

RC1500 Single Axis
Antenna Controller
Operator's Manual
v 1.20



CONTENTS SUBJECT TO CHANGE

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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:
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 - 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.

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Chapter 1 INTRODUCTION

The RC1500 antenna controller controls a single axis satellite antenna. The RC1500 interfaces to 36 volt actuators with single phase, pulse type position sense feedback. Two basic models are available, the RC1500A and RC1500B. The RC1500B can track inclined orbit satellites with either a single axis tracking mount or a single axis feed translation system. The RC1500B is described in an addendum to this manual.

Here is a summary of the capabilities of the RC1500 ...

1. The controller utilizes a solid state drive system capable of providing 8 amps to the antenna actuator. The drive system has built-in over-current sensing with mechanical relay backup to disconnect the drive from the actuator in the event of a fault.
2. The controller can control polarization via a polarotor (or servo) type interface. The AUTO_POL feature allows the polarization to be controlled via a digital input or contact closure supplied by a receiver to the controller. An RC2KPOL option is available to provide control for a Seavey type two or four port feed with potentiometer feedback. If no polarization control device will be present in a given installation configure the controller for the servo option by setting the *24 vdc Rot Feed* CONFIG mode item to '0'.
3. Position sensing feedback is supplied by a single phase, pulse based sensor - reed switch, Hall effect, or electro-optical. Single phase reed switch and Hall effect type sensors are found in 36 volt DC linear actuators. The RC1500 keeps track of both rising and falling pulse edges from the pulse sensor for increased accuracy. The pulse sensors used with the RC1500 should not be coupled directly to the antenna axis of rotation.
4. The RC1500's non-volatile memory can 'remember' the positions of a number of geostationary satellites.
5. The Adapti-Drive variable speed control system allows the user to specify the desired slow speed for the fundamental 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 problem of poor speed regulation with varying direction along a given axis associated with constant voltage slow speed systems.
6. The RC1500 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. 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 used on the RC1500.

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 the fields on the screens which the user will encounter, as well as 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, these chapters 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".

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 an 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 RC1500 contains an ON/OFF switch, a 2 row by 16 column backlit LCD, and a 4 by 4 matrix keypad with tactile feedback. The controller's back panel is described in chapter 3.



Figure 2.1 RC1500 Front Panel

The legend above the top row of the LCD defines the POS, POL, and SS fields. The POS field is the current antenna position. POL defines the polarization field. SS is the signal strength field. The three character field in the lower right hand corner of the LCD (above the MODE label) is reserved for the display of the current controller mode. 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.

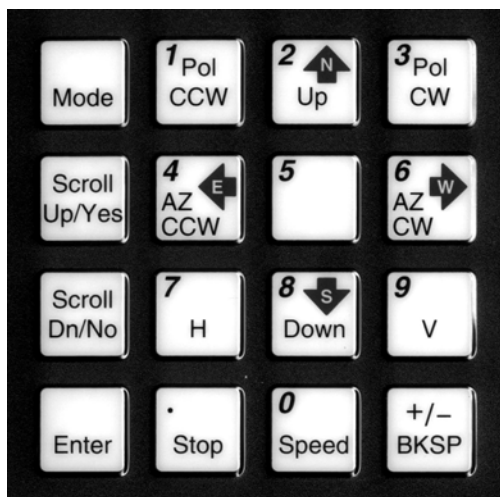


Figure 2.2 RC1500 Keypad

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

MODE

Toggling this key allows the user to set the desired mode of the controller. There are two mode groups – operational and programming. See section 2.2 – Changing Modes with the Mode Key. The MODE key is always active.

SCROLL UP/SCROLL DOWN

These keys are used to scroll up or down through a list of items.

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. During the entry of numeric data, if the cursor is in the first position of the data entry field, hitting the +/- key will toggle the sign of the numeric input.

SPEED

This key toggles the antenna 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 left and down arrow keys jog the antenna one direction while the right and up arrow keys jog the antenna in the other direction.

CCW/CW/H/V

These keys control the Polarization. The CCW and CW keys skew the polarization control device 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 Changing Modes with the MODE Key

The user can switch the current controller mode with the MODE key. The MODE key is always active - when the MODE key is depressed and released, the controller's current mode will change.

There are two mode groups – **Operational** and **Programming**.

Operational modes consist of MAN (manual mode), AUT (auto mode), and REM (remote mode).

Programming modes consist of SET (setup mode), LIM (limits), CFG (config), DEL (delete), FIX (resync mode), RST (reset mode).

The Operational modes are the ones used in everyday operation of the controller.

To switch between modes **in a group**, press the MODE key and release. The new mode will display in the upper right hand corner of the display. To switch to the **other group** of modes, hold the MODE key in for five seconds and release. This scheme was designed to help keep inexperienced personnel from inadvertently changing any of the programmed parameters specified during system setup. It is also recommended that Expert Access be used to safeguard the integrity of the data (see section 2.5).

2.3 Mode Descriptions

The mode system on the RC1500 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 RC1500, the mode which is currently active is always displayed in the lower right hand corner of the LCD. Here is a summary of the modes implemented on the RC1500.

MANUAL

POS	POL	SS
1673	50 H	247
GALAXY	6	F MAN

MODE

In manual mode you can:

1. Jog the antenna about the fundamental control axis using the ARROW KEYS
2. Toggle the speed from fast to slow (and vice versa) with the SPEED key.
3. Jog the polarization with the CCW/CW keys.
4. Use the H/V keys to toggle between the preset H and V polarizations of the satellite which was the last target of an AUTO move.

When MANUAL mode is active the following information is displayed on the top row of the LCD: antenna position, polarization position, polarization position code (H or V) and the current signal strength. The signal strength is derived from a receiver or modem automatic gain control (AGC) output or a dedicated beacon receiver.

The bottom row of the LCD displays the satellite name and the antenna speed ('F' for fast, 'S' for slow). While jogging the antenna at slow speed a symbol is displayed to the right of the 'S' banner. The symbols displayed are ... \, |, /, -, \, ., and + and a function of the voltage applied to the drive.

The RC1500 employs a software servo system to maintain a constant rate of slow speed movement. The user specifies a slow speed via the Slow Speed CONFIG mode item. As the antenna moves at slow speed the controller determines the antenna speed by measuring the time interval between successive position pulses. The voltage applied to the drive is adjusted to maintain a constant antenna speed. As the voltage applied to the drive increases the \, |, /, and – symbols appear to rotate clockwise. Similarly, as the voltage ramps down the symbols appear to rotate counter-clockwise. The . symbol is displayed when the minimum voltage is applied to the drive and the + symbol is displayed when the maximum voltage is applied to the drive.

AUTO

POS	POL	SS
SELECT SAT		
GALAXY6		AUT

MODE

This mode allows the user to automatically position the antenna on any satellite that has been programmed into memory via SETUP mode. The list of programmed satellites is reviewed via the SCROLL UP/DOWN keys, and the ENTER key initiates the automatic move. The STOP key will terminate the move. After the automatic move, MANUAL mode will become active.

REMOTE

POS	POL	SS
1673	50 H	247
GALAXY6		REM

MODE

In this mode the controller receives and acts on commands received via the communications port. This mode can only receive control if enabled via the *Remote Enable* CONFIG mode item. The only key which is active is the MODE key, which can be used to switch to a different mode.

SETUP

POS	POL	SS
761	74 H	132
TELSTAR302		F SET

MODE

SETUP mode allows the user to store satellite position 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.

Here is how a satellite is programmed into memory from SETUP mode.

1. The user peaks the antenna up on the desired satellite.
2. The SCROLL keys are used to scroll through a list of satellite names stored in the controller's EPROM memory. Hit the ENTER key to select the satellite name. If the user wishes to assign a name which is not stored in the satellite's EPROM memory, the USER can manually enter the name. See section xx for details.
3. The user is then prompted to specify the jH and V polarization values for the satellite by jogging the polarization to those positions. If the antenna does not employ motorized polarization adjustment the user must still specify the H and V polarization values to the controller. For this case, the 24 VDC Rot Feed CONFIG mode item should be set to No to indicate to the controller that a 3 wire servo type polarization control system is present. A servo polarization device does not provide feedback to the controller. When the controller is configured for servo based polarization control, when specifying the satellite horizontal and vertical polarization positions at the H and V prompts make sure that the polarization position is not at the CW or CCW limit.
4. When the user has entered in all of the requested data, the controller will respond with "DATA ACCEPTED". SETUP mode remains active, user can repeat the procedure with another satellite.

RESET

POS	POL	SS
JAMMED		
A/E-1 :		RST
MODE		

This mode allows the user to examine the error status of the motor drive circuits and reset them if a fault has occurred. The status of the antenna drive is displayed on the top line below the 'POS' banner and the status of the polarization drive is displayed below the 'POL' banner. Polarization errors will only be shown if a rotating feed is present (the 24 vdc Rot Feed CONFIG mode item is set to Yes).

A DRIVE error indicates that the drive circuits detected an over current fault and shut down. 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 indicates backwards movement of the polarization position sense potentiometer. Any antenna drive error condition can be reset by pressing the key designated on the bottom line of the display. Errors are covered in chapter 6.

DELETE

POS	POL	SS
SELECT	SAT	
GALAXY6		DEL
MODE		

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

RE-SYNC

POS	POL	SS
SELECT	SAT	
GALAXY6		FIX
MODE		

The antenna 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 count.

To resynch the antenna, the operator positions the antenna on a known satellite which has previously been stored in the controller's non-volatile memory (preferably a Ku band satellite, since the beamwidth of the antenna is narrower at Ku band than at C band). The user then activates RE-SYNC mode, and uses the SCROLL UP/DOWN keys to select the satellite name with which the antenna is currently aligned. When the ENTER key is hit, the controller's internal antenna position count register is initialized to the position associated with the satellite

selected from non-volatile memory. A single resynch will realign all satellites stored in non-volatile memory.

CONFIG

```

POS    POL    SS
AUTOPOL ENABLE:*
0-NO, 1-yes  CFG
MODE

```

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 various controller options. The following parameters and options are controlled or configured via data entered into the controller from CONFIG mode:

- AutoPol
- Remote communication port parameters
- Slow Speed control parameter
- Polarization control options
- Drive system automatic move parameters

In CONFIG mode, the SCROLL UP/DOWN keys are used to select the parameter to be viewed or modified. Asterisks (‘***’) in data entry field implies that the present value of the CONFIG item is invalid. The CONFIG mode item can be modified using the numeric keypad to key in a new value. For the value to be accepted the entry must be terminated by the hitting ENTER key. The prompt message on the bottom row of the display provides data entry instructions. For some CONFIG mode items, one of the two possible data values is displayed in lower case text. For these items the upper case prompt specifies the default value of the parameter.

LIMITS

```

POS    POL    SS
  705   24   431
7 - SET CCW LIM
MODE

```

This mode allows the user to set the antenna’s logical limits. To set a logical limit the user jogs the antenna to the position of the desired limit and hits the 7 key. The azimuth CCW limit (as seen by an observer above the antenna) is set first. After this limit is set the user is prompted to set the azimuth CW limit. Once the limits are set the antenna cannot be moved (except in LIMITS mode) to a position that is not within the logical limits. In LIMITS mode the controller will not detect an antenna jammed condition. When the first limit is set the antenna position is initialized to 30.

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

2.4 Mode Access

Access to some modes is restricted in some circumstances. Here are the conditions which can restrict access to certain modes:

1. REMOTE mode is only accessible when the *Remote Mode Enable* CONFIG mode item is set to 1. When enabled, REMOTE mode can be activated either via the MODE key or by the receipt of a command on the serial port. Note that most commands received via the serial port may be processed while TRACK mode is active.
2. The expert access system can restrict access to certain modes. The intent is to avoid corruption of the operating parameters by inexperienced personnel. The expert access system is described in the next section.

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 *Expert On* CONFIG mode item. When the flag is set (*Expert On* CONFIG item has a value of 1) the user has access to all controller modes (subject to the state of the Remote Enable CONFIG mode item). When the Expert Access flag is reset (*Expert Access* CONFIG item has a value of 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 flag is reset, the user only has access to the *Autopol Enable*, *Remote Enable*, and *Expert On* 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 On* CONFIG item. This 5 digit code is contained in appendix A of this manual. Note that the Expert Access flag is set whenever the controller's memory is cleared via the *Reset Sys* CONFIG mode item.

2.6 AutoPol

The AutoPol feature slaves the RC1500's polarization control to a digital output derived from a satellite receiver. The RC1500's AutoPol input accessible via connector J1 on the back of the unit. When the controller is operating in MANUAL or REMOTE modes, this input is monitored and the polarization control device is controlled according to a digital level present at this input.

To configure the controller for AutoPol operation, the user must have:

1. a suitable output available on the satellite receiver which is connected properly to the AutoPol input of the RC1500 (AutoPol input and Return connections are required),
2. the polarity of the AutoPol input must be specified (*Autopol Level* CONFIG mode item), and
3. the AutoPol feature must be enabled (*Autopol Enable* CONFIG mode item).

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 installer through the mechanical and electrical installation of the controller as well as initial software setup.

This chapter describes the electrical connectors on the back panel of the controller, cabling requirements, installation of optional polarization control devices, antenna limits, and configuration of the antenna slow speed system.

3.1 Before You Begin

Before installing the unit the installer must ensure that the controller's line voltage setting 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.

The RC1500 can be configured to operate on either 115 VAC or 230 VAC. The AC line input voltage the unit is currently configured for is displayed in a window located in the fuse holder that is built into the IEC power entry module on the back panel of the controller. To change the AC input voltage selection, remove the fuse holder 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. The RC1500 uses a 5 amp slow blow type fuse. Bussman MDA-5 OR Littlefuse type 3AB series 326, p/n 326 005.

When the AC line voltage has been verified, before the controller is interfaced to the antenna 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 RC1500 and be able to use the MODE key to place the controller in any of the modes described in Chapter 2.

After the AC line voltage is verified and the user has become acquainted with controller's user interface the unit may be powered up. When the unit is powered up, it should be verified that the controller goes to LIMITS mode ('LIM' displayed in the lower right hand corner of the LCD). Before the controller is shipped from the factory, the memory is cleared and the controller's logical limits are invalidated. Whenever the unit is powered up and the limits are invalid, the controller automatically places itself in LIMITS mode. Note that there may also be a limits alarm message flashing on the bottom row of the display.

