bytes 11-16	reserved	Set these bytes to blank characters, 20 hex.
byte 17	ETX	
byte 18	checksum	

If the data index or data value is invalid the NAK reply will be transmitted to the host. The normal reply to this command will be the same as the reply to the device status poll command except that the command code field will be '38h'.

CONFIG READ COMMAND

This command reads CONFIG mode data from the controller's non-volatile memory. The command contains 7 bytes. Here is the format of the command.

Byte 0	STX	
Byte 1	A	where A is the address
Byte 2	39 hex	command code
bytes 3,4	data index	This field specifies the data that will be read from non-volatile memory. The data index is specified in an ASCII format. The data index is right justified and padded on the left with blanks. See the Remote Config Write Command for a list of the data indices. Byte 3 is the most significant digit of the index.
Byte 5	ETX	
Byte 6	checksum	

If the command specifies an invalid index the reply to this command will be the NAK reply. If a valid index is specified the reply will be as follows ...

Byte 0	ACK	
Byte 1	A	The address of the RC2000 antenna controller.
Byte 2	39 hex	The command code of the Config Read command.
Byte 3,4	data index	The data index. See the Config Write command for a description of the data indices.
Bytes 5-10	data field	The data value. See the Config Write command for a description of the formatting applied to the data values. If the data field contains '*****' the data associated with the index is invalid (an alarm should be active).
Bytes 11-16	reserved	These six bytes are reserved for future expansion. They are currently set to blank characters (20 hex).
Byte 17	ETX	
Byte 18	checksum	

SAT DATA WRITE COMMAND

This command creates a satellite data entry in the RC2000's non-volatile memory. The RC2000A's non-volatile memory has space for up to 50 satellites. No validity checks are performed on the az/el/pol position data contained in this command. Note, however, that the controller will not initiate a move to a satellite contained in non-volatile memory if the entry contains invalid data (az/el/pol positions outside of the limit).

If this command specifies the name of a satellite that already exists in the controller's non-volatile memory the existing entry will be over written if the Azim Position field contains a value other than zero.

If the Satellite Name field specifies a satellite that already exists in the controller's non-volatile memory and the Azimuth Position field contains 0, the satellite entry will be deleted.

If the Satellite Name field contains 'CLEAR DATA' all of the satellite entries in the controller's non-volatile memory are erased.

This command contains 47 bytes and the format is ...

byte 0	STX	
byte 1	A	where A is the RC2000 address
byte 2	3ah	the sat data write command code
bytes 3-12:	satellite name	This field will contain the satellite name, normally left justified and right padded with blanks.
bytes 13-17	azim position	This field will contain the satellite's azimuth position in an ASCII format that is right justified and left padded with blanks.
bytes 18-22	elev position	This field will contain the satellite's elevation position in an ASCII format that is right justified and left padded with blanks.
bytes 23-27	hpol position	This field will contain the satellite's horizontal polarization position in an ASCII format that is right justified and left padded with blanks.
bytes 28-32	vpol position	This field will contain the satellite's vertical polarization position in an ASCII format that is right justified and left padded with blanks.
Bytes 33	band	ASCII '0' for C band, '1' for Ku band, and '2' for a dual band satellite.
Byte 34-38	sat longitude	The satellite longitude in tenths of degrees in an ASCII format, right justified and left padded with blanks. West longitude values will be preceded by a minus sign, '-'. The range of values accepted by this command is -1800 to 1800.
Byte 39-44	reserved	Reserved for future expansion
byte 45	ETX	
byte 46	checksum	

If this command contains invalid parameters (with the exception of az/el/pol position data) the response to the command will be the NAK reply. The normal reply to this command will be the same as the reply to the Device Status Query command except that the command code field will be '3a' hex.

SAT DATA READ COMMAND

This command instructs the RC2000 to send back to the host computer an indexed satellite data entry from the list of located satellites stored in non-volatile memory. This list is comprised of those satellites that were saved via SETUP mode in the RC2000. A maximum of 50 can be in the list. This query command contains 7 bytes and the format is ...

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	3bh	the sat data read command code
bytes 3,4:	'XX'	where XX is the index of the satellite name being requested. Normally this would be '01' the first time through and then incremented until the 'YY' (YY being the last entry in the list)

satellite name is read. The maximum possible range for XX and YY is 1 through 50.

byte 5: ETX
byte 6: checksum

The normal response to this query command contains 19 bytes and the format is as follows ...

byte 0	ACK	
byte 1	A	where A is the RC2000 address
byte 2	3bh	the sat data read command code
bytes 3,4	'XX'	where XX is the index of the satellite name being requested.
bytes 5,6	'YY'	where YY is the total number of satellite names contained in the list.
bytes 7-16:	satellite name	This field will contain the satellite name, normally left justified and right padded with blanks.
bytes 17-21	azim position	This field will contain the satellite's azimuth position in an ASCII format that is right justified and left padded with blanks.
bytes 22-26	elev position	This field will contain the satellite's elevation position in an ASCII format that is right justified and left padded with blanks.
bytes 27-31	hpol position	This field will contain the satellite's horizontal polarization position in an ASCII format that is right justified and left padded with blanks.
bytes 32-36	vpol position	This field will contain the satellite's vertical polarization position in an ASCII format that is right justified and left padded with blanks.
Bytes 37	band	ASCII '0' for C band, '1' for Ku band, and '2' for a dual band satellite.
Byte 38-42	sat longitude	The satellite longitude in tenths of degrees in an ASCII format, right justified and left padded with blanks. West longitude values will be preceded by a minus sign, '-'.
Byte 43-48	reserved	Reserved for future expansion
byte 49	ETX	
byte 50	checksum	

Note that if entry 'XX' does not exist in the list (or the list has no entries) the NAK reply will be sent back to the host.

USER AUTO MOVE COMMAND

This command causes the controller to automatically position the antenna in azimuth, elevation, and (optionally) polarization. The auto move can optionally be followed by a peaking operation (if the controller support peakups and peakups are enabled). The command also accepts satellite name, satellite polarization, and satellite longitude strings. The satellite name string and polarization character are displayed in REMOTE and MANUAL modes. Longitude values are only displayed in MANUAL mode.

The command contains 45 bytes. Here is the format ...

byte 0:	STX	
byte 1:	A	where A is the RC2000 address
byte 2:	40h	User auto move command code (ASCII '@')
bytes 3 – 9:	azim position	Azimuth target position. The value must be right justified and left padded with zeroes. Values between 0 and 65535 are accepted. A value of zero implies that azimuth movement will not occur.

bytes 10 – 15:	elev position	Elevation target position. The value must be right justified and left padded with zeroes. Values between 0 and 65535 are accepted. A value of zero implies that elevation movement will not occur.
bytes 16 – 21:	pol position	Polarization target position. The value must be right justified and left padded with zeroes. Values between 0 and 661 are accepted if a polarotor is present in the system. Values between 0 and 1023 are accepted for rotating feed systems. A string of six blank characters (not zero terminated) indicates that pol movement should not occur. If AutoPol is enabled then this field must be set to all blanks.
byte 22:	peakup flag	A blank (20h) specifies that no peakup occur, 'C' specifies that a C band peakup will occur, 'K' specifies that a K band peakup occur. A peakup cannot occur if either the azimuth or elevation positions are zero.
bytes 23-32:	sat_name	This field specifies the satellite name that is to be displayed.
byte 33:	polarization	This field can specify 'H', 'V', 'X', 'C', 'K', or ' ' (blank, 20h). This character is displayed by the pol code display system when the current polarization position is equal to (or very near) the polarization position specified by this command.
bytes 34-40:	sat_longitude	This field can specify an ASCII string that will be displayed after the satellite name. It is intended that this field display satellite longitude.
bytes 41-42:	reserved	Reserved for future expansion, set to 20h for now.
byte 43:	ETX	
byte 44:	checksum	

The normal reply to this command will be the same as the reply to the Device Status Poll except that the command code field will be '40h'. Note that if a position specified in the azimuth, elevation, or polarization fields is outside of the limits for the axis a NAK reply will be sent to the host. A NAK reply will also occur if a peakup is specified and the controller does not support peakups, the controller's Peakup Enable Flag is disabled, or the Peakup related parameters in non-volatile memory are corrupt.

C PROGRAM

A C program has been written which allows a user to exercise the RC2000. The program runs on an IBM PC (or compatible - running DOS) and was designed to aid the software developer who is writing programs to control the RC2000. Most of the commands listed above can be sent to the controller with the program. The program features three windows. In the top window the user is prompted for commands to send to the controller. In the middle window, the command strings sent to the controller are displayed. The bottom window displays all characters received from the controller. The source code is included with the program and a developer may examine and freely use any of the routines. A disk containing this program is included with each controller.

MESSAGE DELIMITERS

Here are the delimiters used with SA bus messages, along with their value in hex and decimal.

ASCII name	hex value	decimal value
STX	2	2
ETX	3	3
ACK	6	6
NAK	15	21

Appendix F - Controlling Antennas Powered by AC or Large DC Motors

The RC1000A, RC2000A, and RC2000C antenna controllers are designed to control satellite antennas powered by 36-volt DC motors that use pulse type position sensors. The RC1000A is designed for use with single axis polar mount antennas. The maximum output current from the RC1000A is 5 amps. The RC1000A has a built-in interface for a Chaparral type Polarotor. The RC2000A and RC2000C are dual axis antenna controllers designed for use with elevation over azimuth or azimuth over elevation type mounts as well as polar mounts with a motorized elevation (latitude angle) or motorized declination adjustment. The RC2000C has all of the features of the RC2000A as well as support for tracking inclined orbit satellites via step track and memory track algorithms. The RC2000A and RC2000C share a common motherboard. In the text that follows the term RC2000 will be used to refer to both versions. The maximum actuator drive current available from the RC2000 is 8 amps. The RC2000 has a built-in interface for a Chaparral type Polarotor. There is an optional interface (designated RC2KPOL) for a 24 volt DC polarization motor which uses a potentiometer for feedback. With this option the output current available to the polarization motor is approximately 200 milliamps. This option was designed to be used with Seavey motorized feeds.

The two issues which must be addressed to successfully interface one of these controllers to a large antenna is the application of power to the antenna motors and sensing the antenna's position. This paper describes a technique to use the antenna controller's +/- 36-volt output voltage to activate AC and higher voltage DC motors as well as the selection and placement of pulse type position sensors that are compatible with these antenna controllers. This paper also includes a description of the products available from Research Concepts, Inc. (RCI) which implement the motor control scheme outlined in this paper and a sensor design example.

Controlling the Motors

Please refer to figure 1. The azimuth motor drive output of the RC2000 on the AZ1 and AZ2 terminals will be +/- 36 volts. When azimuth ccw movement is specified, AZ1 will have the higher voltage, and when azimuth cw movement is specified, AZ2 will have the higher voltage. (Note that the sense of antenna azimuth movement is as seen by an observer located above the antenna). In a similar fashion, when down movement is specified, EL1 will be at the higher voltage, and when upward movement is specified, EL2 will be at the higher potential. When azimuth ccw movement is specified, current will flow out of the AZ1 terminal of the RC2000, through the dropping RESISTOR, through STEERING DIODE D1, through the AZ CCW RELAY COIL, through the AZ CCW LIMIT SWITCH, through the AZ CW LIMIT SWITCH, and back into the AZ2 terminal of the RC2000. Current flowing through the AZ CCW RELAY COIL will activate the relay and close the AZ CCW CONTACT CLOSURE. This will configure the POWER CONTACTOR to move the antenna in the azimuth ccw direction. When azimuth ccw current flows STEERING DIODE D2 keeps current from flowing through the azimuth CW RELAY COIL.

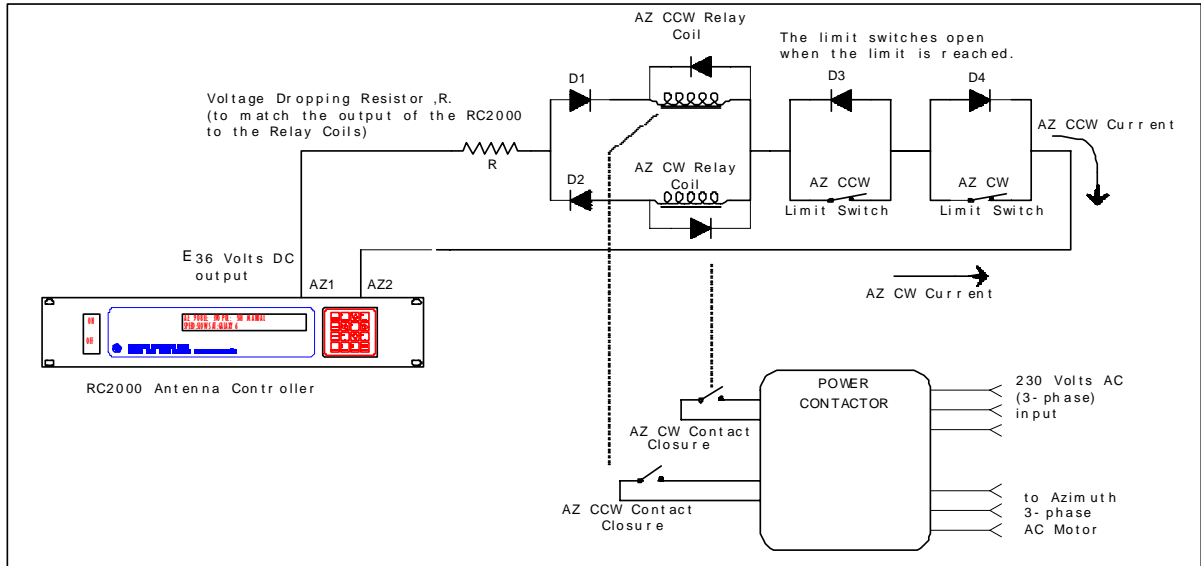
When the antenna is within the azimuth CCW limit, the AZ CCW LIMIT SWITCH is closed. When the azimuth ccw limit is reached, the AZ CCW LIMIT SWITCH will open. When the AZ CCW LIMIT SWITCH is open, STEERING DIODE D3 will keep azimuth ccw current from flowing, but will allow azimuth cw current to flow to move the antenna out of the ccw limit. Azimuth cw movement is accomplished in a similar fashion. Note that limit switches are not required. The RC1000A and RC2000 maintain logical limits based on the position count. Limit switches are pretty cheap insurance, however.

The purpose of the dropping resistor is to match the output voltage of the RC1000A or RC2000 (36 volts) to the voltage necessary to activate the relay coils. A common relay coil voltage is 24 volts. If the relays have 24 volt coils, the dropping resistor should be selected so that at the relay's rated coil current the voltage drop across the resistor will be 12 volts. If 36 volt relays are used the dropping resistor is not needed.

A number of products are available from Research Concepts which implement the motor control scheme outline above. See the section below entitled Motor Control Interface Products for a description of these products.

Note that the scheme shown in Figure 1 does not support slow speed movement. With 36-volt motors, the RC1000 and RC2000 vary the motor speed by rapidly switching the 36-volt antenna drive signals

off and on - which gives an average voltage of less than 36 volts. If this signal is applied to the circuit of Figure 1, the relays would chatter. On the RC2000, slow speed movement may be disabled by setting the azimuth and elevation slow speed codes to 254. On the RC1000, slow speed movement is disabled by setting the slow speed index to the highest possible value.



When controlling AC or large DC motors with either the RC1000 or RC2000, it may be necessary to change the controller's ANTI-REVERSAL DEADBAND, COAST, RETRY COUNT, and MAXIMUM POSITION ERROR parameters. These parameters control the movement of the antenna.

When the antenna has been moving in one direction, it must be allowed to come to a complete stop before it is commanded to move in the opposite direction, or position pulses may not be accumulated properly. The ANTI-REVERSAL DEADBAND specifies the minimum number of milliseconds between antenna movements in opposite directions. On the RC2000A the user may specify four deadbands, azimuth fast, azimuth slow, elevation fast, and elevation slow. For the RC2000C the user can specify two deadbands - Az/EI fast and Az/EI slow. When the circuit of Figure 1 is used, the fast and slow deadbands for a given axis should be set to the same value.