If the unit does not power up in LIMITS mode 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 ('CFG' displayed in the lower right hand corner of the LCD).
2. Use the SCROLL keys to bring up the *Reset Sys* screen. If the *Reset Sys* item does not appear, the Expert Access flag (see section 2.5) may need to be reset.

To inspect the status of the Expert Access flag, use the SCROLL DOWN key (while still in CONFIG mode) to bring up the *Expert On* 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 Sys CONFIG* mode item.

3. At the *Reset Sys* screen enter the same 5 digit code followed by the ENTER key.

3.2 Mechanical and Electrical Installation

Use 4 #10-32 mounting screws (included with the controller) to secure the unit to a standard 19" rack. The controller's back panel is depicted in figure 3.1.

The back panel contains ...

- 1) An IEC AC voltage input module with built-in fuse and line voltage select. Fusing requirements and line voltage selection is described in section 3.1.
- 2) A removable, clamp style, 11 position connector (designated J1) that interfaces to ...
 - a) the antenna actuator position sense lines (antenna position sense connections are described later in this section),
 - b) the analog receiver, modem or beacon receiver analog output voltage that is proportional to antenna received signal strength (interface described in section 4.x),
 - c) the Autopol input (section xx),
 - d) and the Polarotor 3 wire servo polarization control device (section xx). Please refer to section xx even if your system does not support polarization control.

Terminal 1 of connector J1 is labeled.

- 3) A removable, clamp style, 6 position connector (designated J2) to interface to the antenna drive motor. The antenna actuator interface is described in this section. Terminal 1 of connector J2 is labeled.
- 4) A DB-9 female connector (J3) for the SA-Bus compatible remote control interface. Interfacing to the RC1500's remote control connector is described in the appendices.
- 5) Optional – A removable, clamp style, 5 position connector (designated J4) that interfaces to a rotating feed powered by a DC motor that employs a potentiometer for position feedback. This connector will only be present if the RC2KPOL option is installed in the controller. The RC2KPOL option is described in section xx. Terminal 1 of connector J4 is labeled.
- 6) Four potentiometers labeled AGC1 Gain, AGC1 Offset, AGC2 Gain, and AGC2 Offset. The adjustment of these potentiometers is described in section xx.
- 7) A circuit breaker to protect the antenna drive. When a circuit breaker of this type trips, it will protrude from its mounting bezel. To reset a 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.

3.2.1 Antenna Motor Drive

The antenna actuator motor drive is interfaced to the controller via the connector J2, terminals 4 and 6, labeled AZ1 and AZ2, respectively. Do not make any connections to the connector J2 terminals labeled EL1 and EL2.

The conductors that interface the controller to the antenna actuator 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 xx 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 28 and 22 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:

Wire Size → Motor Current ↓	16 AWG	14 AWG	12 AWG	10 AWG
2 amps	600	950	1500	2410
3 amps	340	520	830	1350
4 amps	220	340	550	880
6 amps	90	140	230	340
8 amps	30	40	70	120

Separation (in feet) between controller and antenna which will result in 22 volts being applied to the motors:

Wire Size → Motor Current ↓	16 AWG	14 AWG	12 AWG	10 AWG
2 amps	970	1530	2430	3930
3 amps	580	920	1460	2370
4 amps	400	640	1020	1650

Wire Size → Motor Current ↓	16 AWG	14 AWG	12 AWG	10 AWG
6 amps	220	340	550	880
8 amps	120	190	310	500

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

3.2.2 Position Sense

Shielded cable with a bare drain wire **MUST** be used to minimize noise pickup. The conductors that interface the controller to the sensor are often incorporated into a cable that includes the motor drive conductors. If discreet sensor cable is required, Belden 8772 (consisting of three 20 AWG conductors enclosed in a foil shield with a bare drain wire) can be employed.

Position count errors resulting from improper shielding is the most frequent problem that occurs during the installation of the RC1500. Please observe the following precautions:

- A shielded cable equipped with a bare drain wire must be used to interface the controller to the position sensor.
- The drain wire that provides an electrical connection to the shield must be connected to the J1-6 terminal labeled Sensor AZ -. The Sensor AZ – terminal is at ground potential. The shield must not be allowed to come in contact with earth potential at any other location.
- At the sensor the shield must be left open. A short piece of heat shrink tubing can be employed to insulate a frayed foil shielding from any metal objects at the sensor. If the shield is allowed to come in contact with earth ground at the antenna ground currents could flow in the shield which could induce noise in the sensor input circuitry.
- If the sensor cable is spliced or is routed through a connector, the drain wire should be spliced and not allowed to come in contact with earth ground.
- See the Operation Troubleshooting Tips section of Chapter xx for more information on count problems.

The RC1500 supports two different pulse type position sensor – Hall effect and reed switch. Both types of sensors employ one or more rotating magnets.

For a Hall effect sensor, the magnetic field causes a Hall effect transistor to alternately switch on and off to create the pulse waveform. A Hall effect sensor has three connections to the controller. 5.7 volts DC (J1-11 labeled 5.7V), ground (J1-6 labeled Sensor AZ -), and the pulse output (J1-7 labeled Sensor AZ +). The drain wire must also be connected to the J1-6 terminal labeled Sensor AZ -.

Some Hall effect sensor modules employed by Thomson Saginaw in their actuators employ an unusual color scheme. The red lead is connected to 5.7 VDC, the black lead is the pulse

output (connected to Sensor AZ +), and the green lead is the sensor ground connection which is tied to the Sensor AZ – terminal.

With a reed switch type sensor, the alternating magnetic field causes a mechanical switch to make and break. A reed switch sensor has two connections to the controller: ground and the pulse input. Internally, the pulse input of the controller is tied to 5.7 volts through a pullup resistor. A reed switch sensor is not polarized, either output wire from the reed switch module can be connected to either terminal of the controller. One of the reed switch outputs should be connected to the controller's J1-6 terminal (labeled Sensor AZ –). The other reed switch output should be connected to the controller's J1-7 terminal (labeled Sensor AZ +). The drain wire of the interface cable MUST be connected to the controller's J1-6 terminal (labeled Sensor AZ –).

Some installers feel that Hall effect switches are more reliable because they contain no moving parts. Hall effect sensors, however, are more vulnerable to lightning strikes because of the Hall effect transistor device.

Figures 3.2 and 3.3 detail the connection of an RC1500 to reed switch and Hall effect type sensors, respectively. Under no circumstances should the motor drive current be carried within the same shield as the position sense lines. Note that satellite antenna actuator cable typically includes two unshielded 14 or 16 AWG conductors for motor current and a shielded triple with bare drain wire for the sense lines all enclosed in a common insulating jacket – this type of cable works well with the RC1500.

RC1500 Back Panel

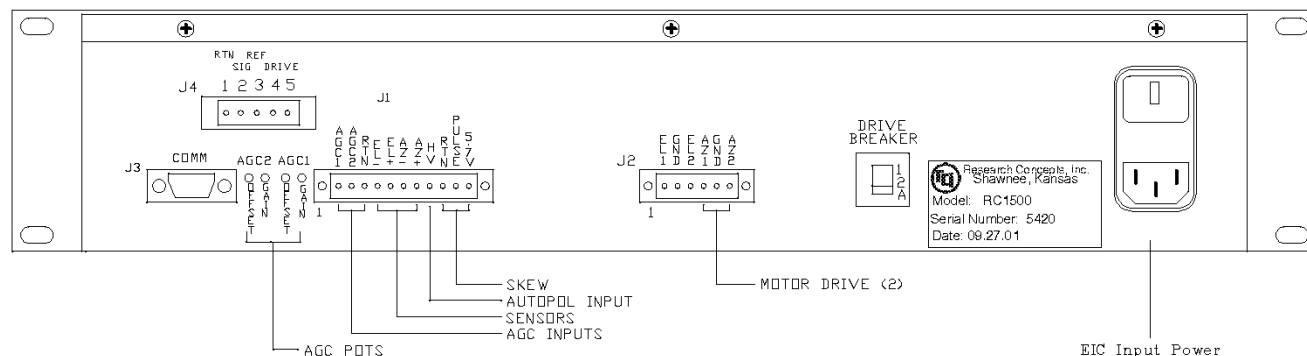


Figure 3.1 RC1500 Back Panel Diagram

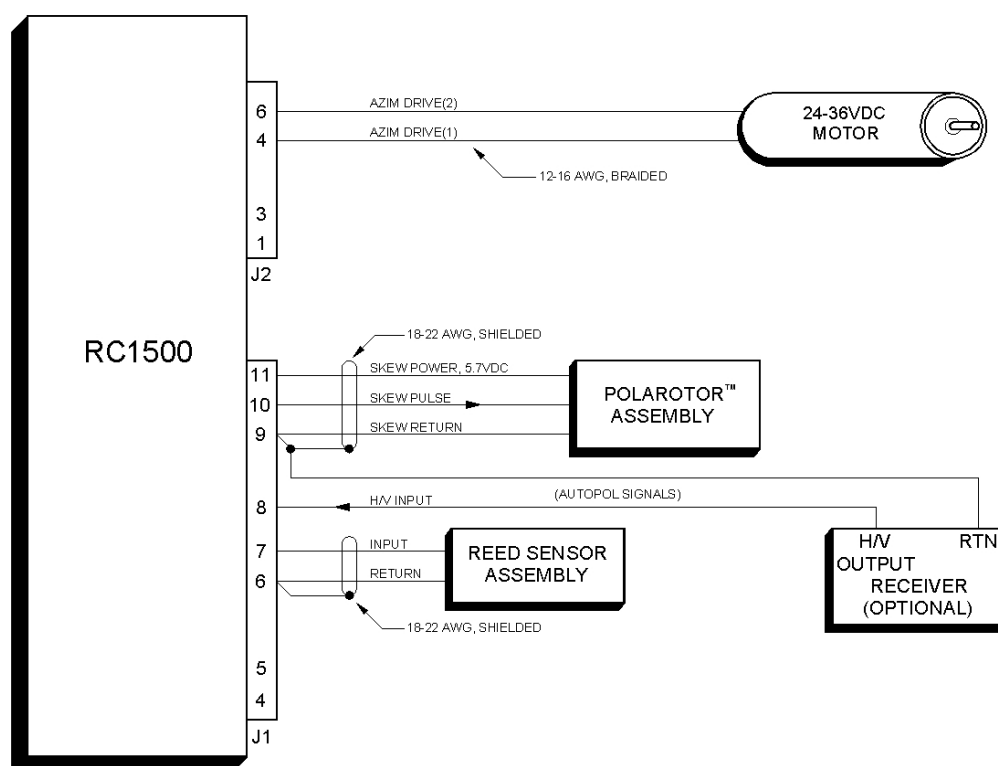


Figure 3.2 Reed Sensor Diagram

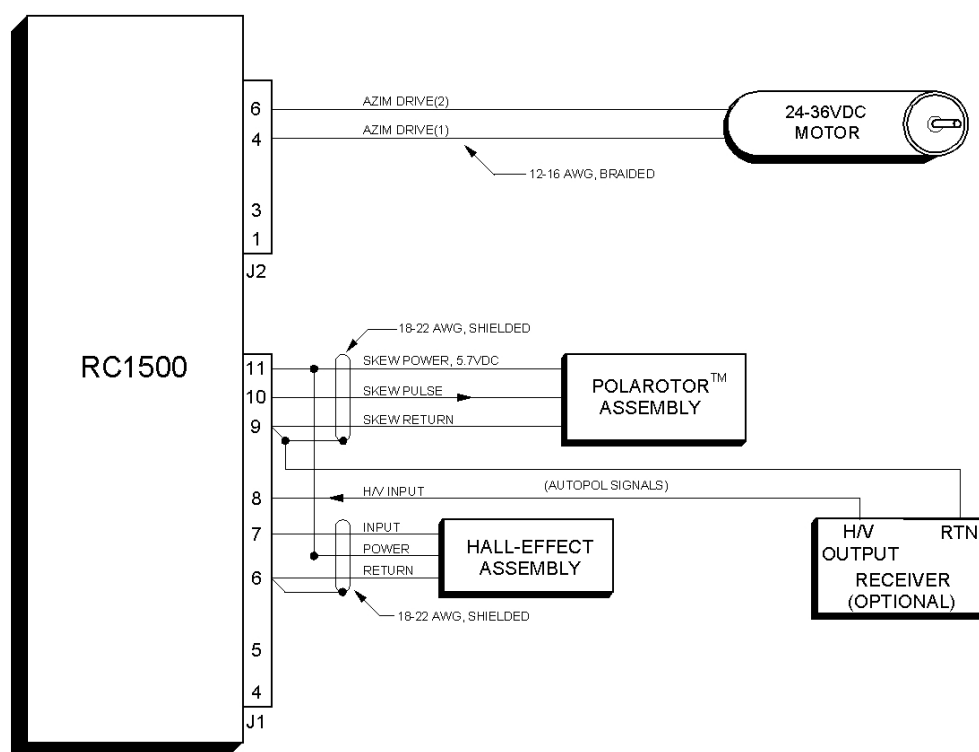


Figure 3.3 Hall Effect Diagram

3.3 Polarization Control

The RC1500 supports two types of polarization control. The standard polarization control device is a Chapparral type Polarotor device. There is an optional polarization control daughterboard (designated RC2KPOL) that interfaces to a rotating feed powered by a DC motor that employs a potentiometer for polarization position sense. The RC2KPOL is often interfaced to rotating feeds made by Seavey Engineering Associates. The RC1500 always assumes that a polarization control device is connected to the system – even if in fact no polarization control device is present at.

3.3.1 Configuring the RC1500 for Use in an Installation that Does Not Employ a Polarization Control Device

When programming satellite's into the controller's non-volatile memory via SETUP mode the user will be prompted to specify the horizontal and vertical positions associated with the satellite. If no polarization control device is present in a given installation the controller must be configured so that it thinks that a Polarotor device is present in the system. This is accomplished by setting the *24 VDC Rot Feed* CONFIG mode item to 0 (No).

This works because the controller controls the Polarotor in an open loop manner. The Polarotor provides no position feedback to the controller so the controller cannot tell if a Polarotor is actually connected to the system or not. Once the controller is configured for Polarotor operation, the installer should insure that the controller does not think that the Polarotor is at a limit. To check for this, go to the MANUAL mode. If the controller thinks that the Polarotor is at a limit "CW" or "CCW" will be displayed in the polarization position field. To correct this condition depress the Pol CW or Pol CCW key to 'position' the polarotor away from the limit.

3.3.2 Configuring the RC1500 for use with a Polarotor

The Polarotor is a 3 wire servo that controls the orientation of probe in the throat of the feed assembly. To configure the RC1500 to control a Polarotor device, set the *24 VDC Rot Feed* CONFIG mode item to 0-No.

The Polarotor was originally developed by Chaparral Communications. Most Polarotor modules use a standard wire coloring convention (outlined in the following table). A shielded cable with a bare drain wire should be used to interface the Polarotor to the controller. The shield is used in a manner identical to that described for the antenna position sense interface in section 3.2.2.

Figures 3.2 and 3.3 show the connection of the Polarotor to the controller. The following table details the interface of a Polarotor to the RC1500 ...

RC2000 Connection	Signal Description	Polarotor Wire Color (typical)
J1-11 labeled 5.7 VDC	DC Power for the Polarotor module.	Red
J1-10 labeled PULSE	Pulse Output to the	White

RC2000 Connection	Signal Description	Polarotor Wire Color (typical)
	Polarotor module.	
J1-9 labeled RTN	DC Power return	Black
J1-9 labeled RTN	Cable Drain Wire	Must be open and isolated from ground at the polarotor.

The Polarotor Pulse output waveform is has an on time that varies from 0.8 to 2.2 milliseconds. Varying the output waveform on time over this range results in approximately 200 degrees of mechanical movement of the polarotor output shaft. The waveform off time is between 15 and 20 msec. Note that the waveform is only present when a polarization skew operating is in progress or immediately after an operation terminates.

3.3.3 Rotating Feed with Potentiometer Position Feedback

With the RC2KPOL option, the RC1500 can control a 24 volt DC rotating feed with potentiometer feedback (400 ma max motor drive current). The RC2KPOL is frequently used to control a Seavey Engineering model 124 ESA rotating feed. The RC2KPOL is a daughter board that is mounted on standoffs above the controller's digital board. If the RC2KPOL is installed a 5 position, removable, clamp style connector will protrude from a rectangular opening in the controller's back panel above the AGC adjustment pots. The connector is labeled J4. If the RC2KPOL daughterboard is not present the rectangular opening will be covered with silver tape. Note that the RC2KPOL daughterboard can optionally be configured at the factory for other output voltages. Contact Research Concepts for more information. If the current rating of the RC2KPOL motor drive outputs is not sufficient for a given application, please contact the factory for other options.

3.3.3.1 Verifying the Potentiometer Center Position

The most common problem experienced during installation of a rotating feed is damage to the potentiometer due to the potentiometer reaching its mechanical limit before the feed reaches its mechanical limit. This problem has occurred quite often with Seavey feeds. Before using a Seavey ESA 124 rotating feed with the RC1500, 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 original pot used with the Seavey feed was a Spectrol model 533 (1K ohm, 3 turn). Later models employ a Contelec PD2205-5K (5k ohm, 5 turn.) To see if the potentiometer is centered properly, the following procedure may be performed on a workbench.

Verifying Pot 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 and Contelec pots this will be terminals 1 and 3.

2. Connect an ohm meter between the wiper of the pot (terminal 2 on the Spectrol or Contelec) 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.)
4. 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".
5. 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 following paragraphs.

Centering the Pot

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 outlined earlier in this section.

3.3.3.2 Connecting the RC1500 to the Rotating Feed

To configure the RC1500 software to work with the RC2KPOL daughterboard, the controller's *24 VDC Rot Feed* CONFIG mode item should be set to 1-Yes.

Figure 3.4 documents the interface of the RC1500 to the rotating feed. Two sets of electrical connections are required to interface an RC1500 equipped with the RC2KPOL option to the rotating feed device. Two conductors are required for the DC motor drive and a shielded triple with bare drain wire is required to interface the potentiometer. The drain wire of the shielded

potentiometer cable should be tied to the daughterboard's Signal Return terminal, J4-1. The treatment of the shield on the potentiometer interface cable is the same as for the antenna position sense lines – see section 3.2.2

The RC2KPOL option can supply around 400 ma to the feed motor. 16 AWG or 18 AWG is usually sufficient for the drive motor connections.

The potentiometer position sense interface wiring carries minimal current – 22 or 20 AWG conductors are typically used to connect the controller to the potentiometer. Belden 8772 is a 3 conductor, shielded cable with a bare drain wire that can be used for the potentiometer interface. Under no circumstances should a 5 conductor shielded cable be used to carry both the motor current and the potentiometer position sense signals.

Figure 3.4 depicts the connection of a rotating feed device with the RC1500. Note that the potentiometer interface cable's drain wire is connected to the Signal Return terminal (1) of connector J4.

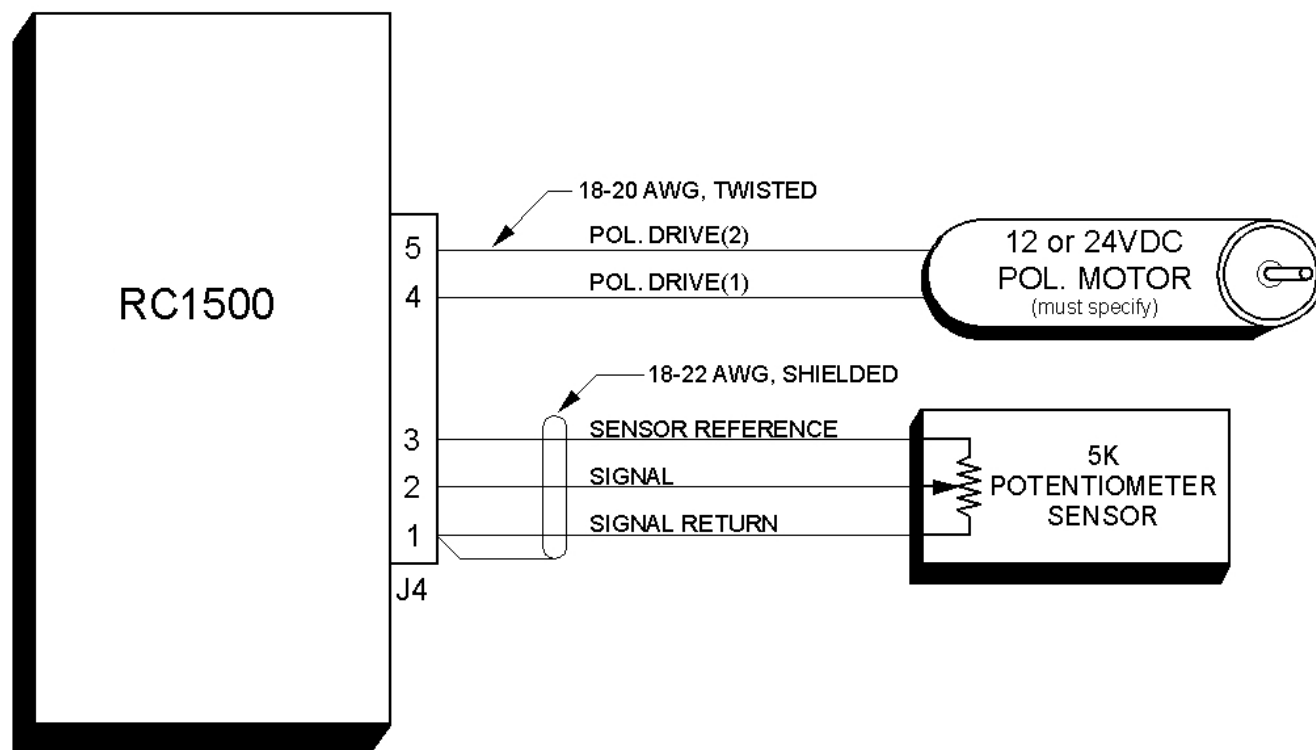


FIGURE 3.4 Rotating Feed Interface (RC2KPOL Option Only)

Use the following procedure to configure the RC2000C for use with a 24V 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.
2. The *24 VDC Rot Feed* CONFIG mode item must be set to YES (1). Activate CONFIG mode and use the SCROLL DOWN key to bring up the *24 VDC Rot Feed* item. Key in a 1 followed by the ENTER key. If the *24 VDC Rot Feed* item is not accessible in CONFIG

mode, the Expert Access flag has been reset. If this occurs, set the Expert Access flag as outlined in section 2.5.

3. In this step the polarity of the polarization motor and sensor wiring is checked.

The sense of polarization movement polarity is somewhat arbitrary. The polarization jog keys are labeled CW and CCW. The polarization drive motor and position sense potentiometer must be configured so that when the polarization is jogged CCW the indicated position count must increase. If the sense of polarization motion is not correct, the installer can either swap the motor DRIVE lines (J4 terminals 4 and 5) or swap the potentiometer reference (REF) and return (RTN) lines (J4 terminals 1 and 3). Note that the shield of the sensor cable must always be connected to the J4 RTN terminal.

To check the polarity of the polarization motor, the rotating feed's logical limits must be set so that unrestricted movement of the feed is possible. To achieve this, the *Feed CW Lim* CONFIG mode item must be set to 0 and the *Feed CCW Lim* CONFIG mode item must be set to 1023.

The polarization motor may be jogged in MANUAL mode. Jog the pol motor and make sure that movement is in the proper direction - position count decreasing for CW movement, and increasing for CCW movement. Note that once the rotating feed limits have been set as described above, there are no limits on polarization movement. The user must be careful to not move the feed past a limit. Damage to the rotating feed, polarization motor, or potentiometer may occur if the limits are exceeded. If the user attempts to jog the polarization motor and no movement is detected on the position sense lines, or movement is detected in the wrong direction, the Antenna Polarization alarm will activate. If a polarization alarm is active, an error message (!! ANT POL) 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.

4. Once the polarity of the motor drive and sense lines have been verified, the pol limits may be set. To set the limits, the pol motor is first jogged (via MANUAL mode) to the positions where it is desired to set the limits. 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. In MANUAL mode, record the polarization position values that correspond to the desired limits. Once the limit locations are recorded, set the limits via the CONFIG mode *Feed CW Lim* and *Feed CCW Lim* items. The *Feed CW Lim* position must be less than that of the *Feed CCW Lim* position.

3.4 Antenna Drive Polarity and Limits

This section describes checking the antenna motor drive polarity and setting the antenna limits. Section 3.4.3 describes setup of a polar antenna mount.

Antenna limits are set via LIMITS mode.

IN LIMITS MODE THE USER HAS UNRESTRICTED MOVEMENT OF THE ANTENNA, THERE ARE NO SOFTWARE 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 antenna motor is connected as outlined in figures 3.2 or 3.3. To check the motor drive polarity, from LIMITS mode, depress the AZ CCW key and verify that the antenna moves counter-clockwise as seen by a user located above the antenna. If the antenna does not move in the proper direction, the wires connected to connector J2, terminals 4 and 6 need to be swapped.

The antenna position sensor operation is checked by jogging the antenna and verifying that the position count changes. Note that the position count will always decrease for AZ CCW movement and increase for AZ CW movement. The count will not decrement lower than 1 or increment higher than 65535.

3.4.2 Setting Antenna Limits

When setting limits, it is recommended that an assistant be stationed at the antenna to ensure that the antenna limits are not exceeded.

To set the limits, invoke LIMITS mode and hit the ENTER key to get past the 'ENTER TO PROCEED' prompt.

The controller will then display '7 – SET CCW' on the bottom row of the LCD to prompt the installer to set the counter-clockwise (CCW) limit (as seen by an observer above the antenna). Use the AZ CCW and AZ CW jog keys to position the antenna at the desired CCW limit. Hit the 7 key to set the limit.

The controller will next display '7 – SET CW' to prompt the user to set the clockwise (CW) limit. Use the AZ CCW and AZ CW jog keys to position the antenna at the desired CW limit. Hit the 7 key to set the limit.

After the CW limit is set CONFIG mode is activated. If the user exits LIMITS mode by hitting the MODE key the limits that existed prior to LIMITS mode becoming active remain intact.

If the controller is powered down while LIMITS mode is active the controller's limits are invalidated. When the controller powers back up the limits alarm will be active ('!! AZ/EL LIMITS' will flash on the bottom row of the LCD).

3.4.3 Polar Mount Adjustment

The RC1500 is used with polar mounts. With a polar mount, a single linear actuator can position the antenna over the entire arc of geostationary satellites. Figure 3.5 is a drawing of a Polar mount showing all possible adjustments.

The Polar Angle (also commonly referred to as the Hour Angle) is controlled by the extension/retraction of the linear actuator.

The Latitude Angle (sometimes referred to as the Elevation Angle) is set approximately to the value of the antenna's latitude. The exact angle value of the Latitude Angle is equal to ...

ANTENNA LATITUDE + DELTA ... where DELTA is a small angle that varies with antenna latitude. Table 3.3 xx provides values for DELTA as a function of antenna latitude. The Latitude Angle is often adjusted with a threaded rod.

The Declination Angle is a function of antenna latitude. Table 3.3 xx provides values of the Declination Angle as a function of antenna latitude. Many mounts provide a precise adjustment of Declination Angle

East – West Bearing Angle adjustment is typically accomplished by rotating the mount's 'mounting base' or 'can' about the pipe or kingpost the antenna is mounted on.

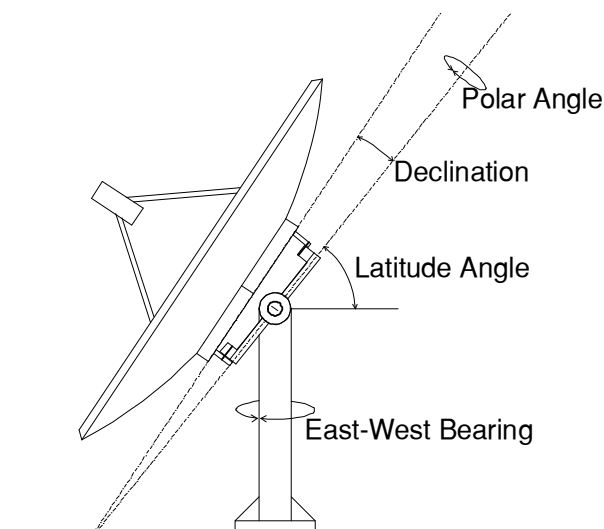


Figure 3.5 POLAR MOUNT GEOMETRY

Table 3.3 Polar Mount Latitude and Declination Angles

Antenna Latitude (degrees)	Delta Angle (degrees)	Latitude Angle (degrees)	Declination (degrees)
5	0.11	5.1	0.76
10	0.24	10.2	1.51
15	0.35	15.3	2.26
20	0.44	20.4	2.98
25	0.53	25.5	3.68
30	0.60	30.6	4.34
35	0.65	35.6	4.97
40	0.68	40.7	5.56
45	0.69	45.7	6.11

Antenna Latitude (degrees)	Delta Angle (degrees)	Latitude Angle (degrees)	Declination (degrees)
50	0.68	50.7	6.61
55	0.65	55.6	7.05
60	0.60	60.6	7.45
65	0.53	65.5	7.78
70	0.44	70.4	8.06
75	0.35	75.3	8.28

Table 3.4 Polar Mount Latitude and Declination Angles

Antenna Location (Hemisphere)	Satellite Location Relative to Antenna	East West Bearing Angle Adjustment	
		Pushing Down on the Lower Edge of Reflector Makes Received Signal Stronger?	Lifting Up on the Lower Edge of the Antenna Makes Received Signal Stronger
Northern	East	ROTATE WEST	ROTATE EAST
Northern	West	ROTATE EAST	ROTATE WEST
Southern	East	ROTATE WEST	ROTATE EAST
Southern	West	ROTATE EAST	ROTATE WEST

Polar Mount Adjustment

Adjusting a polar mount to track the geostationary satellite arc can be challenging.