When the antenna is performing an automatic move to a target position, the antenna drive signals are released before the antenna reaches the target position. The idea is that the drive signals are released and the antenna coasts into position. The COAST parameters specify the number of position counts before a target position is reached where the drive signals are released. There are unique COAST parameters for each axis on the RC2000.

When the antenna is performing an automatic move, the controller will make a number of attempts to hit the target position. The RETRY COUNT parameter specifies how many attempts the controller will make to reach the target position. The MAXIMUM POSITION ERROR parameter specifies the maximum allowable error about the target position. If the antenna comes to a stop within maximum position error counts of the target position, the controller will not attempt to make another move to get the antenna closer to the target position.

On the RC2000 these parameters may be set by the user via CONFIG mode. On the RC1000 these parameters are programmed into the controller's EPROM memory and can only be changed at the factory.

Polarization Control

If the polarization is controlled with something other than a polarotor, an interface for a polarization motor is necessary. If control for a polarization motor is needed, use the RC2000 with the RC2KPOL

option. For a single axis antenna this will mean that the elevation control capability of the RC2000 is not used. The polarization control can use a scheme similar to that used for the azimuth and elevation axis which employs relays and steering diodes. Note that the RC2KPOL option requires the use of a potentiometer for position sensing.

Motor Control Interface Products

A number of products are available from RCI which implement the motor control scheme outlined above.

The 2K90INT is a board level product which implements azimuth, elevation, and polarization control circuits based on the method outlined in figure 1 above. The contact closures generated by the 2K90INT board are isolated from the antenna controller's control outputs and can be used to activate either contactors which control three phase AC motors or DC motors. When used with DC motor drive modules, the 2K90INT board supports a latching relay that allows a single DC motor drive module to power both the azimuth and elevation motors (not simultaneously). This allows for a lower cost installation.

The RC2K90INT-1 and RC2K90INT-2 interface boxes use the 2K90INT circuit board described above with a KBPB DC motor drive module manufactured by KB Electronics (phone: 954 346 4900) to power either 90 or 180 volt DC azimuth and elevation motors. The interface boxes are housed in NEMA 4 enclosures suitable for outdoor mounting. The RC2K90INT-1 interface box uses the latching relay feature described in the previous paragraph to allow a single KBPB DC motor drive module to control both the azimuth and elevation axis. With the RC2K90INT-1 simultaneous azimuth and elevation movement is not supported. The RC2K90INT-2 uses a pair of KBPB motor drive modules and supports simultaneous azimuth and elevation movement. With both interface boxes, the only support for polarization movement is a pair form C relay contact closures activated by steering diodes. These outputs can be used with a DC power supply to control a rotating feed powered by a DC motor if the drive output of the RC2KPOL daughterboard is not suitable for direct interface with the polarization motor.

A heater option is available for the RC2K90INT-1 and RC2K90INT-2 interface boxes that allows operation at temperatures to -45 C.

Position Sensor Interface

The RC1000A and RC2000 antenna controllers require the use of single-phase pulse type sensors to determine the position of the antenna. A pulse type sensor produces a rectangular shaped waveform as the antenna moves about the axis associated with the sensor. A quadrature pulse type sensor produces 2 rectangular waveforms, one being 90 degrees out of phase with the other. With a quadrature type pulse sensor it is possible to determine which way the antenna is moving. The RC1000A and RC2000 antenna controllers are not compatible with quadrature pulse sensors. Please see figure 2.

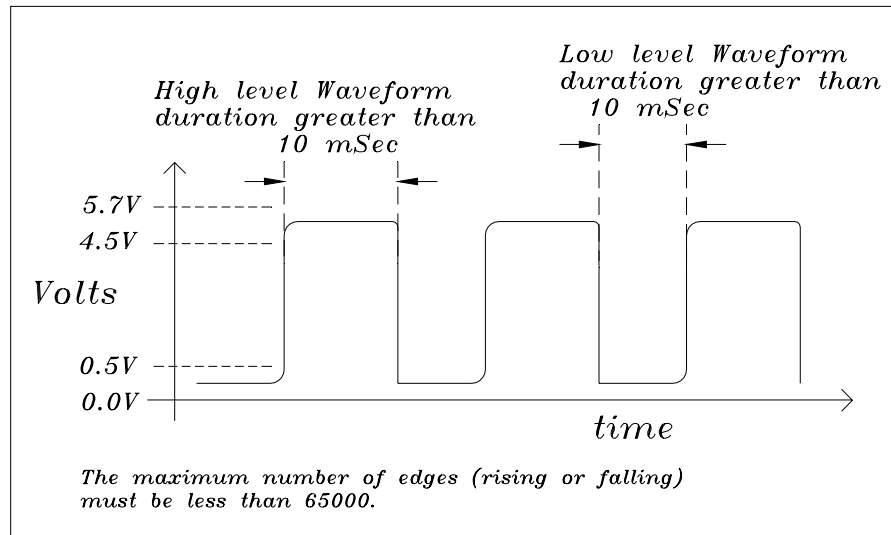


Figure 2.

The RC1000A and RC2000 antenna controllers count the number of rising and falling edges of the waveform. The position count is decremented for azimuth ccw movement and incremented for azimuth cw movement. The waveform's high level should be 4.5 to 5.7 volts, and the low level should be 0.0 to 0.5 volts. The waveform's minimum high or low pulse duration should be at least 10 milliseconds. This means that pulses less than 10 milliseconds long may not be detected by the antenna controller. The maximum number of counts from the antenna's azimuth ccw limit to its azimuth cw limit should be less than 65000. Remember, each rising edge and each falling edge of the sensor's output waveform is a separate count.

Many large antennas use a sensor attached directly to each of the fundamental axis of the antenna. The sensor used may be a resolver, synchro, potentiometer, or a quadrature pulse encoder. A pulse type sensor attached to the fundamental axis of the antenna is not suitable for use with the RC1000A or RC2000 antenna controllers. The reason for this requires a bit of explanation.

When a rising or falling edge is detected on the antenna controller's sensor input, the antenna controller must determine whether to increment or decrement the position count. Since single-phase pulse sensors are used, the antenna controller must determine which way the antenna was last commanded to move, and decrement or increment the count accordingly. With a pulse sensor connected directly to the antenna's fundamental axis, when the antenna vibrates back and forth due to wind, the pulse sensor produces a steady stream of pulses. The antenna controller will increment or decrement the count depending on which way the antenna was last commanded to move. In reality the antenna is just vibrating in the wind and not really moving. The result of this is an error in the position count maintained by the antenna controller.

The antenna controllers are designed to work with 36-volt actuators. With these actuators the pulse sensor is connected directly to the motor. The motor typically drives either a worm or screw type gear, which will not allow forces applied to the antenna to cause rotation of the motor. Therefore, no false counts are recorded by the antenna controller.

On a large antenna, the solution to the sensor dilemma is to place a sensor on the output of the motor. Most motors attach to either gear reduction systems or linear actuators via a C56 type flange. There are pulse sensors that may be placed between the motor and the transmission at this flange. Remember that any pulse sensor used must conform to the requirements of the antenna controller, which are: 1) the total number of rising and falling edges must not exceed 65000, 2) the duration of the high and low segments of the waveform must be at least 10 milliseconds, 3) the high level of the waveform must be 4.5 to 5.7 volts, 4) the low level of the waveform must be 0.0 to 0.5 volts, and 5) sensor must be a zero speed type which will count rotation of the motor shaft at very low speed. Inductive pickup type sensors do not generally meet the last requirement.

A number of manufacturers make sensors that may be placed directly between the motor and the gear reducer of the sensor on the C56 flange. Powermation's #DTK056M1 (phone. 800 811 2691,

www.powermation.com) and Dart's CF Series (phone. 317-873-5211, www.dartcontrols.com) are two examples. These sensors consist of a Hall effect pickup and a magnet wheel that attaches to the shaft of the motor via set screws. They are available with several different pulses per revolution characteristics. Both of these sensors increase the separation between the motor and the gear reducer or actuator by 0.750". In many cases the existing shaft coupling mechanism can accommodate this extra separation without modification.

Regardless of what type of sensors are used, the user must ensure that the five requirements outlined above for the sensor waveform are met. Some signal conditioning circuits may be required to meet the waveform high and low level specification. Note that there is a 5.7-volt supply available on the back of the antenna controller that is meant to be used with the polarotor. The maximum current draw from this supply should not exceed 200 milliamps. Also note that shielded cables are required to interface the antenna controller to the pulse sensors - see the antenna controller manual for more information. Appropriate cables are available from RCI.

To insure that the pulse duration requirement is not violated, the user should consider the speed of the motor and the number of pulses produced by the sensor for each revolution of the motor. To determine the number of pulses per second, take the motor speed in revolutions per minute (rpm) and divide by 60 to get revolutions per second. Multiply this value by the number of pulses per revolution to obtain the number of pulses per second. To obtain the pulse duration in milliseconds divide 500 by the number of pulses per second. Mathematically, this formula is ...

$$\text{PULSE_DURATION (milliseconds)} = 30000 / (\text{RPM} \times \text{PULSES_PER REVOLUTION})$$

Here is an example:

Motor Speed: 1750 rpm

Pulse Sensor: 1 pulse per revolution

Pulse Duration = $30000 / (1750 \times 1) = 17.14$ milliseconds

To make sure that the total sensor waveform edge count requirement is satisfied, the user must determine how many revolutions of the motor are required to move from the azimuth ccw limit to the azimuth cw limit (and from the down to the up limit) along with how many edges are produced for each revolution of the motor.

With the Powermation and Dart pulse sensors mentioned above, the user can select from the following the number of pulses per revolution: 1, 2, 15, or 60. The question comes up - how many pulses per revolution are required? The number of pulses per revolution of the motor determines the resolution with which the antenna controller can position the antenna. In general, it is sufficient to have 10 position counts over the antenna's 3-dB beamwidth. Remember that the controller counts both the rising and falling edges of each position pulse.

See the section of this paper entitled Pulse Sensor Selection Design Example which gives a step by step design example for a 6.1 meter Ku band antenna.

Pulse Sensor Selection Design Example

Here is a design example for the azimuth axis of a 6.1 meter antenna (the calculation for the elevation axis is similar) ...

Antenna Size: 6.1 meters

Operating Frequency: Ku Band (12 GHz)

Azimuth Motor RPM: 1750

Range of antenna azimuth movement: 100 degrees

From this information the 3-dB beamwidth of the antenna can be determined to be: 0.28 degrees

To determine the total number motor revolutions which occur when moving from the antenna's azimuth ccw limit to the antenna's cw limit and to get a rough idea of the number motor revolutions per each degree of movement determine the time that it takes for the antenna to move through a known angle.

For this case, determine the time that it takes the antenna to move from limit to limit (100 degrees for this example): use 110 seconds for this example

Determine the total number of motor revolutions per second: $1750 \text{ rpm} / 60 \text{ seconds} = 29.16 \text{ revolutions per second}$.

Determine the number of motor revolutions required to move from limit to limit: $29.16 \text{ revolutions per second} \times 110 \text{ seconds} = 3208 \text{ motor revolutions}$.

Choose a Powermation pulse sensor with a one pulse per revolution characteristic and check to make sure that the requirements outlined earlier are satisfied:

The duration of the pulse high and low level waveforms is greater than 10 milliseconds,

The total number of position counts encountered moving from limit to limit is less than 65000, and

There are at least 10 position counts that occur as the antenna is moved across its 3-dB beamwidth.

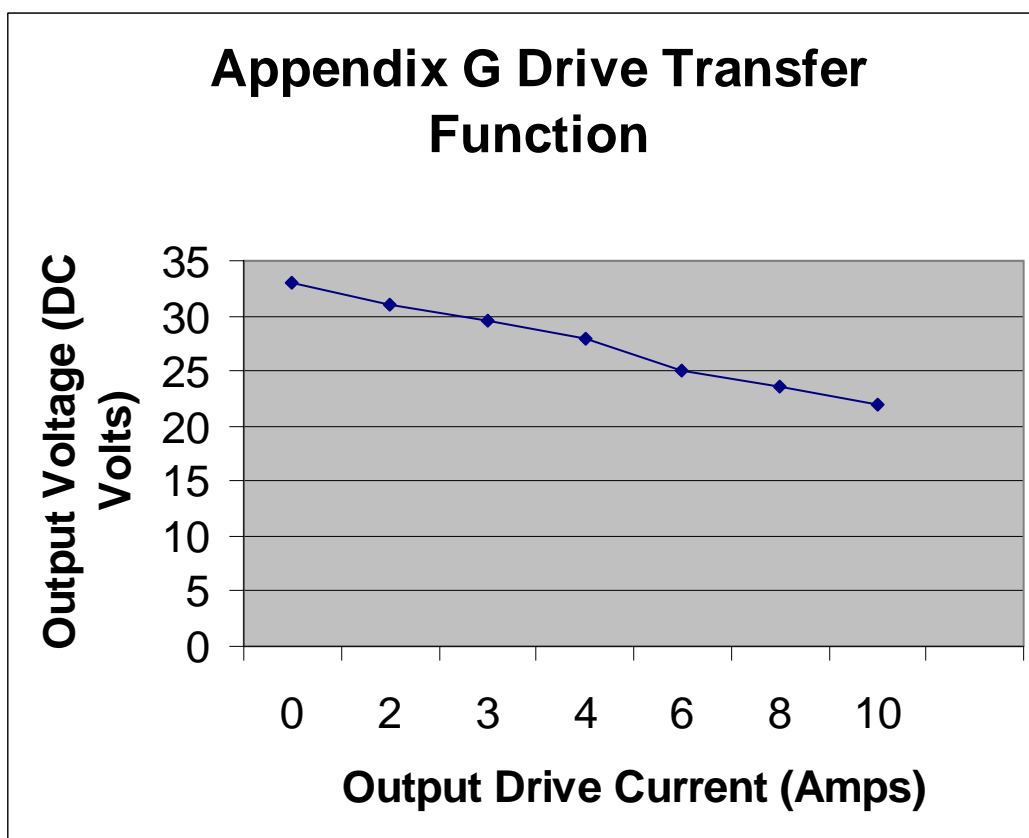
Make sure that the total number of position counts when moving from limit to limit are less than 65000. This is easy. If there are 3208 motor revolutions, one pulse per revolution, and given the fact that the controller counts both the rising and falling edge of each position pulse the total number of position counts can be calculated to be:

$3208 \text{ motor revolutions} \times 1 \text{ pulse per revolution} \times 2 \text{ edges per pulse} = 6416 \text{ total position counts}$

This easily satisfies the requirement that there be less than 65000 total position counts.