We use the following procedure to setup a polarm mount.

1. Insure that the antenna kingpost or mounting pole is vertical.
2. Set the mount's declination angle to the value specified in the table given the antenna latitude.
3. Set the latitude angle to the value specified in table 3.3 xx.
4. In steps that follow, the antenna is aligned with geostationary satellites and the antenna Latitude and East-West Bearing angles are adjusted. If the antenna can receive signals

from both Ku and C band satellites, use Ku band satellites for making the adjustments as the antenna beamwidth will be narrower at Ku band.

5. Find a satellite that is at approximately the same longitude as the antenna. Motor the antenna so that the antenna is at its highest elevation angle. This should be somewhere near the center of travel about the polar axis. Vary the antenna's East-West Bearing and Latitude angle to peak up the received signal strength.
6. Find a satellite to the east or west of the antenna longitude. Motor the antenna to peak up signal strength. Push up or down on the lower edge of the reflector. Note whether a push up or down increases signal strength. Use table 3.4 to adjust the East-West Bearing angle.
7. Go back to the satellite found in step 5. Push the reflector up or down. If the pushing the reflector up increases signal strength decrease the mount's Latitude angle. If pushing the reflector down increases signal strength increase the mount's Latitude angle.
8. Repeat steps 6 and 7 a number of times. For step 5, try to use satellites to both the east and the west of the antenna location. As the adjustments become smaller, choose satellites located farther to the east or west relative to the antenna longitude.
9. After steps 6 and 8 have been repeated a number of times, the mount should track the geostationary arc if the declination angle is correct. If the antenna is tracking 'above' the arc when looking at satellites to BOTH the east AND west the declination angle may have to be increased. If the antenna is tracking 'below' the arc when looking at satellites to the east and west the declination angle may have to be reduced. If the declination angle is changed the latitude angle will have to be adjusted again as outlined in step 7

3.5 Slow Speed Adjustment

The Adapti-Drive slow speed control system allows the user to specify a desired rate of slow speed movement. When the antenna is moving at slow speed the controller will vary the voltage applied to the motor to maintain the desired slow speed. Other dual speed drive systems in use reduce the voltage to the drive to a constant value whenever slow speed movement occurs. This results in poor speed regulation as the load on the motor varies.

For the RC1500 the user sets the slow speed by entering a slow speed code via the *Slow Speed* CONFIG mode prompt. This section outlines the procedure for selecting the appropriate slow speed code. When the system memory is reset the slow speed code is initialized to 254 (maximum). If the speed code for a given axis is set to 254, the slow speed system is disabled, and full voltage is applied to the axis whenever slow speed is selected.

When slow speed movement occurs, the RC2000C determines the speed at which the actuator is moving by measuring the rate at which position feedback pulses are received. 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 or SETUP mode) an indication of the voltage delivered to the drive is displayed to the right of the 'SLOW' banner. 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. 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.

Use the following procedure to determine the slow speed code,. For 36 volt DC linear actuators, slow speed codes of 140 to 180 are common.

1. In MANUAL mode jog the antenna at FAST speed for exactly 10 seconds and record the number of counts which occur. Make sure that the antenna does not reach a limit during the move.
2. Use the following table to determine an initial setting for the speed code.

Position Counts	Speed Code	Position Counts	Speed Code
60	80	300	165
70	90	350	170
80	100	415	175
95	110	525	180
120	120	715	185
145	130	1100	190
170	140	1325	195
200	150	1450	200
250	160		

3. Go to CONFIG mode and use the SCROLL keys to bring up the *Slow Speed* item. Key in the new speed code followed by the ENTER key.
4. Go to MANUAL mode, toggle the speed to SLOW, and jog the antenna. Continue jogging the antenna until the voltage code displayed to the right of the SLOW banner settles to a steady state range of values. This may take 5 to 10 seconds. If a limit is reached, jog the antenna in the opposite direction. 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 by 3 to 5 counts. Increasing the speed code results in a faster rate of slow speed movement. Repeat steps 3 and 4 until satisfactory slow speed movement is attained.

3.6 Signal Strength Display

The RC1500 displays signal strength information in Manual (MAN), Remote (REM), Setup (SET), and Limit (LIM) modes on the far righthand side of the top row of the LCD. The signal strength display is derived from an analog input voltage (0 to 10 volts maximum) that varies with received signal strength. This section describes calibration and display of the analog input voltage. Note that the display of signal strength information does not affect the operation of the controller.

An analog voltage that varies with received signal strength is generated somewhere within every satellite receiver or modem. This voltage is sometimes 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. The two channels are referred to as AGC1 and AGC2. 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.

The RC1500's *AGC Polarity* CONFIG mode item also influences the display of received signal strength information. The *AGC Polarity* 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.

Signal strength information is displayed as a value between 0 and 999 at the far right of the top row of the LCD. '***' will be displayed if the input channel is saturated. In Remote, Setup, and Limit modes the controller displays the stronger of the two AGC inputs (adjusted for the *AGC Polarity* flag).

In Manual mode, for software versions 1.5x and later, the user can hit the Scroll Up and Scroll Down keys to display either AGC1, AGC2, or the stronger of the two AGC1 and AGC2. When the stronger of the two inputs is displayed a blank character (' ') will be present to the left of the signal strength display field. Similarly, a '.' character will be present when AGC1 is displayed and a ':' will be present when AGC2 is displayed.

3.6.1 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. At the conclusion of the adjustment procedure, the displayed signal strength will vary from 50 to 100 Off Satellite to around 650 On Satellite. 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 3.6.1.2.

3.6.1.1 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. 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.

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* 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 counterclockwise. Proceed to step 6.

For versions of the software (v1.4x and earlier) that do not support use of the Scroll Up/Down keys to display AGC1 or AGC2, rotate the OFFSET pot clockwise 20 turns or until a faint click is audible. Similarly, rotate the SCALE pot counterclockwise 20 turns or until a faint click is audible.

- 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 counterclockwise and the SCALE pot clockwise. When this is accomplished proceed to step 6.

For versions of the software (v1.4x and earlier) that do not support use of the Scroll Up/Down keys to display AGC1 or AGC2, rotate the OFFSET pot counterclockwise 20

turns or until a faint click is audible. Similarly, rotate the SCALE pot clockwise 20 turns or until a faint click is audible.

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. For versions of the software that do not support use of the Scroll Up/Down keys to display AGC1 or AGC2 (version 1.4x and earlier), if the receivers have POSITIVE AGC characteristics, one of the receivers can be switched off to insure that displayed signal strength information is from the correct receiver.

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.

3.6.1.2 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 for 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.

The following procedure describes AGC1 and AGC2 potentiometer adjustment for a dual band installation.

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.

3.7 Programming Geostationary Satellites

After the limits have been set and the slow speed code determined, geostationary satellites can be programmed into the controller's memory.

All satellites are programmed into memory via Setup (SET) 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 (horizontal) and V (vertical) polarization values. This information is retained in the controller's non-volatile memory. After a satellite has been stored in the controller's non-volatile memory via Setup mode, the user can automatically position the antenna the satellite by invoking the controller's Auto (AUT) mode. In Auto mode, the Scroll Up/Down keys are used to select a satellite. When the Enter key is depressed the controller will move to the selected satellite.

Setup mode is straightforward. When Setup mode is first invoked, the antenna jog keys and Scroll Up/Down keys are active. The jog keys are used to align the antenna with the satellite the user operator wishes to program into the controller's non-volatile memory. The Scroll Up/Down keys allow the operator to select a satellite name to assign to the entry. The controller maintains a list of satellites in its EPROM memory. The operator can select from one of these satellite names or can select the USER entry from the list to key in another name for the satellite.

When the Enter key is depressed, the polarization jog keys are active and the operator is prompted to set the horizontal and vertical polarization.

To set the horizontal polarization, the operator should tune the receiver to a vertically polarized transponder and use the Pol CW and Pol CCW keys to null out, or minimize, received signal strength. The H key is depressed to store the polarization. When the horizontal polarization is stored, the controller will briefly display H POL SET on the bottom row of the LCD.

Vertical polarization is set in a similar manner by tuning to a horizontal transponder and nulling the received signal.

The polarizations can be set in any order. BOTH polarizations must be set. The polarization position must not be at a limit (as indicated by the display of 'CC' or 'CW' in the polarization position field on the controller's LCD) when the H or V keys are hit.

If the antenna is not equipped with a polarization control device see section 3.3.1. When a polarization control device is not present, the RC1500 must be configured for operation with a Polarotor type servo polarization control device (by setting the *24 vdc Rot Feed* CONFIG Mode item to 0 - Polarotor type servo) and 'CC' or 'CW' must not be displayed in the polarization position field.

It is recommended that the user first program a pair of satellites into the controller's memory. Then use the Auto (AUT) mode to repeatedly position the antenna on one satellite and then the other. This will exercise the controller, actuator, 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. When operation of the system has been verified by testing with a pair of satellites, additional satellites may be programmed into the controller's memory.

3.8 AutoPol

This section describes the hardware and software configuration required to use the AutoPol feature.

When the AutoPol function is enabled and Manual (MAN) or Remote (REM) modes are active, the antenna polarization is controlled via a digital input to the controller. The input is typically generated by a contact closure or digital output from a satellite receiver. AutoPol is enabled via the *AutoPol Enable* CONFIG mode prompt. The *AutoPol VLevel* CONFIG mode item determines if a high level digital input corresponds to vertical or horizontal polarization.

The AutoPol input on the controller has an internal pull-up resistor. This implies 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

(also referred to as 'return') 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. When the relay is deactivated, the relay contacts open and the AutoPol input floats high due to the controller's internal pull-up resistor.

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 RC2000C. 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/Down keys to bring up the *AutoPol Enable* prompt. Key in 1 followed by the Enter key.
4. After the *AutoPol Enable* item is configured, the user will be prompted to enter the *AutoPol VLevel* Config item. If a high level output from the receiver 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. When the AutoPol feature is enabled, in Manual mode, an 'a' is displayed in the third character position after the polarization position field (this will be the twelfth character from the left on the top row of the LCD). When AutoPol is disabled, the field will be blank.

3.9 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 sticker over the power entry module.
2. Make sure that the memory has been cleared. The controller should come up in LIMITS mode.
3. Make the required electrical connections. Shielded cable must be used for the position sensors and the shields must be connected at the back of the controller and NOT at the antenna. If the sensor cable is spliced, the drain wire must also be spliced and must not be allowed to come in contact with ground. Refer to figures 3.1, 3.2, and 3.3.
4. If the RC2KPOL option (which allows the RC1500 to interface to a 24 volt DC polarization control motor) is installed, 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 antenna motor drive polarity. Set the antenna limits.

6. Configure the *Slow Speed* Config mode item. See section 3.5 for setting the slow speed. For a standard 36 volt DC linear actuator with 30 to 40 pulses per inch, a slow speed value code of 140 to 180 is generally appropriate.
7. OPTIONAL – If an analog voltage (somewhere in the range of 0 to 10 volts) that varies with received signal strength is available, configure the AGC channel 1 and/or AGC channel 2 Offset and Gain pots to display received signal strength.
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.

Chapter 4 – Controller Operational and Programming Modes

The controller's current mode is displayed in the lower right hand corner of the LCD. Each of the controller's modes are members of either the Operational mode group or the Programming mode group. Operational modes are the ones used in everyday operation. Programming modes are used to setup and configure the controller.

The Operational Mode Group consists of three modes: MAN (Manual), AUT (Auto), and REM (Remote). Programming Mode Group consists of the following modes: LIM (Limits), SET (Setup), RST (Reset), DEL (Delete), FIX (used for pulse sensor resync), and CFG (Config).

To toggle between the Operational and Programming modes, depress the Mode key for at least five seconds and release. Rapidly depressing and releasing the Mode key will activate the next mode in the current mode group.

4.1 MANUAL Mode

POS	POL	SS
9134	220	Va 210
AMC 8		F MAN
		MODE

Manual mode allows the user to manually jog the antenna position and polarization using Az CCW, Az CW and Pol CW/CCW keys. Note that the Down key has the same effect as the Az CCW key and the Up key has the same effect as the Az CW key.

Depressing the Speed key will toggle between Fast and Slow antenna movement. Section 3.5 describes configuration of the controller's slow speed system.

The POS field displays the current antenna position. The POL field shows the current polarity position. If the antenna or polarization is at a limit, CC or CW (for CounterClockwise and ClockWise) will be displayed in the POL and POS fields.

The H and V keys will select the preset horizontal and vertical polarizations of the satellite that was last a target of the auto-move system. Note that polarization control is available only when the AutoPol feature is disabled. When AutoPol is enabled, the MANUAL mode display will change the character after the polarization position to 'a'. The AutoPol system is described in section 3.8.

The SS (Signal Strength) field displays relative received signal levels derived from a pair of analog voltages input to the controller via the AGC1 and AGC2 terminals on the controller's J1 rear panel connector. The analog voltages must lie somewhere in the range of 0 to 10 volts. Each of the input channels has gain and offset potentiometers that can be adjusted via openings in the controller's back panel. Section 3.6 describes the potentiometer adjustment procedure.