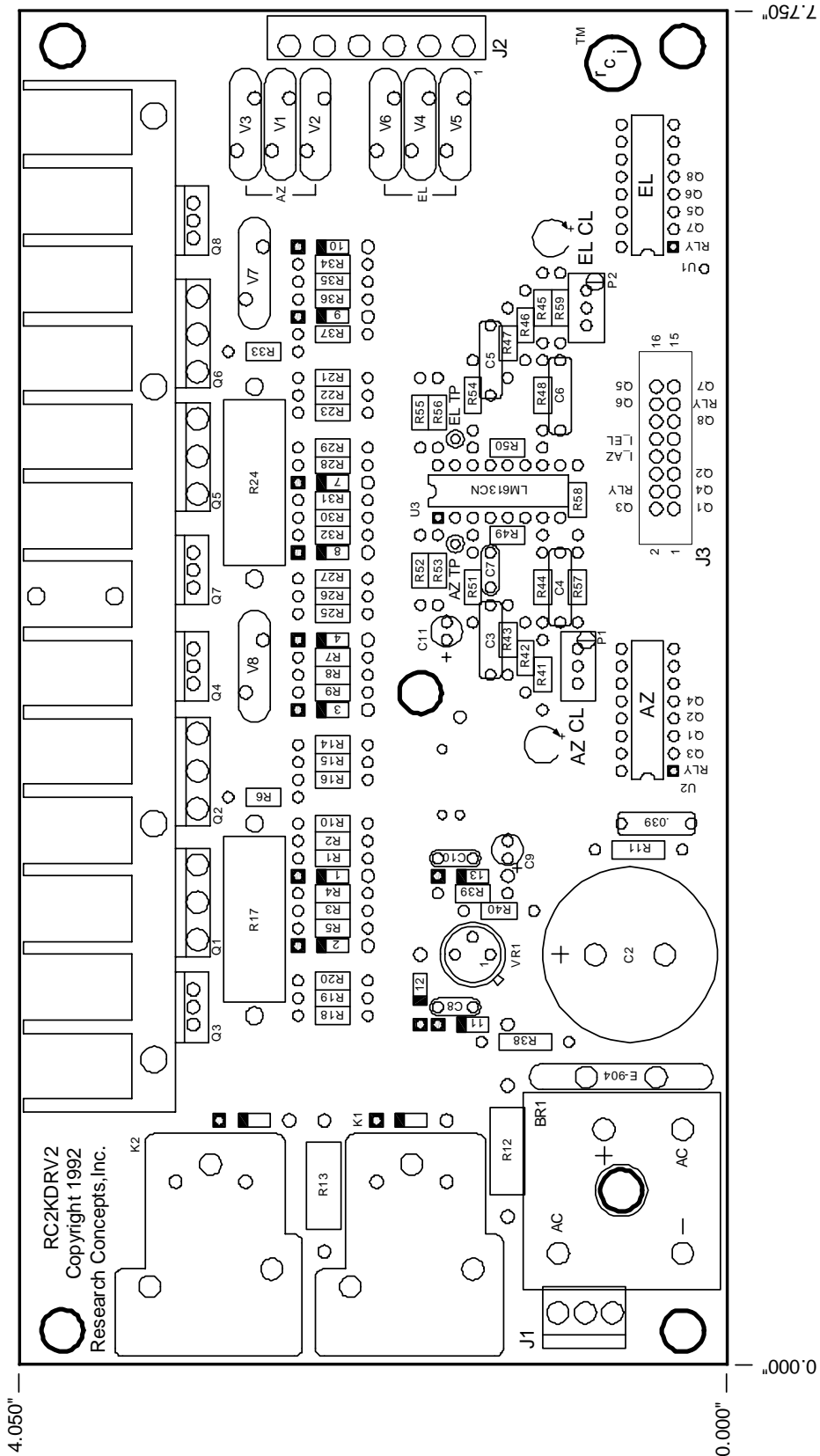
Next make sure that the pulse waveform high and low duration is greater than 10 milliseconds. Use the formula given above: $30000 / (1750 \text{ RPM} \times 1 \text{ PULSE PER REVOLUTION}) = 17.14 \text{ milliseconds per pulse}$. This satisfies the requirement that the pulse duration be greater than 10 milliseconds.

Next calculate the number of position counts which occur as the antenna moves over a 3-dB beamwidth. If there are 6416 position counts over 100 degrees, the number of position counts per degree is 6416 divided by 100 or 64.16 counts per degree. To calculate the number of position counts that occur as the antenna moves over its 3-dB beamwidth (0.28 degrees), multiply the 64.16 counts per degree by 0.28 degrees to obtain 17.96 position counts. This satisfies the requirement that there be at least 10 position counts over the antenna's 3 dB beamwidth.

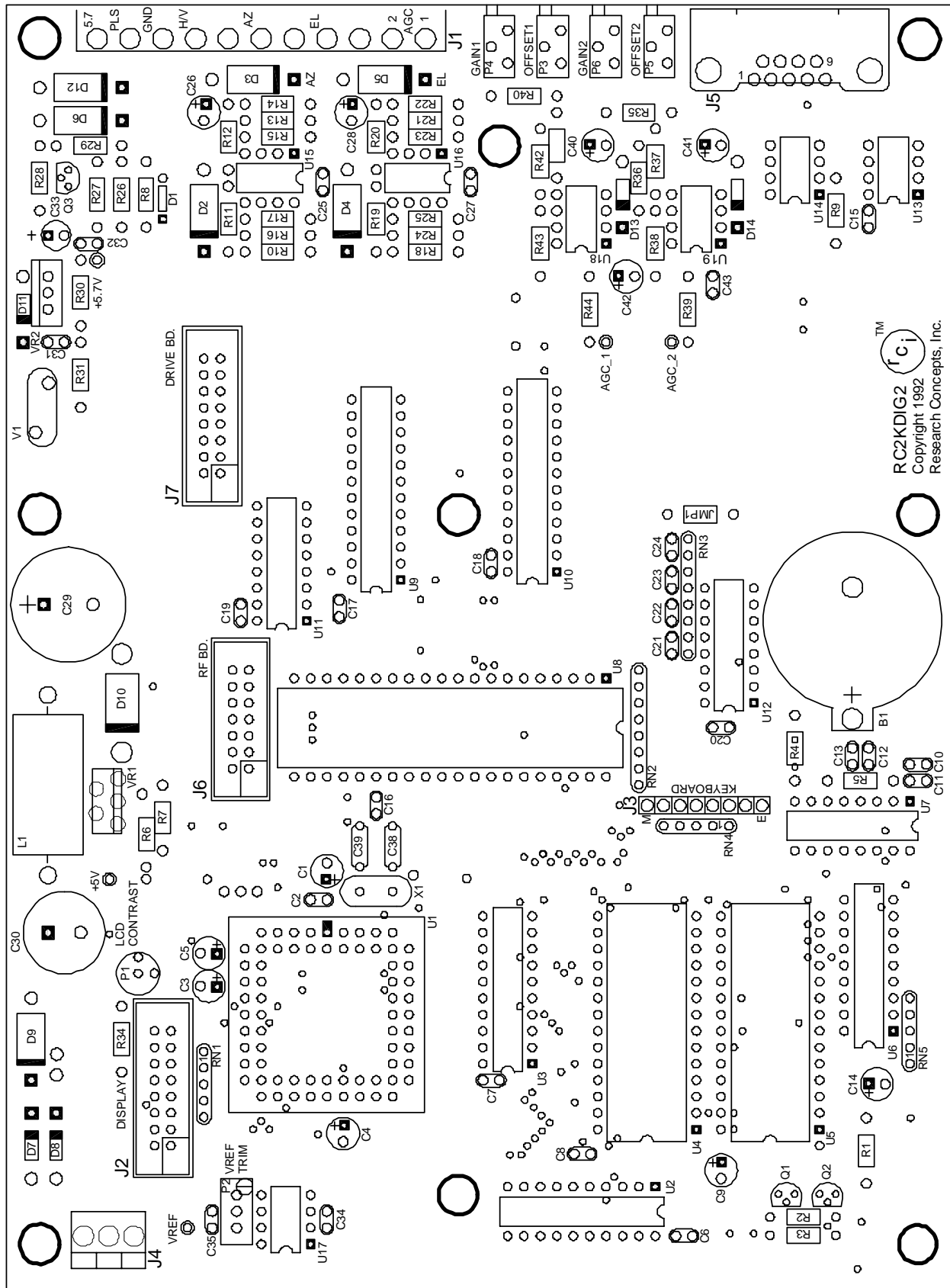
APPENDIX G Drive Transfer Function

APPENDIX H Electrical Diagrams

Drive Board Layout



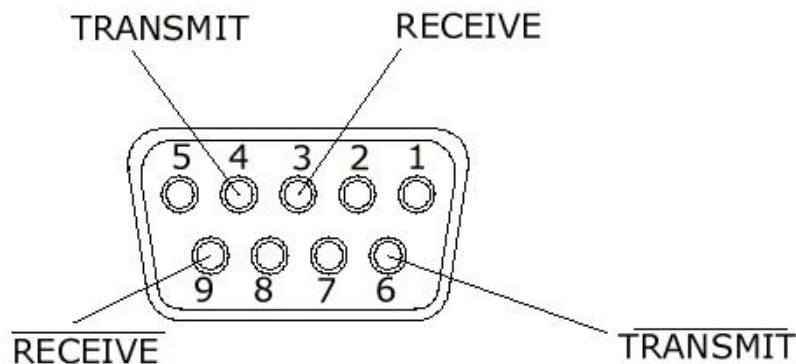
Processor Board Layout



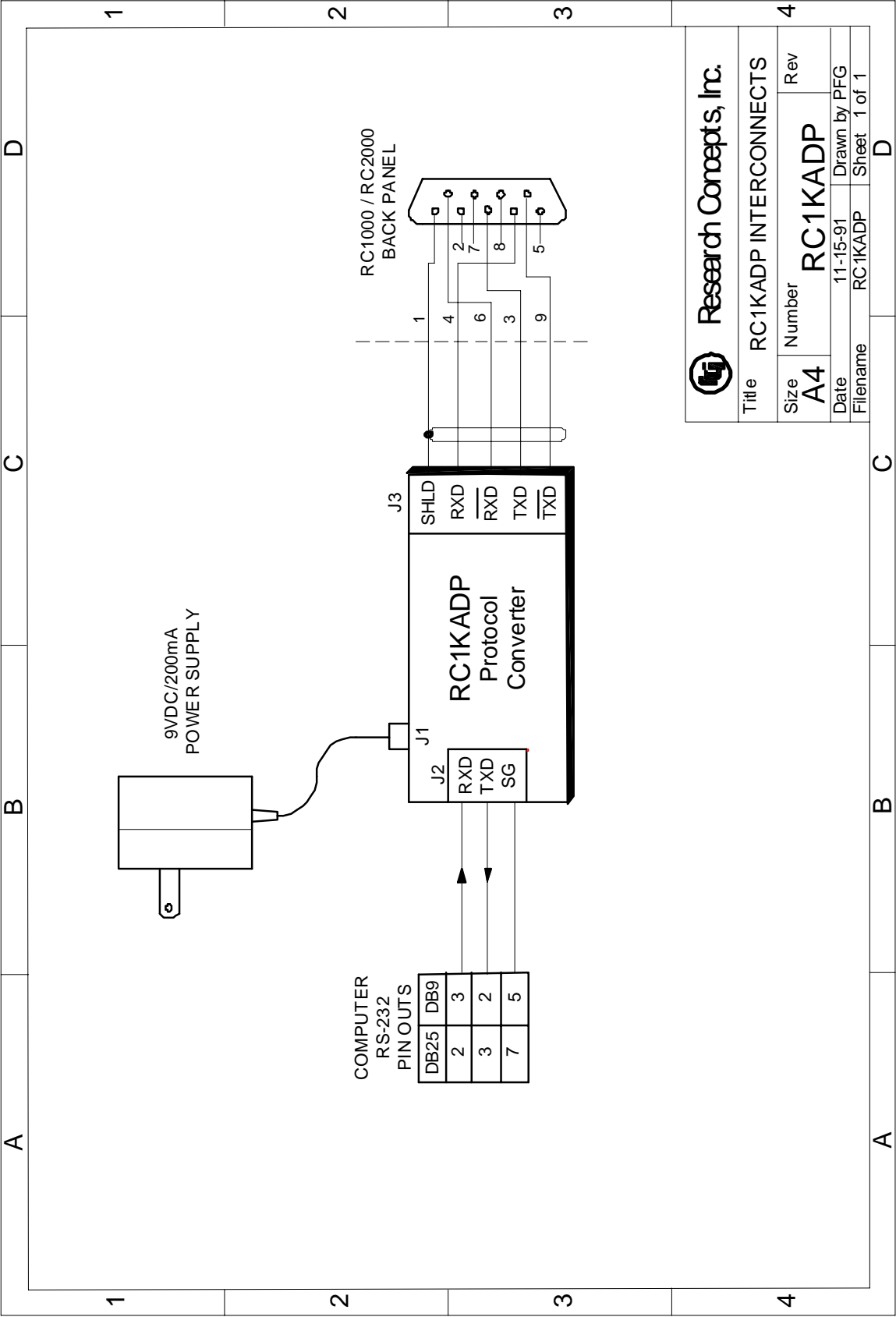
RC2KDIG2TM
Copyright 1992
Research Concepts, Inc.

Comm Port Wiring Legend

DB-9 Receptacle at J3

RC2000 Communications Port
Wiring Legend

RC1KADP Conversion



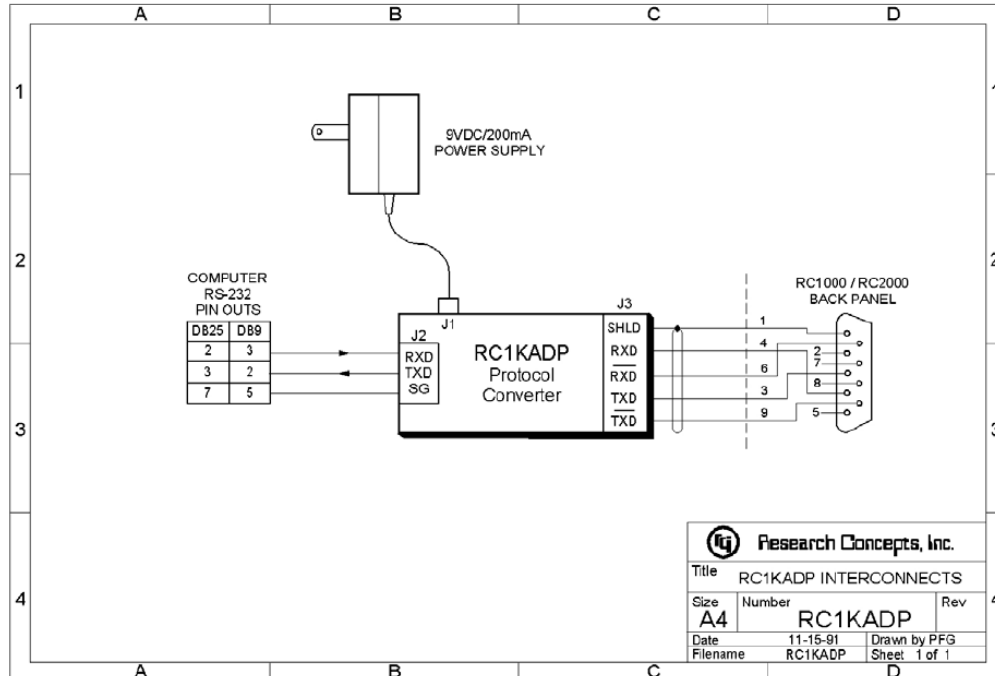
 Research Concepts, Inc.			
Title RC1KADP INTERCONNECTS			
Size A4	Number	Rev	
		RC1KADP	
Date 11-15-91	Drawn by PFG		
Filename RC-1KADP	Sheet	1 of 1	