The Scroll Up and Scroll Down keys determine what is displayed in the SS field (support for the Scroll Up/Down keys was added with version 1.5x of the software). When Manual mode is first invoked, the signal level of the AGC channel with the greatest signal strength will be

displayed. Depressing the Scroll Up and/or Scroll Down keys will cycle between the display of AGC1, AGC2, and the greater of AGC1 or AGC2.

When the greater of the two AGC inputs is displayed a blank character (' ') will be present to the left of the signal strength display field. Similarly, a ' ' character will be present when AGC1 is displayed and a ':' will be present when AGC2 is displayed.

When the antenna is in the vicinity of a satellite which was the target of the last Auto Move operation, that satellite name will be displayed. Similarly, when the current polarization setting is in the vicinity of the preset horizontal or vertical polarizations of the satellite which was the target of the last Auto Move operation, either 'H', 'h', 'V', or 'v' will be displayed. The capital letters will be displayed if the satellite name is displayed, and the lower case letters if the satellite name is not displayed. If there is no polarization indication, it means that the antenna's current polarization setting is somewhere between the preset polarization values.

4.2 AUTO Mode

```

POS    POL    SS
SELECT SAT
AMC 8      AUT
                MODE

```

Satellites that have been stored in the controller's non-volatile memory (via Setup mode) can be recalled via Auto mode. Antenna position and horizontal/vertical presets for up to 50 satellites (38 satellites for software versions prior to v1.5x) may be stored in non-volatile memory.

If no satellites have been programmed into the controller's non-volatile memory the controller will display the following message ...

```

POS    POL    SS
NO DATA PRESENT
MODE TO EXIT AUT
                MODE

```

Here is the procedure for recalling a satellite ...

1. Invoke Auto Mode - Toggle the **Mode** key to enter Auto mode. Section 2.2 describes **Mode** key operation.
2. Select Satellite - Use the **Scroll Up** and/or **Scroll Down** keys to scroll through the satellites stored in non-volatile memory. Hit the **Enter** key to select the desired satellite. If AutoPol is enabled (AutoPol is described in section 3.8) the antenna will begin moving to the satellite. If AutoPol is disabled the user is prompted to select horizontal or vertical polarization.

```

POS    POL    SS
SELECT SAT
AMC 8      AUT
                MODE

```

When the **Enter** key is hit, the controller checks the validity of the data associated with the selected satellite. If the antenna position or polarization data associated with the entry is

outside of the current limits for each of those axis, the antenna will display an INVALID DATA prompt. See section 5.2.1 for more information.

3. Select Polarization – If AutoPol is disabled, the user will be prompted to select a polarization

```

POS    POL    SS
SELECT POL H/V:
AMC 8          AUT
                MODE

```

4. Automatic Movement – The controller will first position the antenna and then adjust polarization. When the antenna is moving the antenna position will be displayed.

```

POS    POL    SS
9134 220      210
AMC 8          AUT
                MODE

```

During an automatic move, antenna movement can be stopped at any time by pressing the **Stop** key. The antenna movement will be controlled by the Config mode items outlined in section 5.9.7 xx – *Auto Move Config, Fast/Slow Threshold, Retry Attempts, Fast Deadband, Slow Deadband, Coast Threshold, and Max Position Error.*

When the automatic move is complete, control will transfer to Manual mode.

Note At power down, the Polarotor probe may slightly shift position. At power up, the RC1500 will position the polarotor probe at the last commanded Polarotor position. When the RC1500 is interfaced to a Polarotor the controller should be left on.

4.2.1 Invalid Data

In step 2 of the procedure outlined above, the user selects the satellite that will be the target of the automatic move. When a satellite is selected, the controller checks the validity of the data associated with the satellite. If the antenna position or polarization data associated with the entry is outside of the current limits for each of those axis, the antenna will display the following message ...

```

POS    POL    SS
ENTER TO PROCEED
INVALID DATA AUT
                MODE

```

Here are the most likely events that lead to the Invalid Data message.

1. The user programs a satellite into the controller's non-volatile memory and later changes the antenna or polarization limits (the Polarotor has fixed limits that cannot be adjusted by the user).
2. The antenna or polarization position was at or past the limit associated with either of these axis when the satellite was originally programmed into the controller's non-volatile memory.

Make sure that CC or CW is not displayed in the antenna position (POS) or polarization position (POL) fields.

3. The *24 VDC Rot Feed* Config mode item was toggled after the satellite was programmed into the controller's non-volatile memory. Setting the *24 VDC Rot Feed* Config item to zero (0) configures the controller to interface to a Polarotor type polarization control device. Setting the *24 VDC Rot Feed* item to one (1) configures the controller to interface to a rotating feed (requires the RC2KPOL daughterboard).

4.3 REMOTE Mode

POS	POL	SS
9134	220	210
AMC 8		REM
MODE		

If Remote mode is active the controller only responds to commands received via the built-in RS-422 serial port. Remote mode can only become active if the *Remote Enable* Config mode item is enabled. If Remote mode is enabled, it can become active either in response to the user hitting the **Mode** key, or in receipt of a valid command from the PC. The RS-422 comm protocol and interface specifications are found in Appendix D. The RC1500 command set is found in Appendix E.

The Remote mode screen is similar to the MANUAL mode screen. The only difference is that the speed, "F" or "S", is not displayed. Only the **Mode** key is active when Remote mode is active.

4.4 LIMITS Mode

Limits mode allows the user to set the software limits. If the controller powers up and the limits are corrupt, LIMITS mode is automatically invoked. An error message ('!! ANT LIMITS') will flash on the bottom row of the LCD when the limits are corrupt.

When Limits mode is active, there are not software-imposed restrictions on antenna movement. Depressing the AZ CCW or AZ CW keys will apply voltage to the antenna motor (unless the controller's thermal circuit breaker or electronic overcurrent sensing circuit have tripped). The controller's software based jammed sensing system is disabled when Limits mode is active. This allows the installer to energize the motors before the antenna position sensor is interfaced to the controller.

If the antenna is equipped with mechanical limit switches, it is recommended that the user set the mechanical limits before setting the software limits. **It may be necessary to recruit a helper to insure that the antenna is not allowed to strike any objects while it is being moved.**

Before setting limits, the installer must insure that the antenna motor drive polarity is correct. See section 3.4.1. Note that polarization movement is allowed while Limits mode is active, polarization position/limit information is also displayed.

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

Here is the procedure for setting the limits.

1. Activate Limits Mode - Go to LIMITS mode. Section 2.2 describes **Mode** key operation. Hit the ENTER key to advance beyond the prompt message. The user will then be prompted with the following display.

```

POS    POL    SS
 9134  220    210
7 - SET CCW  LIM
                MODE
  
```

2. Position Antenna at the CCW Limit - Use the **Az CCW** and **Az CW** keys to position the controller at the desired CCW limit.

3. Set the CCW Limit – Hit the **7** key to set the CCW limit. When the limit is set the controller will initialize the position count to 30 and prompt the user with the following screen ...

```

POS    POL    SS
   30  220    210
7 - SET CW   LIM
                MODE
  
```

4. Position Antenna at the CW Limit - Use the **Az CCW** and **Az CW** keys to position the controller at the desired CW limit.

5. Set the CW Limit – Hit the **7** key to set the CW limit. When the limit is set the controller will transfer control to Config mode.

```

POS    POL    SS
   30  220    210
7 - SET CW   LIM
                MODE
  
```

Note that if Limits mode is terminated by hitting the **Mode** key before both limits are set, the limits which existed prior to this entry will be restored. If the unit powers down while LIMITS mode is active, the limit information will be corrupt when the unit powers up.

4.5 SETUP Mode

Setup mode allows a user to store a satellite name, position, and horizontal and vertical polarization presets into the controller's non-volatile memory. Once a satellite has been stored in non-volatile memory, it may be recalled via Auto mode. Up to 50 satellites may be stored in non-volatile memory (versions of the RC1500 prior to v1.5x supported 38 satellites).

Here is the procedure for using Setup mode to store satellites into the controller's memory.

1. When Setup mode is invoked the user is presented with the following prompt ...

POS	POL	SS
ENTER TO PROCEED		
MODE TO EXIT SET		
MODE		

2. After the **ENTER** key is hit, the user is presented with the following display ...

POS	POL	SS
913	220	210
SAT NAME		SET
MODE		

In this step the user peaks the antenna on the satellite that will be stored in memory using the **Az CCW**, **Az CW**, and **Speed** keys. The **Scroll Up** and **Scroll Down** keys are used to select the satellite name to assign to the non-volatile memory entry.

When the antenna is aligned with the desired satellite and the satellite name displayed, the **Enter** key is hit to proceed to the next step in the procedure.

When the user is peaking the antenna, the **Pol CW**, **Pol CCW**, **H**, and **V** keys. The **H** or **V** keys will select the horizontal or vertical polarization of the last satellite that was either programmed into memory via Setup mode or recalled via Auto mode.

The **Scroll Up** and **Scroll Down** keys scroll through a list of satellite names stored in the controller's EPROM memory. If the desired satellite name is not listed, the USER entry allows to user to specify a 10 character alphanumeric name to assign to the satellite. See section 4.5.1 for information on how to enter a user defined satellite name.

3. If the satellite name selected in step 3 is already stored in non-volatile memory, the user is presented with the following screen ...

POS	POL	SS
DUPLICATE ENTRY		
REPLACE Y/N: SET		
MODE		

The user responds to this by either hitting the **Yes** or **No** keys. If the **No** key is hit, the user is prompted with the 'ENTER TO PROCEED' message (step 1 of this procedure). If the **Yes** key is hit, the existing satellite entry will be replaced.

4. The user is next prompted to specify the horizontal and vertical polarization settings associated with the satellite. At this screen, the **Pol CW** and **Pol CCW** keys may be used to adjust the polarization and the H and V keys may be used to set each polarization.

POS	POL	SS
ADJST	50	
POL,	SET H/V	SET
MODE		

To set the horizontal polarization, the operator should tune the receiver to a vertically polarized transponder and use the **Pol CW** and **Pol CCW** keys to null out, or minimize, received signal strength. The **H** key is depressed to store the polarization. When the horizontal polarization is stored, the controller will briefly display H POL SET on the bottom row of the LCD.

Vertical polarization is set in a similar manner by tuning to a horizontal transponder and nulling the received signal.

The polarizations can be set in any order. BOTH polarizations must be set. The polarization position must not be at a limit (as indicated by the display of 'CC' or 'CW' in the polarization position field on the controller's LCD) when the **H** or **V** keys are hit.

If the antenna is not equipped with a polarization control device see section 3.3.1. When a polarization control device is not present, the RC1500 must be configured for operation with a Polarotor type servo polarization control device (by setting the *24 vdc Rot Feed* CONFIG Mode item to 0 - Polarotor type servo) and 'CC' or 'CW' must not be displayed in the polarization position field.

5. When both horizontal and vertical polarizations have been set, the controller will briefly display the following message ...

POS	POL	SS
DATA	ACCEPTED	
		SET
MODE		

After the message is displayed, control transfers to the initial Setup mode screen (the 'ENTER TO PROCEED' message described in step 1 of this procedure).

If the satellite just entered was not an inclined orbit satellite, after the 'DATA ACCEPTED' message appears the controller remains in SETUP mode. Control transfers to the initial screen, and the process can be repeated.

Note that the **Mode** key may be pressed at any time to exit Setup mode. If the **Mode** key is hit before the 'DATA ACCEPTED' message has not been displayed, nothing is stored in the controller's non-volatile memory.

4.5.1 User-Defined Satellite Names

If the desired satellite name is not available via the the **Scroll Up** and **Scroll Down** keys when the user is peaking the antenna on the satellite to be programmed into non-volatile memory, a user defined satellite name can be specified.

To assign a name to the satellite data entry that is not in the list maintained in the controller's EPROM, use the **Scroll Up** and **Scroll Down** keys to select the USER entry.

POS	POL	SS
913	220	210
USER		SET

MODE

When the **Enter** key is hit, the controller will display the following screen ...

POS	POL	SS
KEY IN	SAT	NAME
*		SET

MODE

Note that the cursor is displayed under the '*' character. The **Scroll Up** and **Scroll Down** keys allow the user to select alphanumeric characters (A-Z, 0-9, hyphen (-), and space). During alphanumeric data entry, the **Enter** key has two functions. If the **Enter** key is depressed while the '*' character IS displayed, the alphanumeric data entry session is terminated. If the **Enter** key is depressed when the '*' character IS NOT displayed, the cursor will advance to the right and the user is be prompted with '*' to enter the next character in the string. Note that the **BKSP** key will delete characters which have been entered and shift the cursor to the left.

4.6 RESET Mode

Reset mode displays antenna and polarization fault conditions. These fault conditions can also be reset from this mode (the fault conditions reported in this mode disable movement about the affected axis).

When Reset mode is activated, one of the following screens will be displayed (if no fault conditions exist).

POS	POL	SS
OK		
ANT-1 : _		RST

MODE

POS	POL	SS
OK	OK	
ANT-1 , PL-2 : _		RST

MODE

The first screen will be displayed if the controller is configured for a Polarotor (24 VDC Rot Feed Config item set to zero). The second screen will be displayed if the controller is configured for a rotating feed (24 VDC Rot Feed item set to one).

The fault status of each axis is displayed on the top line of the LCD below the appropriate banner (POS or POL). Use the **1** key to reset the antenna axis and the **2** key to reset the polarization axis.

Here are the status messages that may be displayed:

OK

Indicates that no fault conditions are active for the axis (antenna 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 (antenna or polarization).

RUNAWAY

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

DRIVE

The axis was deactivated due to an overcurrent condition (antenna and RC2KHPP polarization option).

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 antenna and high power polarization (RC2KHPP only - not the RC2KPOL option) axis are also protected from over-currents by a circuit breaker located on the back panel of the controller. If the circuit breaker opens, the controller will report a JAMMED condition.

4.7 DELETE Mode

POS	POL	SS
SELECT	SATELLITE	
GALAXY 6	DEL	
MODE		

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 following message for a few seconds and return to the active Delete mode screen.

```

POS    POL    SS
DATA DELETED
                        DEL
                        MODE

```

4.8 FIX Mode

```

POS    POL    SS
SELECT SATELLITE
GALAXY 6      FIX
                        MODE

```

The FIX feature allows the position of a satellite stored in non-volatile memory to be loaded into the controller's current position counter. This feature is useful if a faulty position sensor or a noise impulse results in an errant position count.

1. While in MANUAL mode, jog the antenna to a satellite whose location was previously stored in memory. Use a Ku band satellite if the antenna can receive both C and Ku band.
2. Proceed to FIX 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 following message for a few seconds and proceed to manual mode.

```

POS    POL    SS
POSITION FIX
ACCOMPLISHED
                        MODE

```

5. With an assistant out at the antenna, validate the accuracy of the limits by moving the antenna to both limit positions.

4.9 CONFIG Mode

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 keys may be used to select various items for either viewing or modification. The BKSP (backspace) key is active. To change the value of a parameter, the user can simply key in a new value and press ENTER for the change to take effect and update the parameter's value in the controller's non-volatile memory. 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 pressed 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*, *Remote Enable*, and *Expert On*. When the Expert Access flag is set, access to the other CONFIG mode items can be further 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 associated with remote access to the controller are *Remote Enable*, *Comm Address*, and *Baud (100s)*. The *Remote Enable* CONFIG item is the controlling item for the Communications Port Address and Communications Port Baud Rate items. If the *Remote 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 that are controlled by other items will be clearly delineated.

4.9.1 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 2.6 and 3.8 for more information on the AutoPol system.

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

```

POS    POL    SS
AUTOPOL ENABLE:0
0-NO, 1-yes  CFG
                MODE

```

The *AutoPol Vlevel* 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.

```

POS    POL    SS
AUTOPOL LEVEL:1
0-LO, 1-HI   CFG
                MODE

```

4.9.2 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 Enable* item is the controlling item for the *Comm Address* and *Baud (100s)* items.

The *Remote Enable* item is used to enable access to REMOTE mode. If REMOTE mode is enabled, the controller will respond to serial commands whose address matches the controller's address. If a valid command is received via the communications port, the control will transfer to REMOTE mode. See Appendices D and E for additional information on the controller's remote control characteristics.

POS	POL	SS
REMOTE ENABLE: 1		
0-NO, 1-yes		
		CFG
MODE		

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

POS	POL	SS
COMM ADDRESS: 50		
49 - 111		
		CFG
MODE		

The *Baud (100s)* item selects the baud rate that the controller's serial port will be initialized to. Valid values for this parameter are 12 (1200 baud), 24 (2400 baud), 48 (4800 baud) and 96 (9600 baud).

POS	POL	SS
BAUD (100s): 96		
12, 24, 48, 96		
		CFG
MODE		

4.9.3 Slow Speed Code

The *Slow Speed CONFIG* item can be used to set the slow speed code. Please refer to section 3.5 for more information on the slow speed system. The range of values for this parameter is 1 to 254. Higher numbers give a faster rate of slow speed movement. (A slow speed code of 254 will disable the slow speed system - 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 code is changed, test the slow speed system to insure that the selected value yields reasonable results. Access to this CONFIG mode item is allowed only when the Expert Access flag is set.

POS	POL	SS
SLOW SPEED: 254		
0 - 254		
		CFG
MODE		

4.9.4 Polarization Motor Option

The RC2KPOL option allows the RC1500 to control a 12 or 24 volt polarization motor with potentiometer based position feedback. If this option is present, a 5 terminal orange connector will be found on the upper left-hand corner of the back panel. The CONFIG mode items described in this section are used to configure the controller to work with the RC2KPOL option. Access to these CONFIG mode items is allowed only if the Expert Access flag is set. The *24vdc Rot Feed* item is the controlling item for access to the other items described in this section.

The *24vdc Rot Feed* CONFIG mode item is used to inform the controller of whether or not a polarotor servo motor is present in the system. If the RC2KPOL option is installed this parameter should be set to YES (see section 3.3).

POS	POL	SS
24vdc	ROT	FEED:0
0-NO, 1-yes		CFG
MODE		

The following items set the controller's CW and CCW polarization limits when a rotating feed is installed. The procedure to determine these limits is given in section 3.3. Note that the CW limit must by definition be less than the CCW limit.

POS	POL	SS
FEED CW	LIM:	500
0 - 1023		CFG
MODE		

POS	POL	SS
FEED CCW	LM:	500
0 - 1023		CFG
MODE		

4.9.5 Motor Drive Options

The CONFIG mode items described in this section set the automatic movement parameters for the drive. 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 drive's output from the RC1500 to control a 12-36 volt relay (equipped with a steering diode) which in turn activates a larger AC or DC motor. Contact RCI for more information about these applications. Access to the CONFIG mode items described in this chapter is permitted only when the Expert Access flag is set.

The *Auto Move Cnfg* 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 antenna movement. In other words, disabling this item does not reset the other items described in this section to their default values.

POS	POL	SS
AUTO MOVE	CNFG:	0
0-NO, 1-yes		CFG
MODE		

During an automatic move in AUTO mode, the *Fast Slow Threshold* CONFIG mode item is used to set the number of counts before a target position is reached, when the controller switches the speed of the drive from fast to slow.

POS	POL	SS
FST/SLO THRSH: 80		
0-99	CNTS	CFG
MODE		

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

POS	POL	SS
RETRY ATTEMPTS: 3		
2-5		CFG
MODE		

The *Fst Deadbnd* and *Slo Deadbnd* 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 position sensor is pulses. When a pulse is received, the controller checks to see which way the antenna was last commanded to move. If the antenna is moving, or last moved, CCW, the position count is decremented. If the antenna is moving, or last moved, CW, the position count is incremented.

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

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

POS	POL	SS
FST DEADBND: 2000		
175-5000	MS	CFG
MODE		

POS	POL	SS
SLO DEADBND: 800		
175-5000	MS	CFG
MODE		

The values assigned to the *Fst Deadbnd* and *Slo Deadbnd* variables can affect other systems on the controller not related to the anti-reversal system. These features are explained in Chapter 7 - Operational Troubleshooting Tips. For normal operation these features should be

disabled. To DISABLE these features, make sure that the value entered for *Fst Deadbnd* DOES NOT end in '01' (i.e. when the value is divided by 100 the remainder is not 1), and that the value entered for *Slo Deadbnd* DOES end in either '00' or '50' (i.e. the value entered is a multiple of 50).

During an automatic move in AUTO mode, the *Coast Threshold* CONFIG mode item sets 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 Pos Error* counts of the target position.

POS	POL	SS
COAST THRS: 4		
1-40	COUNTS	CFG
MODE		

The *Max Pos Error* CONFIG mode item sets the maximum acceptable error between the final resting position and a target position for an automatic move which occurs in AUTO mode.

POS	POL	SS
MAX POS ERROR: 0		
0-10	COUNTS	CFG
MODE		

4.9.6 Signal Strength Parameters

The controller can display signal strength information. Signal strength information is generally obtained from a receiver's automatic gain control (AGC) circuitry. The procedures used to adjust the controller's AGC input circuits and obtain these parameters is described in section 3.6.1 - AGC Adjustment and Configuration. Access to these CONFIG mode items is permitted only when the Expert Access Flag is set.

POS	POL	SS
AGC POLARITY: 1		
0-neg	1-POS	CFG
MODE		

The *AGC Polarity* flag tells the controller what the sense is on the input AGC voltage used for tracking. A positive sense is defined as one that increases in magnitude as the RF signal strength increases. If the AGC voltage decreases as the RF signal increases, its sense is considered negative. Enter the appropriate value, either 0 or 1, followed by ENTER to key in the value.

4.9.7 Expert Access Flag

Expert Access is used to control access to CONFIG mode items. 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. The purpose of this feature is to keep an operator away from the modes

and CONFIG mode items which can 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, 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 A at the end of this manual. If the information is lost, call the factory for assistance.

POS	POL	SS
EXPERT ON:		1
0-no, 1-yes		CFG
MODE		

4.9.8 Reset System Data

The *Reset Sys CONFIG* mode data item is used to reset the controller's non-volatile memory. When this occurs, the controller limits are invalidated, and most 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 used for Expert Access, followed by the ENTER key.

POS	POL	SS
RESET SYS :		0
ENTER CODE		CFG
MODE		

Following are the default values which are assigned to non-volatile memory, with a space to fill in the values for this installation:

Data Item or Condition	Default Value	User Assigned Value
Position Count	5000	_____
CCW Limit	4999	_____
CW Limit	5001	_____
Limit Checksum	Invalid – The ‘Ant Limits’ alarm message flashes on the bottom row of the LCD	_____
AutoPol Enable	0 - disabled	_____
AutoPol Vlevel	1 – vertical pol corresponds to a high level input	_____
Remote Enable	0 - disabled	_____
Comm Address	50	_____

Data Item or Condition	Default Value	User Assigned Value
Baud (100s) ... Communications port baud rate	9600	_____
Slow Speed	254	_____
24vdc ROT FEED ... 24 volt DC rotating feed	0 – rotating feed not present	_____
Rotating Feed CW Limit	500	_____
Rotating Feed CCW Limit	500	_____
Drive Options	0	_____
Fast Slow Threshold	80 counts	_____
Auto Retry Attempts	3	_____
Fast Deadband	2000 milliseconds	_____
Slow Deadband	800 milliseconds	_____
Coast Threshold	4 counts	_____
Max Position Error	0 count	_____
AGC Polarity Flag	1	_____
Expert Access Flag	1	_____

Chapter 5 SPECIFICATIONS

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

PHYSICAL	
Size	19.0" x 3.5"H x 9.0"D (Rack)
Weight	12.5 lbs.
Temperature	0-50°C
Input Power	115/230 VAC, 50/60 Hz., 48 W (excluding motor drive current)
DRIVE	
Output	12-36VDC, 8.0 Amps, see appendix G for voltage vs. current relationship
Sensor Input	Reed, Hall Effect, Optical
Polarization	Polarotor™ Interface – standard 24V Rotating Feed with potentiometer feedback if the RC2KPOL daughterboard is installed
Fuse	5 amp, Slow blow Bussman MDL 5 Littelfuse 313005
Circuit Breaker	High voltage transformer secondary protected by 12 amp thermal circuit breaker.
Non-Volatile Memory Battery	Duracell DL2450

Chapter 6 TROUBLESHOOTING/ALARM CODES

This chapter covers error messages and system troubleshooting. Two types of error messages can occur: System errors, covered in 6.1, and Track Errors, in 6.2. System errors can occur at any time. When a system error is detected, an error message flashes periodically on the bottom row of the display. Track error messages are displayed when TRACK mode is active, and an error related to the tracking system has been detected. This chapter concludes with a list of troubleshooting tips in section 6.3.

6.1 SYSTEM ERROR 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.

Many of the alarm messages described in this section are caused by corrupt CONFIG mode items. Note that access to certain CONFIG mode items is controlled by the value of other CONFIG mode items. See the first few paragraphs of section 4.9 for an explanation of the role of controlling CONFIG mode items. If the value of a controlling CONFIG mode item is such that access to other CONFIG mode items is restricted, corrupt values of those other CONFIG mode items can still generate an alarm message. Access to the corrupted item is only available if the controlling item is changed to allow it.

All of the CONFIG mode items must be initialized to a valid value, even if the feature associated with that CONFIG mode item is disabled. For example, even if REMOTE mode is disabled, the *Baud (100s)* and *Comm Address* CONFIG mode items must still be initialized properly.

LOW BATTERY

The RC2000C 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 Appendices A1 and A2.

ANT LIMITS

One of the antenna software limits has been corrupted. Go into LIMITS mode and reset the software limits. See Section 4.4.

POL LIMITS

This error indicates that the polarization motor limits have been corrupted. See sections 4.9.4 and 3.3.

ANT AZ/EL, 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 4.6) 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.

AZ/EL COUNT

The internal position count has been corrupted. Manually find a satellite which has previously been stored in non-volatile memory, and go into FIX mode to update positions. See Section 4.8.

SLOW SPEED

The azimuth and elevation slow speed codes have been corrupted. The slow speed codes are entered via the *Slo Speed* CONFIG mode item. See Sections 4.9.3 and 3.5

AUTOPOL CFG

Either the *AutoPol Enable* or *AutoPol Vlevel* CONFIG mode items have been corrupted. See sections 2.6, 3.8, and 4.9.1.

COMM PORT

This error (caused by an incorrect checksum) indicates that the value of at least one of the following CONFIG mode items has been corrupted: *Remote Enable*, *Baud (100s)*, or *Comm Address*. *Remote Enable* is the controlling item for this group of CONFIG mode items - it must be enabled to allow access to the *Baud (100s)* and *Comm Address* CONFIG mode items. See section 4.9.2.

POL OPTIONS

This error (caused by an incorrect checksum) indicates that the value of at least one of the following CONFIG mode items has been corrupted: *24vdc ROT FEED*, *Feed CW Lim*, or *Feed CCW Lm*. The *24vdc ROT FEED* item is the controlling item for this group of CONFIG mode items - it must be set to YES to allow access to the other items. See sections 4.9.4 and 3.3.

AZ/EL OPTIONS

This error (caused by an incorrect checksum) indicates that the value of at least one of the following CONFIG mode items has been corrupted: *Auto Move Cnfg*, *Fst/Slo Thrsh*, *Retry Attempts*, *Fst Deadbnd*, *Slo Deadbnd*, *Azim Coast Thrsh*, or *Max Pos Error*. The *Auto Move Cnfg* CONFIG mode item is the controlling item for most members of this group of CONFIG mode items - it must be enabled to allow access to the other items. See section 4.9.5.

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 in one position when approaching the satellite from the west and another when approaching the satellite from the east. To test for this, move the antenna quite a distance west of the satellite and manually move the antenna east at slow speed until the peak is reached. Repeat the procedure when approaching the satellite from the east. The difference in azimuth position between the 2 peaks is the mechanical hysteresis. In this situation, try to eliminate the slop in the mount. If this is not possible, always approach each satellite from the same direction in which it was originally programmed (typically east to west).

ANTENNA ERROR OCCURS

To determine the cause of this error go to 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 in section 4.9.5.

DRIVE - This error indicates that the controller's electronic overcurrent sensing has detected an overcurrent condition and has shut the drive down. There are pots which control the level at which the electronic overcurrent 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 pressed 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.

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 '*24vdc ROT FEED*' CONFIG mode item was changed after the satellite was programmed into non-volatile memory.

DISABLING RUNAWAY ERRORS

The controller has a provision to only allow the accumulation of position counts when the antenna has been commanded to move, or movement has just ceased (as defined by the *Az/EI Fast Deadband* and *Az/EI Slow Deadband* CONFIG mode items). This has the effect of disabling RUNAWAY errors. It is generally not recommended to disable the runaway error. If necessary, it can be accomplished by setting the *Az/EI Fast Deadband* CONFIG mode item to a value which ends in '01', i.e. 2001, 2301, etc.