RC1KADP PROTOCOL CONVERTER WIRING

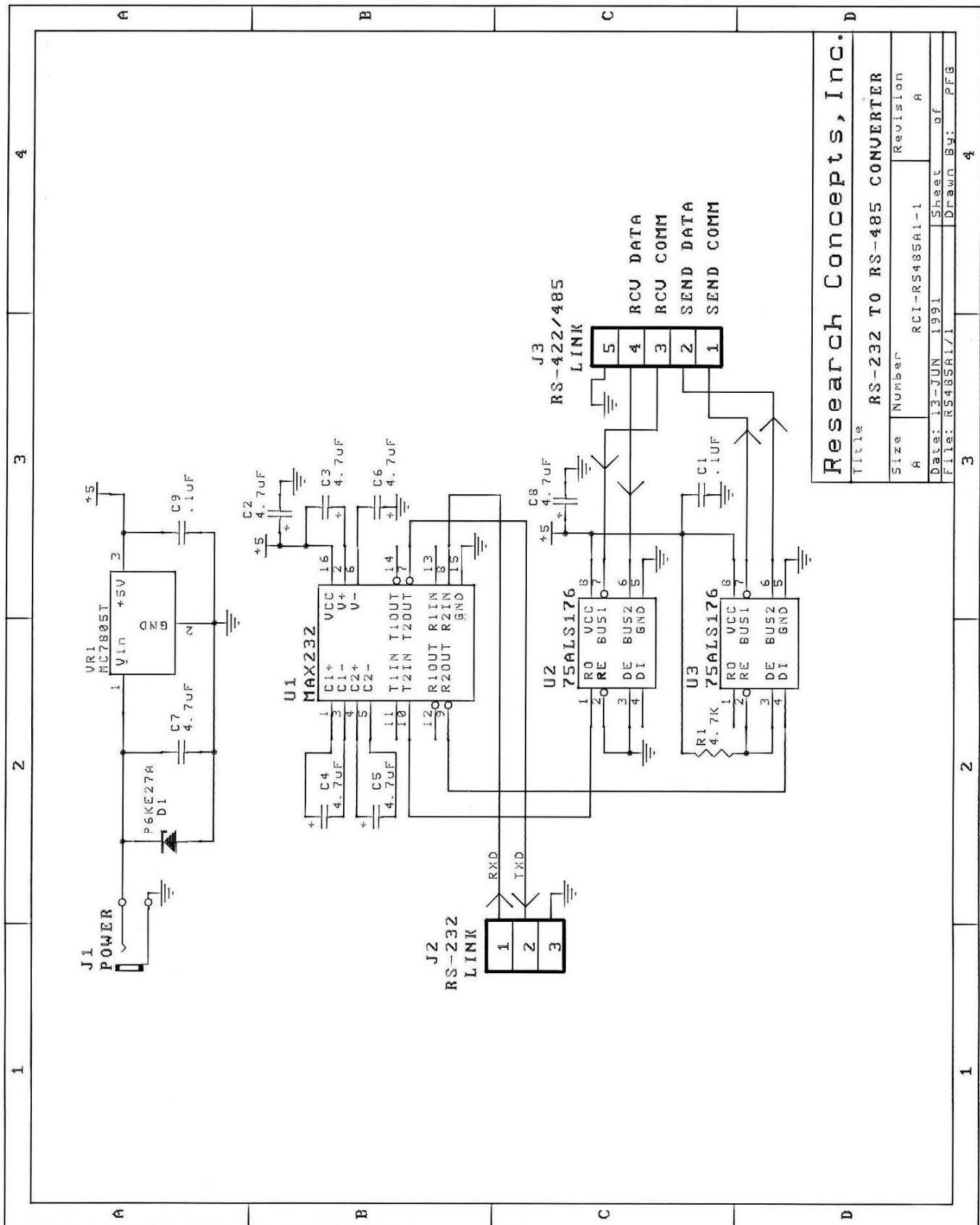
IBM PC Serial Port Signals	IBM PC Serial Port	Cable from J2 ADP	RC1KADP J2 Terminal Strip	RC1KADP J3 Terminal Strip	Cable from RC1KADP J3	RC2000 J3	RC2000 J3 Signal Name
	DB9 male	DB9 female	See note	See note	DB9 male	DB9 female	
				SHLD			
Transmit data	3	3	RXD	RXD /RXD	4 6	4 6	Transmit /Transmit
Receive data	2	2	TXD	TXD /TXD	3 9	3 9	Receive /Receive
Common	5	5	Ground				

IBM PC Serial Port Signals	IBM PC Serial Port	Cable from J2 ADP	RC1KADP J2 Terminal Strip	RC1KADP J3 Terminal Strip	Cable from RC1KADP J3	RC2000 J3	RC2000 J3 Signal Name
	DB25 male	DB25 female	See note	See note	DB9 male	DB9 female	
				SHLD			
Transmit data	2	2	RXD	RXD /RXD	4 6	4 6	Transmit /Transmit
Receive data	3	3	TXD	TXD /TXD	3 9	3 9	Receive /Receive
Common	7	7	Ground				

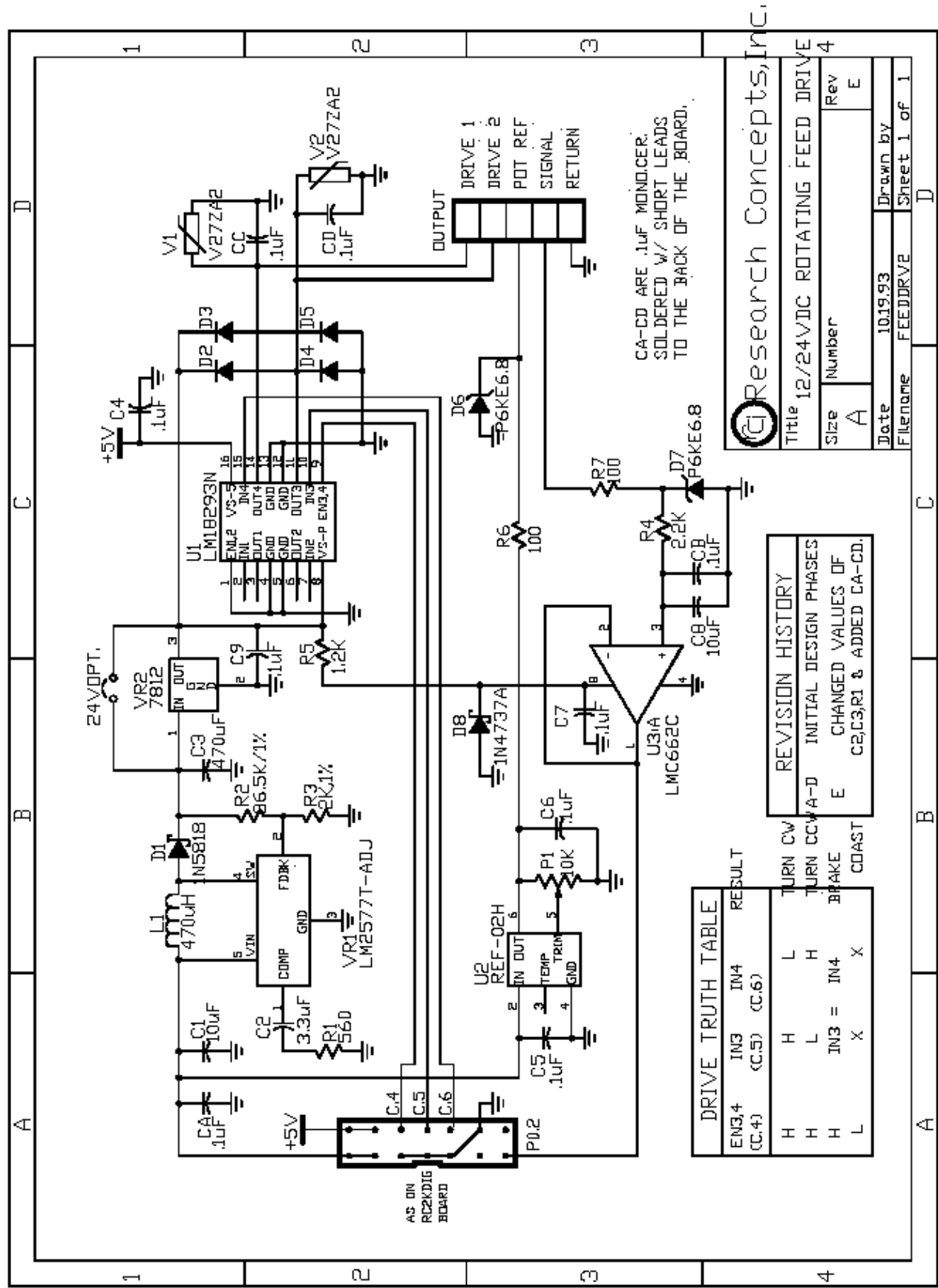
NOTE: The RC1KADP, J2/J3 connectors, are equipped with clasp type terminals. Each terminal can accommodate one or two 20 AWG or smaller wires. Secure wire clasps with a 1/8" (3mm) wide straight blade screwdriver. If the RS-422 cable is shielded, the shield should be connected to the SHLD terminal of connector J2 of the RC1KADP.



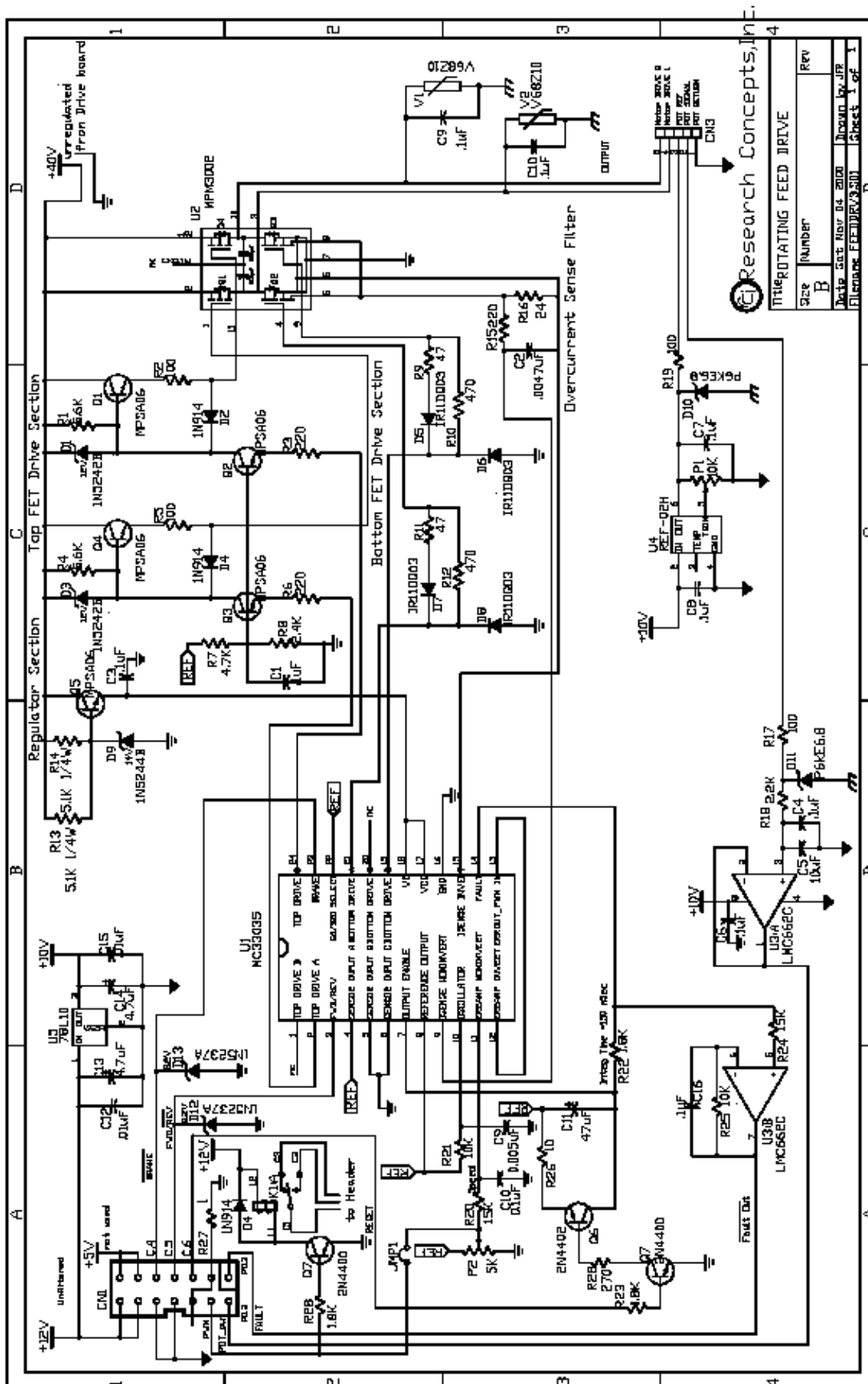
RC1KADP Schematic



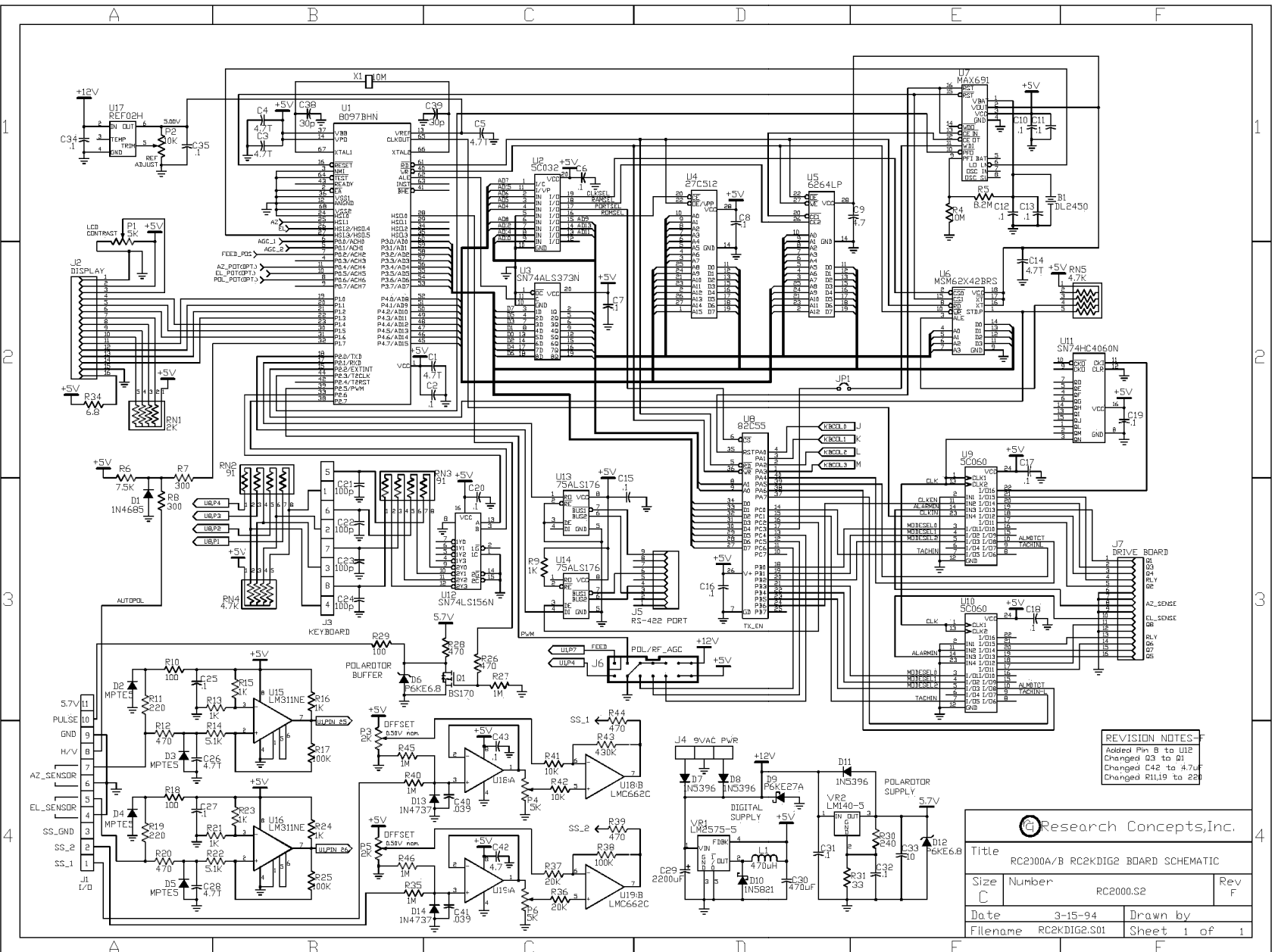
RC2KPOL Schematic



RC2KHPP Schematic



Processor Board Schematic



[illegible]

Appendix I RC2000A version 2.6x Addendum

1.0 Introduction

This addendum documents the RC2000A version 2.6x modifications. The major changes introduced with this revision of the software are ...

1) Support for an optional Signal Strength Pickup function that can be initiated either by the user from the front panel or via reception of a remote command on the controller's serial port. An analog voltage that varies with received signal strength is required to implement the Pickup Function (0 to 10 volts DC max input range).

2) Enhanced remote commands that allow the controller's memory to be read and restored via the controller's serial ports, and

3) Support for remote commands that allow the controller to be remotely controlled with commands received on the device's serial port.

Minor changes to the software include ...

1) Explicit support for the following types of polarization control equipment: ...

a) None – no polarization control device,

b) Chaparral type Polarotor servo polarization control device,

c) a two port motorized feed with potentiometer position feedback (two port refers to the feed's ability to receive both horizontal and vertical polarizations simultaneously – one example of this type of feed is the Seavey Engineering Associates model ESA 124D), and

d) a single port motorized feed with potentiometer position feedback.

Earlier versions of the software supported a Polarotor servo and a single port motorized feed.

2) Support for a Sticky Key Jog function. This feature is sometimes useful during antenna setup and while cutting antenna patterns. With Sticky Key Jog, in MANUAL mode an az/el jog is initiated by hitting the Az CCW, Az CW, El Down, or El Up keys. Once a sticky key jog is initiated it will continue until the user hits the Stop key or leaves MANUAL mode.

Users upgrading to this version of the software from a previous version should refer to section 4.6 of this addendum for a checklist of issues that need to be addressed.

1.1 Version Identification

On power up the controller displays the version number of the software running in the controller along with an alphabetic suffix that identifies the SETUP mode satellite list stored in the controller's EPROM memory.

The version number displayed on power up will have the following form:

v 2.6xd

where **x** and **d** are interpreted as follows ...

x is referred to as the software minor version number:

'0' – Optional Pickup function not supported, also includes support for the standard polarization control daughter board which is designated RC2KPOL,

'1' - Optional Peakup function not supported, also includes support for the optional high power polarization drive daughter board which is designated RC2KHPP,

'5' – Optional Peakup function supported, also includes support for the standard polarization control daughter board which is designated RC2KPOL,

'6' - Optional Peakup function supported, also includes support for the optional high power polarization drive daughter board which is designated RC2KHPP,

Note: If a version of the software supports either the RC2KPOL or RC2KHPP polarization control daughter-boards this does not mean that the daughterboard is actually installed in the controller. If either of these devices are present a five position J4 connector will protrude from the back of the controller.

d specifies the satellite list stored in the controller's EPROM memory:

'w' specifies the satellites that can be seen from easterly longitudes (North and South America)

'e' specifies the satellites that can be seen from easterly longitudes (Europe, Africa, Asia, Australia)

1.2 Organization of this Addendum

Section 2 – Signal Strength – An analog voltage that varies with received signal strength is required to implement the peakup function. That maximum range of this analog voltage is 0 to 10 volts DC. The controller can accept two channels of analog voltages. These channels are referred to as AGC1 and AGC2. AGC is an abbreviation for Automatic Gain Control. These analog voltages are often generated by receiver or modem AGC circuits. Section 2 describes the adjustments and controller CONFIG mode items related to the Signal Strength inputs.

Section 3 – Peakup Function – This section documents the operation of the Peakup system and describes the controller CONFIG mode items associated with the Peakup System.

Section 4 – This section describes the polarization control device options and the operation of the Sticky Key Jog system. Section 4.6 describes concerns of particular importance to customers upgrading from a previous version of the software.

2.0 Signal Strength

To implement the peaking algorithm, the controller requires an analog input which indicates the strength of the received signal. Such a voltage is generated within a satellite receiver, and is referred to as an AGC signal (Automatic Gain Control). On many receivers this signal is available at a terminal on the back of the receiver. 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 which the receiver is currently tuned to.

The controller has the provision to process two channels of AGC information. This means that two receivers can be connected to the controller (at least one receiver is required to implement peakup function). The two channels are referred to as AGC1 and AGC2. The controller uses the stronger of the two as its AGC input. Each channel has separate gain and offset potentiometer adjustments. The installer uses the pots to transform the receiver's AGC signal swing into a range of values which is easily measured by the controller.

In addition to the potentiometers, there are three CONFIG mode items which are related to the AGC system. The three items are ...

1. **AGC Polarity Flag** - This flag indicates to the controller whether a stronger satellite signal corresponds to a higher AGC voltage (positive polarity) or a lower AGC voltage (negative polarity). Both AGC channels must have the same polarity. Each AGC channel contains an internal pull

down resistor. This means that if one of the AGC channels is unused, its input is pulled to ground. This can cause problems if the *AGC Polarity Flag* specifies negative polarity, because an input of zero volts (ground potential) corresponds to the strongest possible satellite signal. For this case the installer must place a jumper from connector J1, pin 11, to the unused AGC input channel and adjust that channel's potentiometers (after negative polarity has been specified) so that its signal strength value is 0. J1 - pin 11 has a potential of 5.7 volts.

2. **AGC C Band Threshold** - When the receiver is tuned to a C band satellite and the signal strength is above this value, it is assumed that a satellite signal is present. The same threshold is applied to both AGC channels.
3. **AGC K Band Threshold** - This is similar to the *C Band Threshold* described above, except it pertains to Ku Band. If the signal strength is above this value when the receiver is tuned to a Ku band satellite, the controller assumes that a satellite signal is present.

The signal strength is displayed in MANUAL, REMOTE, SETUP, and LIMIT modes. In REMOTE, SETUP, and LIMIT modes the signal strength is displayed to the right of the 'S:' banner. In these modes the value displayed will be the greater of the AGC1 or AGC2 channels. In MANUAL mode the user can use the Scroll Up and Scroll Down keys to display either the greater of the AGC1 or AGC2 channels ('S:' banner displayed), AGC1 ('1:' banner displayed), or AGC2 ('2:' banner displayed).

The signal strength value is represented as a number in the range of 0 to 1023. The displayed value takes into account the setting of the *AGC Polarity Flag*. In other words, a greater signal strength value on the display of the controller always corresponds to a stronger received satellite signal.

2.1 Controller AGC Potentiometer Adjustment

The following steps guide the installer through the pot adjustment process in an installation that will operate at a single frequency band. If the controller is being interfaced to a receiver that will be used for both C and Ku band, the procedure given below must be modified slightly. The modifications to the procedure for the dual band case are described in section 2.1.2.

2.1.1 Single Frequency Band Potentiometer Adjustment

The following steps are performed when the controller is in MANUAL mode.

1. Align the antenna with a strong satellite (geostationary or inclined orbit). Place a voltmeter on the receiver's AGC output, measure and record the voltage. In the description that follows, the term 'on satellite' will be used to refer to the antenna aligned with a strong satellite.

Note that if both AGC inputs will be utilized, record the 'on satellite' voltage for both receivers.

2. Jog the antenna off of the satellite so the antenna is looking at nothing. Measure and record the receiver's AGC voltage. In the description that follows, the term 'off satellite' will be used to refer to this case where the antenna is positioned well off of any satellite, looking at nothing.

Note that if both AGC inputs will be utilized, record the 'off satellite' voltage for both receivers.

3. If the difference between the two recorded values is less than 1 volt, connect the receiver's AGC output to the controller's AGC1 input. Otherwise, connect the receiver's AGC output to the controller's AGC2 input. Be sure to connect the ground return of the controller to a ground on the receiver. See figure 3.1.

Note that if both AGC channels will be utilized, connect the Signal Strength output of the receiver with the smaller 'on satellite' – 'off satellite' voltage difference to the controller's AGC1 input. Connect the other receiver's Signal Strength output to the controller's AGC2 input.

4. If the AGC voltage associated with the 'on satellite' case is greater than that of the 'off satellite' case, the receiver has POSITIVE AGC polarity (otherwise the receiver has NEGATIVE AGC polarity). Go to CONFIG mode and use the SCROLL keys to bring up the *AGC Polarity Flag* item. Key in the proper polarity using either the 0 or 1 key, and terminate the entry with the ENTER key.

- 5a. If two receivers are interfaced to the controller proceed to step 6. If the receiver's AGC has NEGATIVE polarity, go to step 5b. If the receiver's AGC has POSITIVE polarity, from MANUAL mode use the Scroll Up/Scroll Down keys to examine the signal strength for the AGC channel which was NOT selected in step 3. If the signal strength reading for that channel is greater than 10, adjust the OFFSET and GAIN for that channel until the signal strength reading for that channel is less than 10. To lower the displayed signal strength turn the OFFSET pot clockwise and the SCALE pot counter-clockwise. Proceed to step 6.
- 5b. If the receiver's AGC has NEGATIVE polarity and only one receiver is interfaced to the controller, connect a jumper from the controller's unused AGC input channel to connector J1, pin 11. From MANUAL mode use the Scroll Up/Down keys to examine the signal strength for the AGC channel which was not selected in step 3 above. If the signal strength reading for that channel is greater than 10, adjust the OFFSET and GAIN pots for that channel until the signal strength reading for that channel is less than 10. To lower the displayed signal strength value, turn the OFFSET pot counter-clockwise and the SCALE pot clockwise. When this is accomplished proceed to step 6.
6. In the next few steps of the procedure, the OFFSET and GAIN pots of the AGC channel(s) connected to the receiver's AGC output are adjusted so that the 'off satellite' signal strength value is between 50 and 100 and the 'on satellite' signal strength value is between 600 and 700. The adjustments are made from MANUAL mode.

If both controller AGC ports are used, steps 7 through 9 should be performed for each channel. Use the Scroll Up/Down keys to view the AGC channel whose pots are being adjusted.

Note that the GAIN and OFFSET adjustments are implemented using 20 turn pots. A lot of turns may be required.

7. Go to MANUAL mode, position the antenna 'off satellite' (if it is not already there), Adjust the OFFSET pot (for POSITIVE polarity receivers) or the GAIN pot (for NEGATIVE polarity receivers) so that the signal strength reading is about 75.

If the AGC has POSITIVE polarity and the signal strength is too low, turn the OFFSET pot counter-clockwise. If the AGC has POSITIVE polarity and the signal strength is too high, turn the OFFSET pot clockwise.

If the AGC has NEGATIVE polarity and the signal strength is too low, turn the GAIN pot counter-clockwise. If the AGC has NEGATIVE polarity and the signal strength is too high, turn the GAIN pot clockwise.

8. While still in MANUAL mode, position the antenna 'on satellite' and adjust the GAIN pot (for POSITIVE polarity receivers) or the OFFSET pot (for NEGATIVE polarity receivers) so that the signal strength value is about 650.

If the AGC has POSITIVE polarity and the signal strength is too low, adjust the GAIN pot clockwise. If the AGC has POSITIVE polarity and the signal strength value is too high, adjust the GAIN pot counter-clockwise.

If the AGC has NEGATIVE polarity and the signal strength is too low, adjust the OFFSET pot clockwise. If the AGC has NEGATIVE polarity and the signal strength value is too high, adjust the OFFSET pot counter-clockwise.

9. Position the antenna 'off satellite'. If the signal strength is between 50 and 100, proceed to step 11. If the signal strength is less than 50 or greater than 100 perform steps 8 and 9 again.
10. Position the antenna 'on satellite'. Jog the antenna off of the satellite until the picture is just barely watchable. Note the signal strength value. Go to CONFIG mode and use the SCROLL keys to bring up either the AGC C Band Threshold item or the AGC K Band Threshold item, whichever is appropriate for the frequency band that the user has chosen to operate at (and has adjusted the pots at). Key in the signal strength value noted above. Terminate the entry with the ENTER key.

For a dual receiver system, both AGC channels are used. The thing to remember is that the same

'Threshold' value is applied to both channels for operation at a given band. There are unique 'Threshold' values for each band.

2.1.2 Dual Frequency Band Potentiometer Adjustment

The setup procedure described above was for a single band antenna system (either C or Ku). A slight increase in complexity occurs dual C and Ku band operation. This is because the same AGC channel is used for both frequency bands, and therefore the OFFSET and GAIN pot adjustments for that channel must be made so as to accommodate both frequency bands. At the heart of the problem is the fact that the signal strength (as seen by the receiver's AGC circuits) will vary with the frequency band selected due to differences in antenna gain, LNB gain, and the differences in output power between C and Ku band satellites.

1. Align the antenna with a strong C band satellite. Place a voltmeter on the receiver's AGC output, measure and record the voltage. This voltage will be referred to as 'RCV1 - on satellite - C band' where 'n' is 1 or 2 depending on which AGC channel is used. In a similar manner, align the antenna with a strong Ku band satellite. Record the receiver voltage. This voltage will be referred to as 'RCV1 - on satellite - Ku band'.

Note that if both AGC inputs will be utilized, record the 'on satellite' voltages associated with the other receiver 'RCV2 - on satellite - C band' and 'RCV2 - on satellite - Ku band'.

2. Jog the antenna away from any satellites so the antenna is looking at nothing. Measure and record the receiver's AGC voltage. Refer to these voltages as 'RCV1 - off satellite - C band', 'RCV1 - off satellite - Ku band'.

Note that if both AGC inputs will be utilized, also record the 'off satellite' voltages for the other receiver ... 'RCV2 - off satellite - C band' and 'RCV2 - off satellite - Ku band'.

3. Choose that band that has the greatest difference between the 'on satellite' and 'off satellite' voltages. If the difference between the two is less than 1 volt, connect the receiver's AGC output to the controller's AGC1 input. Otherwise, connect the receiver's AGC output to the controller's AGC2 input. Be sure to connect the ground return of the controller to a ground on the receiver. See figure 3.1.

Note that if both AGC channels will be utilized, connect the Signal Strength output of the receiver with the smaller 'on satellite' - 'off satellite' voltage difference to the controller's AGC1 input. Connect the other receiver's Signal Strength output to the controller's AGC2 input.

4. If the AGC voltage associated with the 'on satellite' case is greater than that of the 'off satellite' case, the receiver has POSITIVE AGC polarity (otherwise the receiver has NEGATIVE AGC polarity). Go to CONFIG mode and use the SCROLL keys to bring up the *AGC Polarity Flag* item. Key in the proper polarity using either the 0 or 1 key, and terminate the entry with the ENTER key.
- 5a. If two receivers are interfaced to the controller proceed to step 6. If the receiver's AGC has NEGATIVE polarity, go to step 5b. If the receiver's AGC has POSITIVE polarity, from MANUAL mode use the Scroll Up/Scroll Down keys to examine the signal strength for the AGC channel which was NOT selected in step 3. If the signal strength reading for that channel is greater than 10, adjust the OFFSET and GAIN for that channel until the signal strength reading for that channel is less than 10. To lower the displayed signal strength turn the OFFSET pot clockwise and the SCALE pot counter-clockwise. Proceed to step 6.
- 5b. If the receiver's AGC has NEGATIVE polarity and only one receiver is interfaced to the controller, connect a jumper from the controller's unused AGC input channel to connector J1, pin 11. From MANUAL mode use the Scroll Up/Down keys to examine the signal strength for the AGC channel which was not selected in step 3 above. If the signal strength reading for that channel is greater than 10, adjust the OFFSET and GAIN pots for that channel until the signal strength reading for that channel is less than 10. To lower the displayed signal strength value, turn the OFFSET pot counter-clockwise and the SCALE pot clockwise. When this is accomplished proceed to step 6.
6. In the next few steps of the procedure, the OFFSET and GAIN pots of the AGC channel(s) connected to the receiver's AGC output are adjusted so that the 'off satellite' signal strength value is between 50 and 100 and the 'on satellite' signal strength value is between 600 and 700. The

adjustments are made from MANUAL mode. Note that the GAIN and OFFSET adjustments are implemented using 20 turn pots. A lot of turns may be required.

To adjust the potentiometers, several quantities have to be identified for each receiver. If the controller has NEGATIVE polarity, go to step 6b. For POSITIVE polarity AGC, the installer needs to identify the satellite band (C or Ku) that resulted in the greatest 'on satellite' voltage (strongest on – satellite received signal) and the least 'off satellite' voltage (weakest off satellite signal).