Appendix A Expert Access and System Reset Code

A five digit code must be entered to reset the controller or toggle the controller's Expert Access flag.

The 5 digit code is **41758**. Be sure to terminate the entry with the ENTER key.

The controller is reset via the *Reset Sys Config* item discussed in section 5.9.9.

The Expert Access flag is toggled via the *Expert On Config* item. See sections 2.5 and 5.9.8.

Appendix A1 - Restoring Non-Volatile Memory

This appendix outlines a procedure which allows the user to restore the contents of non-volatile memory. A number of events can make this necessary, including:

- 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, or
- iv. upgrading to a newer version of the software which uses a memory map different from the original memory map.

Here is the procedure ...

1. In manual mode, jog the antenna to the west and up limit. Record the position count value for each axis just before the limit is reached. (If position display in degrees is enabled, disable that feature before starting this procedure.)
2. Go to CONFIG mode and record the value of each CONFIG mode item.
3. Using AUTO mode, position the antenna on each of the geostationary satellites stored in non-volatile memory. Record the azimuth and elevation positions and the longitude value of each geostationary satellite. Use the H and V keys to position the polarotor. Record the H and V positions for each satellite. (If polarization position display in degrees is enabled, disable that feature.)
4. Move the antenna to the position just before the east and down limits are reached. This should correspond to a position count value of 30 for both the azimuth and elevation axis.
5. Turn the unit off, unplug the unit from the AC power, and perform whatever maintenance is required. If the EPROM is replaced, be sure to insert the chip into the socket properly. The notch on the end of the chip should line up with the notch of the outline silk-screened onto the printed circuit board under the EPROM socket. When the maintenance has been performed, power the unit up. If the non-volatile memory has been corrupted, the unit will either go to LIMITS mode or will flash an error message on the bottom line of the display. If this occurs, the following steps of this procedure will have to be performed to restore the non-volatile memory.
6. Go to LIMITS mode. WITHOUT MOVING THE ANTENNA set the down and east limits. AFTER THE EAST AND DOWN LIMITS HAVE BEEN SET, jog the antenna to the positions for the west and up limit recorded in step 1. Set the west and up limits. After the west and up limits have been set, exit LIMITS mode by hitting the MODE KEY.
7. Go to CONFIG mode and key in the data recorded in step 2 above. Each entry must be terminated with the ENTER key. After the data has been entered scroll through the CONFIG mode items (using the SCROLL keys) and make sure that the data has been entered correctly.

8. In this step, the positions of the geostationary satellites are stored in non-volatile memory. Go to SETUP mode. Position the antenna on each of the satellites which were recorded in step 3 above. Select the satellite name, enter the satellite longitude, and move the polarotor to the recorded H and V positions in response to the appropriate SETUP mode prompts.

Appendix A2 - 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 east and down limits are set. If the antenna can be unambiguously placed at the east 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 east 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.

If the contents of non-volatile memory are recorded as outlined in steps 1-4 above, recovery from an unexpected memory upset can be readily accomplished. If the memory is corrupted, the antenna can be moved (in LIMITS mode) to the east and down limit with the aid of an assistant stationed at the antenna. Next, steps 7-9 can be used to restore the contents of non-volatile memory.

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 C – RS-422 Serial Interface

The RC2000A and RC2000C antenna controllers support an RS-422 serial interface. The communications protocol employed by the RC2000 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 RC2000 antenna controller are described in appendix E - RC2000 Communications Protocol.

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. The diagrams and schematics at the end of this appendix document the connection of a PC to an RC2000 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 pair of programs that allow a PC to control an RC2000 (a protocol converter is required). The RC2K.EXE (or RC2KC.EXE for use with the RC2000C) program is designed primarily for use by software developers or during installation. These programs feature 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 these programs be used to verify the operation of the system during initial installation and checkout of the RC1KADP and the associated cabling.

The RC2KDEMO.EXE program found on the diskette is derived from the Autopilot software package (described below). This program features a user friendly user interface.

The Autopilot software package is produced by Broadcast Automation Systems ((905) 822-7935) and is available from Research Concepts. This program can control the RC2000 and the RC1000A antenna controllers as well as the Standard Agile Omni model 830BR or the DX657 satellite receiver. This program runs under DOS and gives the user the ability to schedule antenna and receiver events. Contact Research Concepts for more information on this product.

Here are other suppliers of software products that are compatible with the RC2000...

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 RS-422 Interface Specification

Introduction

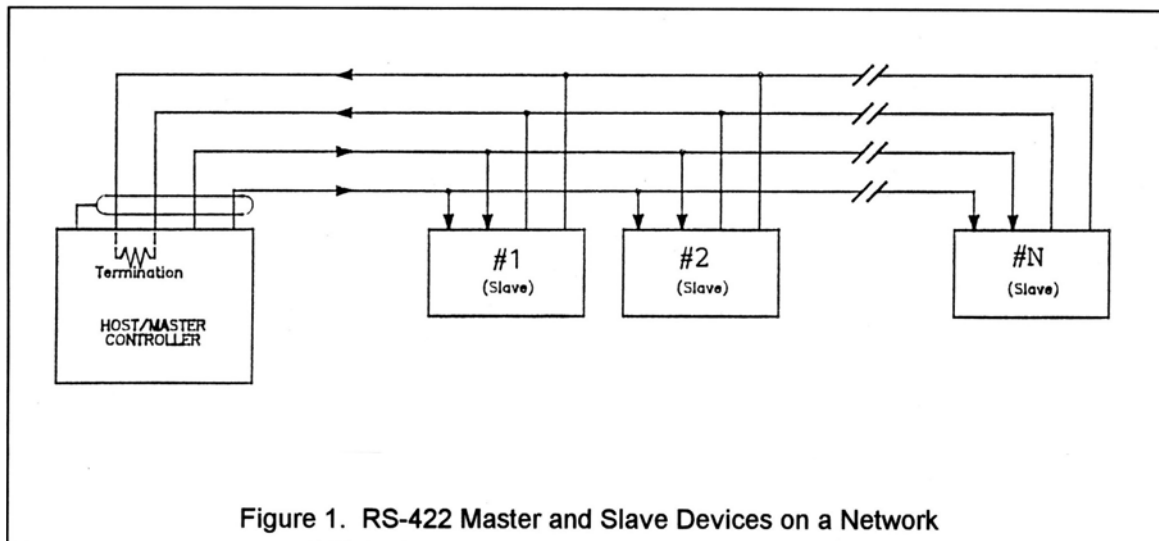
The purpose of this document is to explain the key parameters needed by a user to interface to the RCI RS422 Interface. This interface is compatible with the SAbus and can be readily integrated into an existing SAbus network. A few query and control commands are all that are needed to control the equipment 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

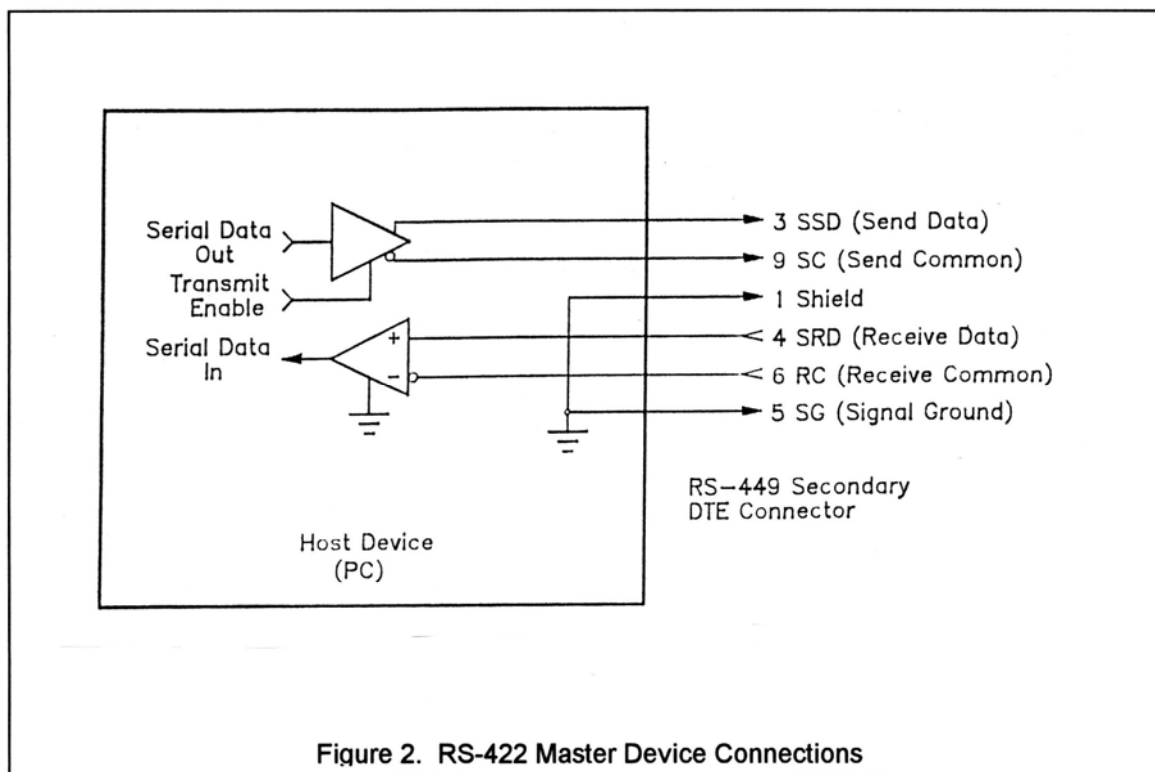
The physical implementation of the interface takes the form of a 9-pin "D" connector located on the rear panel of the controller. This connector and its wiring is compatible with EIA RS-449, which is the mechanical specification for RS-422/423-compatible equipment. The 9-pin connector chosen is described 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.

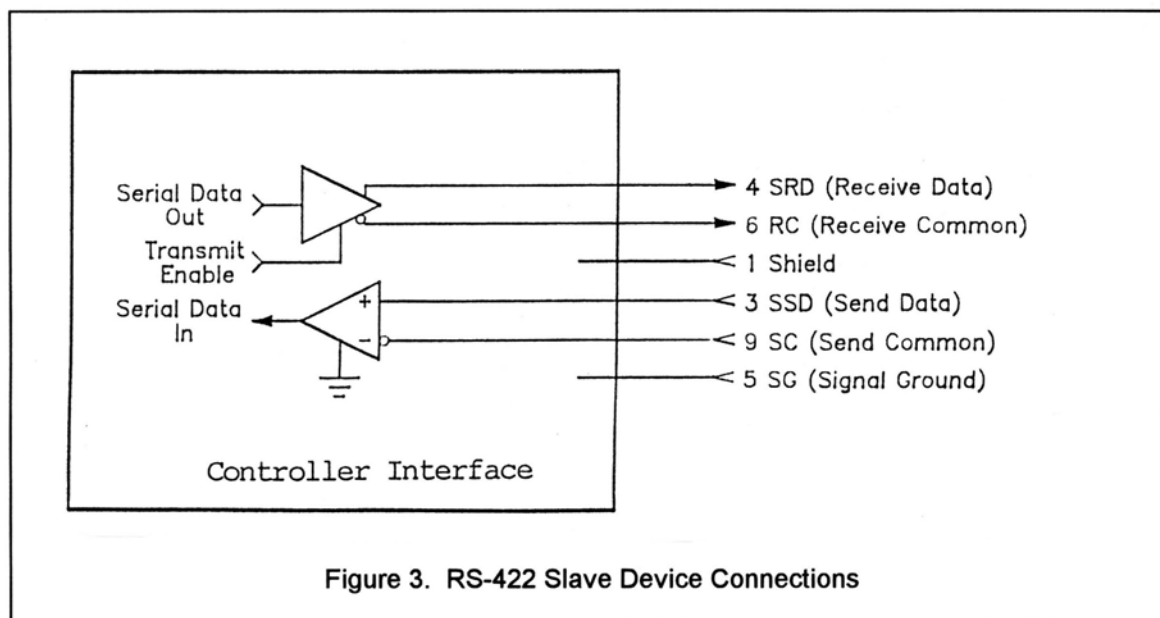


Figure 2 and 3 show RS-422 Master and Slave connections respectively.

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.

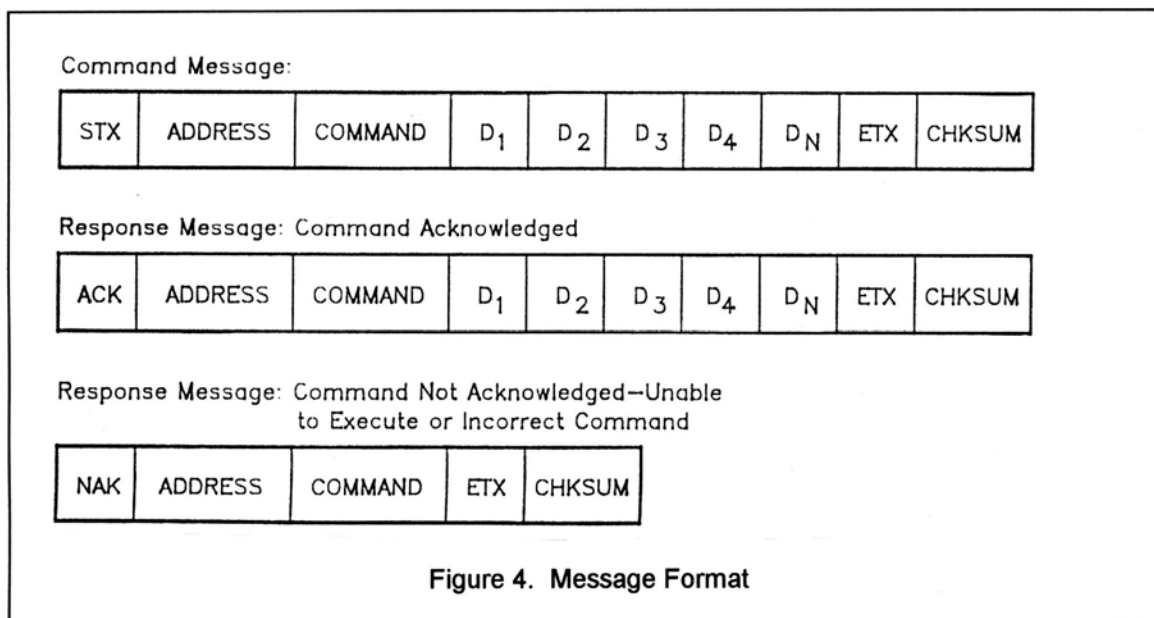
Message Protocol

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.