In step 1, the 'on satellite' AGC voltage was recorded for both C and Ku bands. Which voltage was larger, C or Ku? _____. In the following steps, when instructed to position the antenna 'RCV1 - on satellite – strong band' align the antenna with the _____ Band satellite found in step 1 (use the band specified at the end of the previous sentence).

In step 2, the 'off satellite' AGC voltage was recorded for both C and Ku bands. Which voltage was smaller, C or Ku? _____. In the following steps, when instructed to position the antenna 'RCV1 - off satellite – weak band' align the antenna with the _____ Band satellite found in step 2 (use the band specified at the end of the previous sentence).

If both controller AGC inputs are utilized, record similar values for 'RCV1 – on satellite – strong band' _____ (C or Ku band) and 'RCV1 – off satellite – weak band' _____ (C or Ku band). If both controller AGC inputs are utilized steps 7 through 9 must be performed for each AGC channel. Use the Scroll Up/Down keys to view the AGC channel whose pots are being adjusted.

- 6b. For NEGATIVE polarity AGC, the installer needs to identify the satellite band (C or Ku) that resulted in the least 'on satellite' voltage (strongest on satellite received signal) and the greatest 'off satellite' voltage (weakest off satellite signal).

In step 1, the 'on satellite' AGC voltage was recorded for both C and Ku bands. Which voltage was larger, C or Ku? _____. In the following steps, when instructed to position the antenna 'RCV1 - on satellite – strong band' align the antenna with the _____ Band satellite found in step 1 (use the band specified at the end of the previous sentence).

In step 2, the 'off satellite' AGC voltage was recorded for both C and Ku bands. Which voltage was smaller, C or Ku? _____. In the following steps, when instructed to position the antenna 'RCV1 - off satellite – weak band' align the antenna with the _____ Band satellite found in step 2 (use the band specified at the end of the previous sentence).

If both controller AGC inputs are utilized, record similar values for 'RCV2 – on satellite – strong band' _____ (C or Ku band) and 'RCV2 – off satellite – weak band' _____ (C or Ku band). If both controller AGC inputs are utilized steps 7 through 9 must be performed for each AGC channel. Use the Scroll Up/Down keys to view the AGC channel whose pots are being adjusted.

7. Go to MANUAL mode, position the antenna 'RCVx - off satellite – weak band' (if it is not already there), Adjust the OFFSET pot (for POSITIVE polarity receivers) or the GAIN pot (for NEGATIVE polarity receivers) so that the signal strength reading is about 75.

If the AGC has POSITIVE polarity and the signal strength is too low, turn the OFFSET pot counter-clockwise. If the AGC has POSITIVE polarity and the signal strength is too high, turn the OFFSET pot clockwise.

If the AGC has NEGATIVE polarity and the signal strength is too low, turn the GAIN pot counter-clockwise. If the AGC has NEGATIVE polarity and the signal strength is too high, turn the GAIN pot clockwise.

8. While still in MANUAL mode, position the antenna 'RCVx - on satellite – strong band' and adjust the GAIN pot (for POSITIVE polarity receivers) or the OFFSET pot (for NEGATIVE polarity receivers) so that the signal strength value is about 650.

If the AGC has POSITIVE polarity and the signal strength is too low, adjust the GAIN pot clockwise. If the AGC has POSITIVE polarity and the signal strength value is too high, adjust the GAIN pot counter-clockwise.

If the AGC has NEGATIVE polarity and the signal strength is too low, adjust the OFFSET pot clockwise. If the AGC has NEGATIVE polarity and the signal strength value is too high, adjust the OFFSET pot counter-clockwise.

9. Position the antenna 'RCVx - off satellite – weak band'. If the signal strength is between 50 and 100, proceed to step 11. If the signal strength is less than 50 or greater than 100 perform steps 8 and 9 again.
10. Position the antenna 'RCVx - on satellite – strong band'. Jog the antenna off of the satellite until the picture is just barely watchable. Note the signal strength value. Go to CONFIG mode and use the SCROLL keys to bring up either the *AGC C Band Threshold* item or the *AGC K Band Threshold* item, whichever is appropriate for the frequency band that the user has chosen to operate at (and has adjusted the pots at). Key in the signal strength value noted above. Terminate the entry with the ENTER key.

For a dual receiver system, both AGC channels are used. The thing to remember is that the same *Threshold* value is applied to both channels for operation at a given band.

2.2 Checking the AGC Pot Adjustments

In the previous section a procedure was presented to adjust the AGC pots and to determine the AGC C/Ku Band Thresholds. That adjustment was performed using one transponder on one strong satellite. After the AGC pot adjustment has been performed a check should be made to insure that the adjustments are valid for all transponders on strong and weak satellites. In some cases, additional potentiometer or *Threshold* adjustments may be required.

To understand the tests that need to be performed, recall that the purpose of the AGC input is to let the controller determine whether a satellite signal is present or not, and to provide relative signal strength information when for peaking the antenna. A signal is assumed to be present whenever the AGC input is above the threshold level for whichever band - C or Ku - has been selected.

Three possible problems can be encountered ...

- i) The receiver is tuned to an inactive transponder and the AGC input is above the appropriate Threshold. In this case the controller will attempt to peak the antenna because the AGC input is above Threshold. The controller will attempt to peakup the antenna but a true peak cannot be found. In the process, the antenna may move away from the actual position of the satellite. Note that the noise output of a satellite receiver will increase when the antenna is aligned with the sun. This will occur when the sun lies in the earth's equatorial plane – this occurs in mid March and mid September. Note that if the controller is peaking the antenna on the sun, in many cases a Peak Limit Error will occur – see chapter 3 for more information.
- ii) The antenna is aligned with a satellite, the receiver is tuned to an active transponder, but the AGC input is below the appropriate threshold. In this case peaking will not occur because the AGC is below threshold.
- iii) The antenna is aligned with a satellite, the receiver is tuned to an active transponder, but the AGC input channel is saturated (AGC reading near 1023). In this case peaking will occur but a true peak will not be found because moving the antenna closer to or farther away from the satellite does not change the signal strength as displayed by the controller.

2.2.1 AGC Above Threshold for Noise Input Test

To insure that (i) is unlikely to occur tune the antenna away from any satellite. Tune the receiver over all transponders on any frequency bands of interest. Watch the displayed signal strength to insure that it is never above the appropriate Threshold. If the antenna is equipped with a four port feed that can receive both C and Ku band, horizontal and vertical polarizations simultaneously (like the Seavey ESA124D), make sure that the test is performed with both bands and both polarizations. Additionally, if both controller AGC channels are in use, perform the test for both receivers (the Scroll Up/Down keys can be used to select the AGC channel of interest from MANUAL mode).

2.2.2 AGC Input Below Threshold for Active Satellite Transponder Test

Perform the following procedure to insure that type (ii) problems do not occur.

Align the antenna with a weak satellite.

Tune the receiver over all transponders on any frequency bands of interest.

Insure that for all active transponders the displayed signal strength is above Threshold.

Note that for four port feeds, perform the test for both bands and both polarizations. For installations that utilize both controller AGC input channels, perform the test on both receivers. From MANUAL mode, the Scroll Up/Down keys can be used to select the AGC input which is displayed. As an alternative to aligning the antenna with a weak satellite, a strong satellite can be employed if the antenna is jogged off of the satellite to reduce the received signal strength.

2.2.3 AGC Input Saturated for Active Satellite Transponder Test

Perform the following procedure to insure that type (iii) problems do not occur.

Align the antenna with a strong satellite.

Tune the receiver over all transponders on any frequency bands of interest.

Insure that for all active transponders the displayed signal strength is well below saturation. A conservative approach is to treat any signal with a displayed signal strength above 900 as saturation.

Note that for four port feeds, perform the test for both bands and both polarizations. For installations that utilize both controller AGC input channels, perform the test on both receivers. From MANUAL mode, the Scroll Up/Down keys can be used to select the AGC input which is displayed.

2.2.4 What to do if Problems are Found

For a type (iii) problem in the absence of type (i) or type (ii) problems, the pot adjustment procedure can be performed again using the transponder/satellite where saturation was encountered as the 'on satellite' signal.

For type (i) or type (ii) problems, it may be possible to adjust the Threshold values up or down. For a given AGC input (receiver), if type (i) problems are encountered for one band and type (ii) problems are encountered for the other band, the insertion of pads (attenuators) or amplifiers in the IF line can sometimes help.

If problems persist the usual culprit is gain flatness. 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).

There are four places in a satellite receiving system that may have gain flatness problems that can affect the pickup operation. 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 horizontal then some gain variation with frequency is present. The type (i) test above is essentially a test of gain flatness.

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 really terrible gain flatness characteristics.

3.0 Signal Strength Pickup

This version of the software includes optional support for a signal strength pickup function after an auto move to a satellite. The software version number indicates whether or not the software installed in a given controller supports the pickup function. The controller displays its software version on power-up. Controllers that have a software version number that ends with '5', '6', '7', '8', or '9' support the pickup function. Controllers that have a software version number that ends with '0', '1', '2', '3', or '4' do not support the pickup function. This section pertains to controllers that support the automatic pickup function.

3.1 Enabling Peakups and Configuring Pickup Parameters

To use the pickup feature several controller CONFIG mode items have to be configured properly and peakups have to be enabled.

3.1.1 Enabling Peakups

To implement the peaking function the controller requires an analog input voltage that varies with received signal strength (0 to 10 volts DC max range). This voltage is typically provided by a receiver or modem AGC (Automatic Gain Control) circuit. The interface of this analog voltage to the controller is described in section two.

On controllers that support the pickup function, peakups can be enabled via the Pickup Enable CONFIG mode item. When enabled, peakups will follow an automatic move either initiated via the front panel or via certain commands received via the controller's serial port.

Peakups initiated by the user via the controller's user interface occur at the conclusion of automatic move commands. At the completion of the automatic move, if peakups are enabled and the Pickup related CONFIG mode items are valid, a pickup is initiated. Note that invalid Pickup related CONFIG mode items will result in display of a flashing 'PEAKUP CONFIG' alarm message on the bottom row of the controllers LCD.

3.1.2 Pickup Holdoff

When a pickup is initiated the controller will either immediately look for signal strength and begin a pickup OR it will enter a 5 second wait interval depending on the value of the Pickup Holdoff Interval CONFIG mode item. If the Pickup Holdoff Interval has a value of 0 the controller will begin a pickup operation if the controller's signal strength input is greater than the AGC C Band Threshold (if a C band satellite was the target of the automatic move) or AGC K Band Threshold (if a Ku band satellite was the target of the automatic move). If the Pickup Holdoff Interval is set to zero and signal strength above the appropriate Threshold is not available, the controller will not perform a pickup operation.

If the value of Pickup Holdoff Interval is 1 or greater (up to a maximum value of 300 seconds), at the conclusion of the automatic move the controller will enter a 5 second wait interval. During this 5 second interval, 'PEAKUP SETTLE' will be displayed on the bottom row of the controller's LCD (liquid crystal display). The purpose of this interval is to allow the AGC input signal to settle. After the SETTLE interval, the controller looks for signal strength. If signal strength is available the controller immediately initiates a pickup. If signal strength is not available, the controller will display 'PEAKUP HOLDOFF: XXX'. XXX is initially the value of the Pickup Holdoff Interval CONFIG mode item (in seconds), it is decremented once each second. If signal strength becomes available before the timer expires (reaches zero) a pickup will occur, otherwise, a pickup will not occur.

3.1.3 Pickup Step Sizes

The most important pickup related CONFIG mode items are C Band Azim Step Size, C Band Elev Step Size, Ku Band Azim Step Size, and Ku Band Elev Step Size.

3.2 Peakup Algorithm

When a peakup occurs, the controller first peaks the antenna in elevation and then is azimuth. Here is how the peakup occurs for the elevation axis (the azimuth axis is similar) ...

1. Measure the signal strength at the starting position (average for 3 seconds).
2. The antenna is jogged up (or azimuth CW for azimuth peakups) by an amount equal to either the C Band EI Step Size position counts or the K Band EI Step Size position counts, depending of the frequency band of the satellite (In SETUP mode the user specifies the satellite frequency band as either C, Ku, or C and Ku. For a 'C and Ku' band satellite the user is prompted to specify the frequency band before automatic moves occur. Older versions of software did not allow the user to specify the satellite band from SETUP mode. For those controllers the user is always prompted for C or Ku band. Note that it is possible to edit the controller's satellite data entry in non-volatile memory to specify a satellite band, see section 3.6).

At the conclusion of the move the controller will measure the signal strength (again averaging for 3 seconds).

3. If the signal strength measured at the conclusion of the upward movement (measured in step 2) is greater than the signal strength measured at the starting position (measured in step 1) the controller will make another step upward and again measure the signal strength. This process will continue until the controller makes a step that results in weaker signal strength or an error occurs (errors are described in section 3.3). When weaker signal strength is detected the controller backup one step – the peakup of the elevation axis is complete.

If the signal strength at the conclusion of the upward step is weaker than that of the starting position, the controller will return starting position and measure the signal strength again.

4. The controller will make a step downward and measure the signal strength. If the signal strength measured at the conclusion of the downward step is weaker than that at the starting position, the controller will return to the starting position and the peaking process ends.

If the signal strength measured at the conclusion of the downward step is greater than that measured at the starting position (measured in step 3) the controller will make another step downward and again measure the signal strength. This process will continue until the controller makes a step that results in weaker signal strength or an error occurs (errors are described in section 3.3). When weaker signal strength is detected the controller backup one step – the peakup of the elevation axis is completed.

3.3 Pickup Errors

The following error conditions can cause a pickup to terminate prematurely ...

Azim Alarm, Elev Alarm, or Pol Alarm ... These alarms are generated whenever the controller detects a fault for an axis. Fault conditions detected include are over-current sense, jammed (or no position pulse feedback), or runaway. These alarms will be accompanied by a flashing error message on the bottom row of the controller's LCD.

Stop Key – If the Stop key is hit the pickup will be terminated. In a similar manner, a mode change in response to a Mode key or certain serial commands will terminate a pickup.

Azimuth or Elevation Limit – If a pickup step movement will result in the controller moving outside of the azimuth or elevation limits the terminate the pickup.

Lost Signal Strength – If the received signal strength falls below the threshold for the frequency band specified the pickup will terminate.

Remote Commands – If a pickup initiated by a remote command received via the serial port is in progress and another remote command is received which specifies azimuth, elevation, or polarization movement the pickup in progress will be aborted.

Peak Limit Error – The controller will take up to four steps away from the initial position looking for a peak. If a peak is not found after 4 steps the controller terminates the peaking operation. A peak limit error is typically the result of too small of step size. The following section discusses step size selection.

3.4 Poor Pickup Performance – The Importance of Proper Step Size Selection

The pickup performance is determined by proper selection of the Az/EI Step Size CONFIG mode items. Several factors will govern step size selection including signal fading, the noise voltage present on the analog signal strength input, and the mount's mechanical hysteresis (sometimes referred to as 'slop').

For a given axis, the pointing accuracy of the antenna can be no greater than one half the step size used for peaking about that axis. Based on this it would seem that the smallest possible step size, 1 position count, would yield the greatest possible accuracy. In the absence of signal fading, noise on the controller's AGC input, and hysteresis, this would be the case.

3.4.1 How Signal Fading, Noise, and Mechanical Hysteresis Affect Pickup Performance

To see how these factors affect the peaking process it is useful to review the basic peaking operation. When peaking the antenna, the controller measures the received signal strength by averaging for 3 seconds, moves the antenna by an amount equal to the azimuth or elevation step size for the frequency band of the current satellite, and then makes another measurement of signal strength by averaging for 3 seconds. If the signal strength measured after the move is greater than the signal strength measured before the move, the controller assumes that the movement resulted in the antenna being brought closer to the antenna peak position. Signal fades, noise, and mechanical hysteresis can sometimes result in the controller measuring greater signal strength when the antenna is moved away from the satellite. This event is referred to as a 'bad decision' by the controller.

Signal Fading

Fading refers to the variation in received signal strength due to atmospheric conditions. The effects of fading are usually greater at higher frequencies. Moisture in the form of clouds, fog, or precipitation contribute to fading. The changes in signal strength associated with fading can occur over periods of time measured in seconds, minutes, or even hours. It is the short term time variations in signal strength that can cause the controller to make a bad peaking decision.

Here is an example of how fading can lead to a bad peakup decision. Assume that during a peaking operation the controller takes a step away from the true satellite position. If during that movement a cloud that had previously been positioned between the antenna and the satellite 'moves out of the way' the controller will record a stronger signal even though the antenna has been moved away from the satellite. To reduce the probability of this bad decision occurring the position step size can be made larger or the received signal averaging period can be made shorter to cause the peakup to occur more quickly. The controller's signal averaging interval is fixed at three seconds. Note that a reduction of the signal averaging time interval leads to an increased probability of a bad peaking decision due to noise in the receiver AGC circuits as described in the next section.

AGC Noise

The controller's signal strength input is an analog signal typically generated by a receiver's AGC output circuits. A certain amount of noise is present in any analog signal. The noise voltage is summed with the signal. The noise typically has an average value of zero volts. To minimize the affect of noise the controller's averaging interval can be increased. Note that an increase of the signal averaging time interval leads to an increased probability of a bad peaking decision due to signal fading as described in the previous section.

Mechanical Hysteresis

Mechanical hysteresis, or slop, is looseness in the antenna drive system. Hysteresis is typically caused by backlash in a linear actuator or chain drive or looseness in the actuator attachments bolts or pivot points. When the step sizes used for peaking result in antenna movements smaller than or equal to the antenna's mechanical hysteresis, a step may not result in a change in the antenna's absolute pointing angle. If this occurs, any change in measured signal strength will be due to fading or noise in the receiver's AGC circuits and the controller will make a 'bad decision' regarding the peakup.

Here is a test to quantify the amount of mechanical hysteresis in a given mount. Better results will be obtained if the winds are calm when the test is performed.

1. Jog the antenna far off of the satellite in one direction.
2. Jog the antenna back towards the satellite. Initially approach the satellite moving the antenna at high speed.
3. When the antenna is close to the satellite jog towards the satellite at slow speed moving 1 or 2 position counts at a time. Only jog the antenna in one direction – do not back up. Record the signal strength at each position. Continue until well past the peak of the antenna pattern.
4. Next position the antenna far off of the satellite in the other direction and repeat steps 2 and 3 as you approach the satellite from the other direction.
5. Using a spreadsheet, plot signal strength vs. position for movement in both directions. Compare the plots, any difference between the peak positions is probably due to slop in the antenna.

Note that the test is more accurate for larger antennas and higher frequencies (which result in a narrower antenna beamwidth). Sometimes this test will not fully characterize slop about the elevation axis due to the weight of the antenna. Elevation slop can still affect a heavy antenna in gusty winds.

3.5 Step Size Selection

The controller's peakup step size is specified in position counts via the following CONFIG mode items: C Band El Step Size, C Band Az Step Size, K Band El Step Size, and K Band Az Step Size. Section 3.5.5 tabulates recommended step sizes (in position counts for a number of antennas).

3.5.1 Azimuth and Elevation Step Size Calculation

The controller's peaking accuracy can be no better than one half of the step size used for peaking. Section 3.4 described the problems that occur when the step size is made too small. It has been found that peakup step sizes that results in a 0.5 to 1.0 dB drop in signal strength (assuming that the antenna

is perfectly aligned with a satellite) gives the best performance. Stated another way, the step size should be the antenna pointing error in degrees from antenna boresight, that corresponds to an antenna pointing loss of 0.5 to 1.0 dB.

For an elevation over azimuth type antenna mount, to determine the optimal elevation step size it is necessary to know ...

1. The angular deflection (in degrees) that results in a given drop in signal strength (in dB - note that this relationship is a function of frequency band), and
2. The antenna's elevation axis position_count per degree characteristic.

Mathematically, this is represented as ...

El Step Size (position counts) = Angle (degrees) x (elevation position counts / degree),

where Angle is angular deflection away from antenna boresight (in degrees) that results in the desired drop in signal strength (0.5 to 1.0 dB).

The calculation of the optimal azimuth step size is similar to that for the elevation axis except that an additional correction factor is required to account for the fact that one degree of azimuth movement does not change the antenna pointing angle by one degree when the elevation angle is greater than zero. To visualize this, note that if the elevation angle could be adjusted to 90 degrees (the antenna pointing straight up), azimuth movement does not change the antenna pointing angle at all, it merely rotates the antenna (changes polarization). The correction factor varies with antenna elevation angle which is related to the latitude of the earth station.

Mathematically, this is represented as ...

Az Step Size (position counts) =

Angle (degrees) x (azimuth position counts / degree) x
(degrees of az movement for one degree of antenna pointing angle change)

3.5.2 Pointing Error (degrees) Given Pointing Loss (dB) Relationship

The following relationship calculates antenna pointing error (in degrees) given antenna pointing loss (in dB) ...

Antenna_Pointing_Error (deg) =

$[\text{SQRT}[\text{Signal_Loss (dB)}] \times 5.55] / [\text{Antenna_Diameter (meters)} \times \text{frequency (GHz)}]$

The following table gives the antenna pointing error (in degrees) for 0.5/1.0 dB pointing loss values for C Band (4 GHz) and Ku Band (12 GHz).

Antenna Diameter	C Band (degrees) 0.5 dB / 1.0 dB Pointing Loss	K Band (degrees) 0.5 dB / 1.0 dB Pointing Loss
2.4 meters	0.41 / 0.58	0.14 / 0.19
3.1 meters	0.32 / 0.45	0.11 / 0.15
3.8 meters	0.26 / 0.36	0.09 / 0.12
4.5 meters	0.22 / 0.31	0.07 / 0.10
6 meters	0.16 / 0.23	0.05 / 0.08

3.5.3 Determining The Antenna Azimuth and Elevation Count per Degree Characteristic

To calculate the optimal step sizes for a given antenna it is necessary to know the antenna mount's azimuth and elevation count per degree characteristic. Note that for an antenna powered by a linear actuator the antenna's azimuth and elevation count per degree characteristic is not a single value, it is described by the law of cosines, and varies depending on actuator extension/retraction. For determining pickup step sizes, assuming that the antenna azimuth and elevation count per degree characteristics are constant does not introduce a large error.

The easiest way to determine the count per degree characteristic of a given antenna is to derive it from antenna pointing data using a satellite antenna pointing calculator. An antenna pointing calculator, ANTENNA.EXE, is included on the diskette in the back of the antenna controller manual. ANTENNA.EXE can also be downloaded from the Research Concepts web site, www.researchconcepts.com.

An example will demonstrate the technique. This example is based on an EASi 4.5 meter antenna employing a ViaSat reflector and a Baird mount powered by 90 volt DC motors. The antenna is located in Seattle, latitude 47° 40', longitude 122° 30'. In the following table, each row represents a unique satellite.

Satellite Location (longitude)	Azimuth Position Count	Elevation Position Count	Antenna True Heading (degrees from true north)	Antenna Elevation Heading (degrees)
87° West	1455	1639	136.0	25.4
99° West	2110	2167	149.5	30.7

The columns labeled 'azimuth position count' and 'elevation position count' represent the position of the satellite in the controller's non-volatile memory. The data in the columns labeled 'Antenna True Heading' and 'Antenna Elevation Heading' is obtained from the ANTENNA.EXE program.

Here is a screen shot of the ANTENNA.EXE program for the satellite located at 87° West. Note that for geostationary satellites, the Inclination field in ANTENNA.EXE should be set to 0.0.

```
** RESEARCH CONCEPTS, INC ** Phone (913) 469-4125 ** Copyright 1992
**
```

Antenna Location

```
Latitude:      47.40
```

```
Longitude:     -122.30
```

```
Mag Variation: -18.73
```

Satellite Data

```
Longitude:     -87.00
```

```
Inclination:   0.00
```

Pointing Solution (in degrees)

```
Elevation:     25.4
```

```
True Heading:  136.0
```

Mag Heading: 117.3

Here are the calculations for the antenna azimuth and elevation count per degree characteristics for the data in the table above.

Azimuth Counts per Degree =

$$[2110 - 1455] / [149.5 - 136.0] = 375 / 13.3 = 48.5 \text{ counts per degree}$$

Elevation Counts per Degree =

$$[2167 - 1639] / [30.7 - 25.4] = 355 / 5.3 = 99.6 \text{ counts per degree}$$

Here are some count per degree characteristics that have been tabulated for

3.5.4 Azimuth Step Size Correction Factor (for Elevation over Azimuth Antenna Mounts)

The azimuth step size calculation requires a Correction Factor that relates antenna movement about the azimuth axis to the change in antenna pointing angle. The azimuth step size should correspond to a change in the antenna pointing angle that will reduce the received signal strength by 0.5 or 1.0 dB. In section 3.5.1, pointing angle change required to produce a 0.5 and 1.0 dB drop in signal strength is calculated. The Correction Factor is required because when the antenna is not at zero degrees elevation (pointing at the horizon) a one degree change in azimuth angle changes the antenna pointing angle by an amount less than one degree.

The Correction Factor is the number of degrees of azimuth movement required to produce one degree of antenna pointing angle change. The Correction Factor is a function of elevation angle. The Correction Factor is larger for higher elevation angles.

Correction Factor vs. Elevation Angle

Antenna Elevation Angle	10 deg	20 deg	30 deg	40 deg	50 deg	60 deg	70 deg	80 deg
Correction Factor	1.02	1.05	1.15	1.31	1.46	2.00	2.92	5.78

An antenna with an elevation over azimuth mount works over a range of elevation values. The exact range is a function of earth station latitude and the difference in longitude between the earth station and the satellite.

The following table lists elevation look angles vs. antenna latitude for i) satellites located at the same longitude as the antenna, and ii) satellites whose longitude is 50 degrees away from that of the antenna. The table also includes a recommended value for the Correction Factor used for antennas located at that antenna latitude.

Antenna Latitude	25°	30°	35°	40°	45°	50°
Elevation Angle for satellite whose longitude value is the same antenna.	60.8°	55.0°	49.4°	43.7°	38.2°	32.7°
Elevation Angle for satellites separated from the antenna by 50 degrees longitude.	28.0°	26.0°	23.8°	21.4°	18.8°	16.1°
Recommended Correction Factor	1.75	1.50	1.40	1.30	1.25	1.10

3.5.5 Recommended Step Sizes for Various Antennas

In the following tables, the first value in each field corresponds to a step size that will result in a 0.5 dB drop in received signal strength (assuming that the antenna was perfectly aligned with the satellite before the antenna movement occurred). The second value in each field is the step size that will correspond a drop in received signal strength of 1.0 dB.

Antenna Type: EASi 4.5 meter ViaSat reflector, Baird mount, 90 volt DC Az/EI Motors

Azimuth and Elevation Step Sizes

Band	Elev Step Size	Azimuth Step Size vs. Antenna Site Latitude (0.5 dB steps/1.0 dB steps)					
		25 degrees latitude	30 degrees latitude	35 degrees latitude	40 degrees latitude	45 degrees latitude	50 degrees latitude
C Band	22/31	19/27	16/23	15/22	14/20	14/19	12/17
Ku Band	7/10	6/9	5/8	5/7	5/7	5/6	4/6

3.6 Specifying the Satellite Band When Upgrading From a Previous Version of the Software

Most previous versions of the RC2000A software (all versions before v2.4x) did not prompt the user to specify the satellite band when a satellite was programmed into non-volatile memory via SETUP mode. The peaking feature of the controller requires band information to select the az/el stepsize before the peakup operation can occur. To accommodate upgrades of these controllers a Band Edit mode has been created. To enter Band Edit mode enter 1984 at the controller's Expert Access prompt. This will immediately cause control to transfer to the Band Edit mode (which is actually a sub-set of AUTO mode).

In Band Edit mode the satellite band will be displayed to the right of the satellite name. The user can hit the 0, 1, or 2 keys to specify the satellite band. The value entered by the user is stored in non-volatile memory. To exit the Band Edit mode use the Mode key to change the mode. Peakups can still be performed via the front panel if the satellite band has not been defined. In this case the user will be prompted to specify either C or Ku band. Remote commands that initiate a peakup specify the band.

4.0 Other Features Introduced with the RC2000 v2.6x

In addition to the optional peakup capability described earlier, several other modifications were introduced with the RC2000A version 2.6x software.

These include

1. The RC2000 can service remote Device Status Poll commands without transferring control to REMOTE mode.
2. The RC2000A communication protocol now supports the upload/download of all configuration and satellite data. The additions to the controller's communications protocol is described in section 5.
3. The CONFIG mode system has been modified to allow a user to access any corrupt CONFIG mode item as long as Expert Access is enabled.
4. A sticky key jog feature that is useful during system setup or when cutting antenna patterns. See section 4.1 for more information.

5. The controller now displays signal strength information received via the AGC1 (automatic gain control channel 1) and AGC2 inputs. In MANUAL mode the user can use the Scroll Up/Down keys to display either the signal present at the AGC1 input, the AGC2, or the strongest signal on AGC1/AGC2. See section 4.2 for more information.
6. The following CONFIG mode items have been added ...

AGC Polarity Flag, AGC C Band Threshold, AGC K Band Threshold – these items are related to signal strength display (section 2) and the peakup system (section 3),

Peakup Enable, C Band Az Step Size, C Band El Step Size, K Band Az Step Size, K Band El Step Size, Peakup Holdoff Interval – these items configure the peakup system (section 3),

Polarization Motor CCW Limit, Polarization Motor CW Limit, Azimuth CW Limit, Azimuth Position, Elevation Up Limit, and Elevation Position. See section 4.3 for more information on these CONFIG mode items.
7. Enhanced support for various types of polarization control devices. See section 4.4.
8. With version 1.6x of the RC2000A software, a feature was added that allows the user to disable azimuth and elevation runaway alarms. That feature is documented in section 4.5.

Section 4.6 provides information for users upgrading from a previous version of the software.

4.1 Sticky Key Jog

The controller has been modified to support a feature referred to as Sticky Key Jog. This feature is sometimes useful during antenna setup and while cutting antenna patterns. With Sticky Key Jog, in MANUAL mode, an az/el jog is initiated by hitting the Az CCW, Az CW, El Down, or El Up keys. Once a sticky key jog is initiated it will continue until the user hits the Stop key, the antenna encounters a limit, or the controller exits MANUAL mode.

To activate a Sticky Key Jog, at the CONFIG mode Expert Access prompt enter 50562. Control will immediately transfer to MANUAL mode. The Sticky Key Jog will be enabled until the user exits MANUAL mode by hitting the Mode key, the controller is powered down, or a remote command is received that causes activation of REMOTE mode.

4.2 Signal Strength Display From Manual Mode

The controller now displays signal strength in MANUAL, SETUP, LIMIT, and REMOTE modes. The signal strength value is derived from the analog voltages presented to the controller's AGC1 and AGC2 inputs. Section 2 of this addendum describes the configuration and calibration of the controller's signal strength display.

Normally, the controller displays the signal strength of the AGC input with the greatest signal strength. In MANUAL mode the Scroll Up/Down keys can be hit to select the quantity displayed to the right of the 'S:' banner. The controller accepts two channels of AGC input, referred to as AGC1 and AGC2. Hitting the Scroll Up or Scroll Down keys causes the S: banner to toggle between '1:' (AGC1 channel displayed), '2:' (AGC2 channel displayed), and 'S:' (the greater of AGC1 or AGC2 displayed).

4.3 New CONFIG Mode Items

Several new CONFIG mode items have been defined to support the upload and download of the controller's non-volatile memory. All of the following CONFIG items specify data that can be entered via other modes.

Pol CCW Limit and Pol CW Limit

These items can also be specified via POL LIMITS mode if a rotating feed is present (Pol Control set to One Port or Two Port).

Azimuth CW Limit and Azimuth Position

Setting the Azimuth CW Limit CONFIG mode item also initializes the Azimuth CCW Limit to 30. Normally these limits are set via LIMITS mode. The Azimuth Position count is normally set to 30 when the Azimuth CCW Limit is set via LIMITS mode. The Azimuth Position count can also be set via RE-SYNC mode.

Elevation Up Limit and Elevation Position

Setting the Elevation Up Limit CONFIG mode item also initializes the Elevation Down Limit to 30. Normally these limits are set via LIMITS mode. The Elevation Position count is normally set to 30 when the Elevation Down Limit is set via LIMITS mode. The Elevation Position count can also be set via RE-SYNC mode.

4.4 Polarization Control Options

In the v2.6x revision of the RC2000A software the Rotating Feed Present CONFIG mode item has been replaced with the Pol Control? CONFIG mode item. At the Pol Control CONFIG mode prompt the user can specify either None, One Port, Two Port, or Polarotor. At the Rotating Feed Present CONFIG mode prompt found in earlier versions of the software the user could specify No for polarotor control or Yes for a (one port) rotating feed.

The following paragraphs describe the various possible responses to the Pol Control? CONFIG mode prompt.

1. If the user enters None at the Pol Control? prompt the controller assumes that a polarization control device is not present in the system. Polarization jog commands are ignored and the user is not prompted to specify polarization values in SETUP mode.
2. One Port refers to a single port rotating feed powered by a DC motor that employs a potentiometer for position feedback. This type of feed can only receive a single signal (and only has one LNB). When a single port feed is looking at a satellite that transmits both horizontally and vertically polarized signals, the controller has to 'remember' both a horizontal and vertical position for each satellite. Accordingly, the user is prompted for horizontal and vertical polarization positions in SETUP mode. If this option is specified the RC2KPOL polarization control daughterboard must be installed in the controller. Setting the Pol Control? CONFIG mode item to One Port results in controller operation identical to that of older versions of the software with the Rotating Feed Present CONFIG mode item set to Yes.
3. A two port feed can receive horizontally and vertically polarized signals simultaneously. Like a one port feed, a two port feed is powered by a DC motor, employs a potentiometer for position feedback, and requires that the RC2KPOL daughterboard be installed in the controller. In SETUP mode, when a single band (either C or Ku) satellite is specified the user is only prompted to specify a single polarization. When the feed is adjusted to that position it can receive horizontally and vertically polarized signals simultaneously. In SETUP mode, when a dual band satellite is specified the user is prompted to specify both a C Band and Ku Band polarization position (they can be set to the same value).

This behaviour for dual band satellites when a two port feed is specified is designed to accommodate the Seavey Engineering Associates ESA 124D feed. The ESA 124D feed can simultaneously receive horizontal and vertical signals for both C and Ku bands. Most satellites that include both C and Ku band transponders (also known as hybrid satellites) have identical horizontal and vertical polarization orientations for C and Ku band. Some satellites, however, do have unique H/V polarization orientations for C and Ku band.

4. A polarotor is a 3 wire servo developed by Chaparral Communications. A polarotor is a single port device (meaning it can only receive a single signal for a given band). Some polarotor based feeds can receive C and Ku band signals simultaneously.

4.4.3 RC2000 Non Volatile Memory Satellite Data Polarization Position Fields

Satellite data is stored into the RC2000A's non-volatile memory via the the controller's SETUP mode. When the Pol Control? CONFIG mode item is set to something other than None, SETUP mode prompts the user to specify the band (C, Ku, or hybrid C and Ku) of each satellite stored in non-volatile memory. Each satellite data entry contains two polarization position values. One normally holds the horizontal polarization position and the other the vertical polarization position.

If the antenna is equipped with a two port feed and the user specifies either a C band satellite or a Ku band satellite (i.e. not a hybrid satellite) the user will only be prompted to supply a single polarization position. For this case, the polarization position supplied by the user is copied to both polarization positions associated with the satellite data entry.

If the antenna is equipped with a two port feed and the user specifies a hybrid satellite, SETUP mode prompts the user to specify whether or not he or she wishes to specify unique C and Ku band polarization values. If the user opts to provide unique C and Ku band polarization values the C band polarization position is stored in the location commonly employed to store the horizontal polarization position. The Ku band polarization position is stored in the location normally used to store the vertical polarization position.

4.4.4 Polarization Code Display

Previous versions of the RC2000 displayed 'H', 'h', 'V', or 'v' to indicate the present polarization position. To do this the RC2000 keeps track of the satellite data entry in non-volatile memory that is closest to the current antenna az/el position. The polarization position values associated with this 'closest satellite' are compared to the current polarization position. If the current polarization position is very close to the horizontal polarization position of the satellite data entry of the 'closest satellite' an 'H' is displayed. If the current polarization position is somewhat close to the horizontal position of the closest satellite 'h' is displayed. Similarly for display of 'V' and 'v'.

With introduction of support for a Two Port feed, the pol code display scheme described above was modified in the following manner when the user has specified that the antenna is equipped with a two port feed ...

If the 'closest satellite' is specified to be either a C band or Ku band satellite (i.e. not a hybrid satellite), the polarization code displayed will be either 'X' or 'x'. For this case both the 'horizontal' polarization field and the 'vertical' polarization field associated with the satellite's entry in non-volatile memory will contain identical values. If the current polarization position is very close to the polarization positions stored in non-volatile memory an 'X' will be displayed. Somewhat close and an 'x' is displayed.

If the closest satellite is a hybrid satellite (both C and Ku band) and the two polarization positions associated with the satellite's data entry in non-volatile memory are THE SAME, the displayed polarization codes will again be 'X' or 'x'.

If the closest satellite is a hybrid satellite (both C and Ku band) and the two polarization positions associated with the satellite's data entry in non-volatile memory are DIFFERENT the displayed polarization codes will again be 'C', 'c', 'K', or 'k'.

4.4.5 AutoPol Disabled for Dual Port Feeds

The RC2000A supports a feature called AutoPol. The AutoPol system slaves the RC2000A's polarization control output to a digital input to the controller. AutoPol is commonly enabled when the antenna is equipped with a polarotor servo type polarization control device. Many analog receivers provide an output for an H/V select relay. This output can often be tied directly to the RC2000's AutoPol Input. As the user selects satellite transponders with the receiver the controller commands the polarotor to the H/V values corresponding to the satellite that was the last target of an auto move (or the closest satellite if the antenna has been jogged since the last auto move). The AutoPol Enable and AutoPol Vpol Level CONFIG items enable and configure the system.

With version 2.6x of the RC2000A software, the behavior of the AutoPol system was modified. With version 2.6x, if the Pol Control? CONFIG mode items is set to Two Port the AutoPol system is disabled regardless of the state of the controller's AutoPol Enable flag. Note that previous versions of the

RC2000A only allowed the user to select either a Polarotor type polarization control device or a Rotating Feed. If this altered behaviour of the AutoPol System causes a problem, set the Pol Control Equipment code to One Port even if a two port feed is connected to the system. With the Pol Control? CONFIG mode item set to One Port, version 2.6x (and later versions of the software) will behave in a manner identical to previous versions of the software with respect to the AutoPol system.

4.5 Azimuth/Elevation Axis Runaway Alarm Disable

The RC2000 is designed to interface to antenna mounts that employ pulse type position sensors on the azimuth and elevation axis. A runaway alarm occurs when the antenna controller's pulse position input circuit detects a position pulse and the antenna has not been commanded to move and is not in a coast interval immediately following a move.

The term 'coast interval' requires an understanding of the antenna controller's anti-reversal system. When a runaway alarm is triggered for a given axis the bottom row of the display will flash AZIM ALARM or ELEV ALARM and further movement about that axis is disabled. Note that an overcurrent or jammed condition can also trigger these alarms. The controller's RESET mode will allow the user to determine type of fault that triggered the alarm and also reset the alarm.

The anti-reversal system is controlled by the Azim Fast Deadband, Azim Slow Deadband, Elev Fast Deadband, and Elev Slow Deadband CONFIG mode items. The operation of the anti-reversal system is described by an example. Assume that the antenna is moving about the elevation axis in the upward direction at fast speed (either as part of an automatic move or a manual jog operation). When the antenna elevation drive is released the controller will not allow the antenna to move in the downward direction until the drive has been idle for a time interval (in milliseconds) defined by the Elev Fast Deadband CONFIG mode item. This keeps the antenna from rapidly reversing direction. If the antenna was driven in the upward direction and was suddenly commanded to move in the downward direction, for a short time the antenna would continue to move in the upward direction before reversing direction and moving downward. Any elevation position pulses that occur between the time when the antenna is commanded to move downward and actually begins moving downward will not be accumulated properly. This will lead to an inaccurate elevation position count.

A 'coast interval' is the time immediately after a move in a given direction about a given axis when the controller will not allow the antenna to move in the opposite direction about that axis. To repeat, a runaway position count (for a given axis) is a position count that occurs when the antenna is not commanded to move and is not in the coast interval immediately following a move (about the axis).

Previous versions of the RC2000A software (version 1.50 and earlier) would activate a runaway alarm whenever a runaway position count was detected. The software modification described in this addendum allows the user to modify the behavior of the runaway system to either disable runaway errors or to require that more than one runaway count occur before the runaway alarm is triggered.

I-4.5.1 Configuring the Runaway Sensing System

The user can modify the operation of the runaway alarm sensing system via the values assigned to the Azim Fast Deadband and Elev Fast Deadband CONFIG mode items. Each axis can be configured separately.

If the value assigned to the Azim Fast Deadband CONFIG mode item ends in '40' the controller will only accumulate azimuth position counts when the antenna is moving about the azimuth axis or is in a coast interval immediately proceeding an azimuth move. This effectively disables the runaway alarm for the azimuth axis. The operation of the elevation runaway sensing system is configured via the Elev Fast Deadband CONFIG mode item in a manner similar to that of the azimuth axis. Examples of 'Fast Deadband values that disable runaway sensing are 2040 and 940.

If the value assigned to the Azim Fast Deadband CONFIG mode item ends in '41' through '49' the azimuth runaway count threshold will be assigned a value of 1 through 9, respectively. The azimuth runaway count threshold is defined as the number of runaway counts which must be exceeded before an azimuth runaway alarm is triggered. For example, if the Azim Fast Deadband CONFIG mode item has a value of 1845 six runaway position counts must be accumulated before an azimuth runaway alarm is triggered. The elevation axis is configured in a similar manner using the Elev Fast Deadband CONFIG mode item.

Note that to obtain access to the Azim Fast Deadband and Elev Fast Deadband CONFIG mode items the controller's Az/EI Drive Options Enable CONFIG mode item must be set to 1 and the Expert Access Flag must be set.

4.6 Upgrading Controllers

This section contains information for customers with older controllers upgrading to the most current version of the software.

I-4.6.1 Precautions

To upgrade the RC2000 controller's software an EPROM has to be replaced (U4 on the controller's digital board – the digital board is the one without the large heatsink).

The memory map of this version of the software is compatible with controller's currently running software versions 1.30 and higher. This means that it is possible to update the EPROM and not corrupt the contents of the controller's non-volatile memory (current positions, limits, satellites and CONFIG mode items).

Note that whenever IC's (like the EPROM) are replaced there is a slight chance that the contents of non-volatile memory will be corrupted. For this reason we recommend that the user make a record of the contents of the controller's non-volatile memory. This includes the CONFIG mode items and satellite data. To record satellite data use AUTO mode to position the antenna on each of the satellites stored in non-volatile memory. Record the satellite name, azimuth position, elevation position, H position (horizontal polarization), and V position (vertical polarization) values for each satellite. It is also recommended that the user position the controller at the antenna's east (azim ccw) and down limit before powering the controller down to replace the EPROM.

When replacing the EPROM, make sure that the notch on the end of the IC package is aligned with the notch on the IC socket and the notch depicted on the silkscreen on the top of board. Some users remove the keyboard cable from the connector on the digital board when replacing the EPROM. If the cable is removed make sure that the cable is properly connected. If the controller powers up but the keyboard is un-responsive check the cable.

I-4.6.2 Rotating Feed Present CONFIG Mode Item Replaced

The Rotating Feed Present CONFIG mode item is not present on this version of the software. The type of polarization control device attached to the system is now specified via the Pol Control? CONFIG mode item. The Pol Control? mode item is described in section I-4.4 Polarization Control Options.

The Pol Control? CONFIG mode item allows the user to specify the following types of polarization control equipment ... i) no polarization control device, ii) one port polarization control, iii) two port polarization control, or iv) Chapparral Polarotor type three wire servo.

It is possible to have the latest software emulate the operation of previous software versions that contain the Rotating Feed Present CONFIG mode item.

To emulate the polarization control behavior of previous versions of the software where the Rotating Feed Present CONFIG mode item is set to 0 (FALSE), specify 3 – Polarotor at the Pol Control? prompt.

To emulate the polarization control behavior of previous versions of the software where the Rotating Feed Present CONFIG mode item is set to 1 (TRUE), specify 1 – One Port at the Pol Control? prompt.

Note that if Two Port polarization control is specified the controller's AutoPol feature is disabled regardless of the state of the AutoPol CONFIG mode item.

I-4.6.3 Satellite Band Data

Versions of the RC2000A software before v2.4x did not prompt the user to specify the satellite band when a satellite was programmed into non-volatile memory via SETUP mode. The peaking feature of

the controller requires band information to select the az/el stepsize before the pickup operation can occur. If a pickup is specified and satellite band information is not available for a given satellite the controller will prompt the user to specify the satellite band before a pickup occurs.

It is possible to edit a satellite's band data entry in the controller's non-volatile memory. This feature is described in section I-3.6.

Declaration of Conformity

Application of Council Directive: 72/23/EEC; 89/336/EEC

Standards to which conformity is declared:

EN-55022:1991, EN 50082-2, EN60950

Manufacturer's Name: RESEARCH CONCEPTS, INC.

Manufacturer's Address: 9501 DICE LANE

LENEXA, KANSAS 66215 USA

Type of Equipment: Satellite Antenna Controllers

Model No's.: RC2000A

Year of Manufacture: 1998

In order to meet the EMC directive, fully shielded, properly connected cable is required for all connections.

WARRANTY

One Year Limited Warranty

Research Concepts, Inc., RCI, warrants to the original purchaser this product shall be free from defects in material and workmanship for one year, unless expressed otherwise, from the date of the original purchase.

During the warranty period, RCI will provide, free of charge, both parts and labor necessary to correct such defects. In some cases, RCI can supply the customer with a loaner unit during the time of repair. This offer is subject to the availability of a loaner unit of the correct model. The loaner charge is equal to the drop ship charge plus shipping charges to the site. The end-customer is liable for the return of the loaner unit within 30 days in the amount of the current list price for the product.

To obtain such warranty service, the original purchaser must:

1. Notify RCI as soon as possible after discovery of a possible defect of:
 - a. the model and serial number
 - b. identity of the seller and date of purchase
 - c. detailed description of the problem, including details on the electrical connection to associated equipment's and list of such equipment, and circumstances when problem arose.
 - d. Obtain a return material authorization (RMA) number from RCI.
2. Deliver the product to RCI, or ship the same in its original container or equivalent, fully insured and shipping charges prepaid. Failure to properly pack the equipment will lead to product damage in shipment. RCI is not liable for this damage.

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

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

There are no implied warranties.

For equipment returned for warranty without an RMA number will carry a minimum charge of 1 hour shop time if no problem is found.

The foregoing constitutes RCI's entire obligation with respect to this product, and the original purchaser and any user or owner shall have no other remedy and no claim for incidental or consequential damages. Some states do not allow limitations or exclusions of incidental or consequential damages, so the above limitation and exclusion may not apply to you.

This warranty gives you specific legal rights and you may also have other rights which may vary from state to state.

For service information: Phone: 913/422-0210; Fax: 913/422-0211; E-mail: support@researchconcepts.c