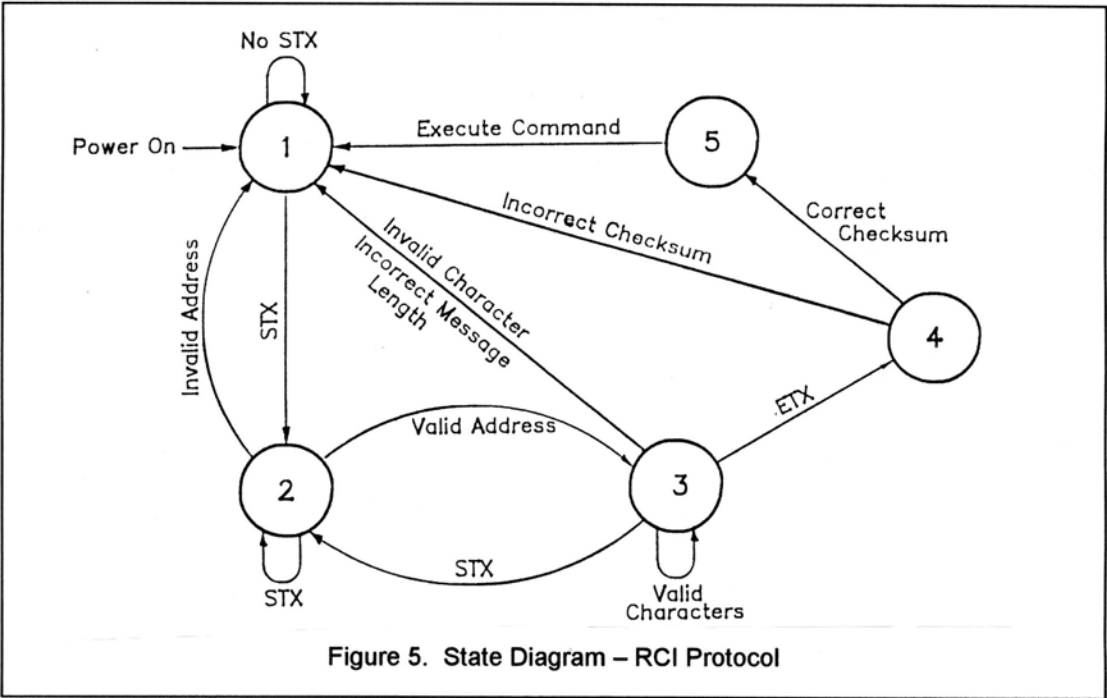


Table 1. State Diagram Mnemonics

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.

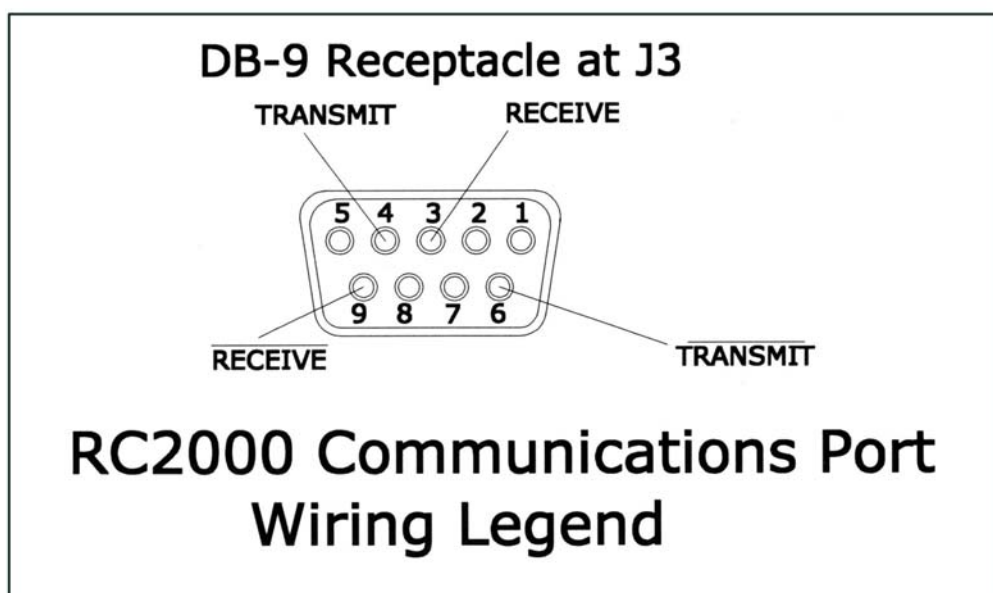
State 4 (Slave Data Error State). In State 4, a slave is waiting to receive a Checksum byte that tests the transmitted message for errors.

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 – RC1500 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/EI 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.

5.31.95 - Revised for the RC2000C version 1.00 inclined orbit satellite tracking software. Extra track status information has been included in the device status pol reply. A track MISCELANEOUS command has been included to set the frequency band for dual band satellites and to reset track errors.

11.6.95 - Revised for the RC2000C version 1.1x release. The only change in the comm protocol is the reply to the Query Id command. The alarm codes that appear in this document have also been corrected.

2.6.04 – The RC1500 single axis antenna controller was derived from RC2000C Polar dual axis inclined orbit tracking antenna controller. The remote interface of the RC1500 is nearly identical to that of the RC2000. The RC1500's comm protocol can best be described as that of the RC2000C Polar with all of the elevation related fields ignored. Two versions of the RC1500 are offered. The RC1500A is for use with polar mounts looking at geostationary satellites. The RC1500 supports tracking of an inclined orbit satellite with a single axis mount whose axis of motion is aligned with the apparent motion of the satellite.

OVERVIEW

The RC1500 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 RC1500 antenna controller. See the SA bus specification included with RC1500 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.

RC1500 ONLINE/OFFLINE

To enable remote mode on the RC1500, 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 when a valid command arrives via the serial port. Certain commands can be processed by TRACK 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 RC1500 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:	'chksum'	the 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.

RC1500 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 RC1500 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 require 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 RC1500 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 RC1500 address
byte 2:	30h	the device type query command code
bytes 3-8:	'15_xxx'	where xxx is the version number, for example if the current software version number were 4.31, XX would be '431'.
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 RC1500 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 that 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 RC1500 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 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:	position	This field will contain the current antenna position, formatted in a manner identical to how the position is displayed on the front of the unit, '0' to '65535'. If a limit is active, the field will contain either 'CCW' or 'CW'.
bytes 19-23:	Not Used	
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.

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 * auto pol disabled
1 x x x auto pol enabled
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

```

* 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: Not Used

```

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

```

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

```

bytes 30-31: These bytes are used to encode the alarm code. The alarm code (a byte value) specifies the alarm condition that is presently active. See the table below for the various alarm codes.

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

```

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

```

least significant nibble
a a a a of the alarm code
3 2 1 0

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

```

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

```

most significant nibble
a a a a of the alarm code
7 6 5 4

Alarm codes - See the system error codes in chapter 6 of the RC1500 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 - no alarm active
0 0 0 0 0 0 0 1	1 - LOW BATTERY alarm
0 0 0 0 0 0 1 0	2 - ANT alarm
0 0 0 0 0 0 1 1	3 - NOT USED
0 0 0 0 0 1 0 0	4 - COUNT alarm
0 0 0 0 0 1 0 1	5 - NOT USED
0 0 0 0 0 1 1 0	6 - LIMITS corrupt alarm
0 0 0 0 0 1 1 1	7 - NOT USED
0 0 0 0 1 0 0 0	8 - AUTOPOL CFG alarm
0 0 0 0 1 0 0 1	9 - NOT USED
0 0 0 0 1 0 1 0	10 - SLOW SPEED alarm
0 0 0 0 1 0 1 1	11 - NOT USED
0 0 0 0 1 1 0 0	12 - COMM PORT alarm
0 0 0 0 1 1 0 1	13 - ELEV ZERO (RC1500B) alarm
0 0 0 0 1 1 1 0	14 - TRACK CONFIG (RC1500B) or AGC POLARITY (RC1500A) data alarm
0 0 0 0 1 1 1 1	NOT USED
0 0 0 1 0 0 0 0	16 - TIME/DATA (RC1500B) alarm
0 0 0 1 0 0 0 1	17 - NOT USED
0 0 0 1 0 0 1 0	18 - POL OPTIONS alarm
0 0 0 1 0 0 1 1	19 - ANT POL alarm
0 0 0 1 0 1 0 0	20 - OPTIONS alarm

byte 32: This byte gives information that allows the user to determine the exact value of the controller's internal polarization position representation. This may be used with the auto\$move command to position the polarization control device at a specific value.

The RC1500 currently supports two polarization control devices, a Polarotor and a rotating feed with potentiometer position sense feedback.

For the Polarotor, 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. $(39 * 661) / 99 = 260$).

When a Polarotor is present in the system the upper nibble of byte 32 will be '0010'.

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. Note that when a rotating feed is present in the system, the upper nibble of byte 32 will be '0011'.

byte 33: Track Mode submode or error status and track frequency band.

7	6	5	4	\$	3	2	1	0
-	-	-	-	-	-	-	-	-
0	1	b1	b0	\$	s	s	s	s

where		
b1	b0	meaning
--	--	
0	0	c band
0	1	k band

1	1			I band
S	S	S	S	
-	-	-	-	
0	0	0	0	track mode not active
0	0	0	1	track setup submode active
0	0	1	0	track auto mode entry
0	0	1	1	step track submode active
0	1	0	0	track search submode active
0	1	0	1	program track submode active
1	0	0	0	track jammed error
1	0	0	1	track limit error
1	0	1	0	track drive error
1	0	1	1	track peak limit error
1	1	0	0	track azim scale factor error
1	1	0	1	track geo position error
1	1	1	0	track system error
1	1	1	1	track checksum error

byte 34: AGC (automatic gain control) input channel (1 or 2) which has the greater signal and the five least significant bits of the agc input level on that channel.

7	6	5	\$	4	3	2	1	0
-	-	-		-	-	-	-	-
0	c1	c0	\$	a	a	a	a	a

where	
c1 c0	meaning
-- --	
0 1	agc channel one has the greater input level
1 0	agc channel two has the greater input level

a	a	a	a	a
-	-	-	-	-

the least five significant bits of the agc input level on the channel specified by c1 and c0 above.

byte 35: This byte indicates the status of the flag that specifies whether or not remote polarization commands will be accepted when TRACK mode is active and the five most significant bits of the agc input level.

7	6	5	\$	4	3	2	1	0
-	-	-		-	-	-	-	-
0	1	p		a	a	a	a	a

where	
p	meaning
-	
0	polarization movements are not allowed
1	polarization movements are allowed

Discussion - The 'p' field described above only contains meaningful data when TRACK mode is active.

Polarization movement is not allowed during a TRACK mode peaking operation. If a polarization operation occurs during peaking the peak obtained may not be reliable. If a 'go to' H or V polarization command is received via the serial port the controller will execute the command after

the peaking operation is completed. The reply to a go_to command will be an ACK.

A polarization jog command that is received during a peaking operation will not be registered and executed later. The reply to the command will be a NAK.

```
a  a  a  a  a
-  -  -  -  -
```

the five most significant bits of the agc input level on the agc channel specified in byte 34.

```
byte 36:    ETX
byte 37:    checksum
```

QUERY NAME COMMAND

This query command instructs the RC1500 to send back to the host computer an indexed satellite name 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 RC1500. 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 RC1500 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:      'chksum'    the 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 RC1500 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:     'chksum'    the 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.

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.

With this form of the command, the polarization field may contain either 'H', 'V', 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 (if 'H' is specified) or vertical (if 'V' is specified) polarization specified for the satellite. 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 antenna position the antenna will move to the position specified. The first 5 characters of the sat_name/position field specify the antenna position, the last 5 characters of the sat_name/position field will be ignored. Within the first 5 characters of the sat_name/position field, the antenna position must be right justified and left padded with zeroes. For example, a sat_name/position field value of '0152500000' specifies an antenna position of 1525 counts. For the command to be accepted the position must be within the antenna limits. 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 RC1500 address
byte 2:	32h	the auto move command code
byte 3:	polarization	This field can specify 'H', 'V', ' ' (blank), or 'P'.
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.

ANTENNA JOG COMMAND

This command jogs the antenna. The command contains 11 bytes. Here is the format of the command;

byte 0:	STX	
byte 1:	A	where A is the RC1500 address
byte 2:	33h	the command code
byte 3:	direction	this field can specify 'E', 'W', 'D', 'U' or 'X'. 'E' or 'D' specifies counterclockwise (CCW) movement for the RC1500A and down movement for the RC1500B, 'W' or 'U' specifies clockwise (CW) movement for the RC1500A or up movement for the RC1500B. An 'X' specifies that the antenna stop moving.
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 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:	'chksum'	the 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.

The format of the command is as follows;

byte 0:	STX	
byte 1:	A	where A is the RC1500 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 RC1500 memory.

MISCELLANEOUS COMMAND

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

byte 0:	STX	
byte 1:	A	where A is the RC1500 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 specifies the azimuth or elevation drive reset command. This accomplishes the same function as the RESET mode of the RC1500: it allows the user to reset the solid state drive circuits if an antenna or polarization alarm has been detected. When the sub-command code is 'R', the sub-command parameter 'Y' must be either 'A', 'E', or 'P' to specify which axis will be reset. 'A' and 'E' reset the antenna drive, 'P' resets the polarization drive. If the 'P' command is specified, the command will be accepted only if the RC1500 is configured for use with the optional polarization control motor.
'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' = 'T'	This sub-command is used to reset track mode errors (sub-command parameter 'Y' = R). When the TRACK mode ERROR sub-mode is active this command will cause the ERROR sub-mode to terminate. The controller will react as if TRACK mode was activated via AUTO mode. Note that if a system error is active (an error message flashing on the bottom row of the display) the condition that generated the system error must be rectified or the controller will probably return to the TRACK mode ERROR sub-mode. This sub-command can also be used to switch frequency bands when a dual band satellite is being tracked. A sub-command parameter of 'C' will specify C band and a sub-command parameter of 'K' will specify K band. The reply to this command will be a NAK if TRACK mode is not active, the satellite being tracked was not specified as a dual band satellite (when the track was initiated via SETUP mode), or if track polarization movement is not allowed (see byte 35 of the device status poll command).

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

C PROGRAM

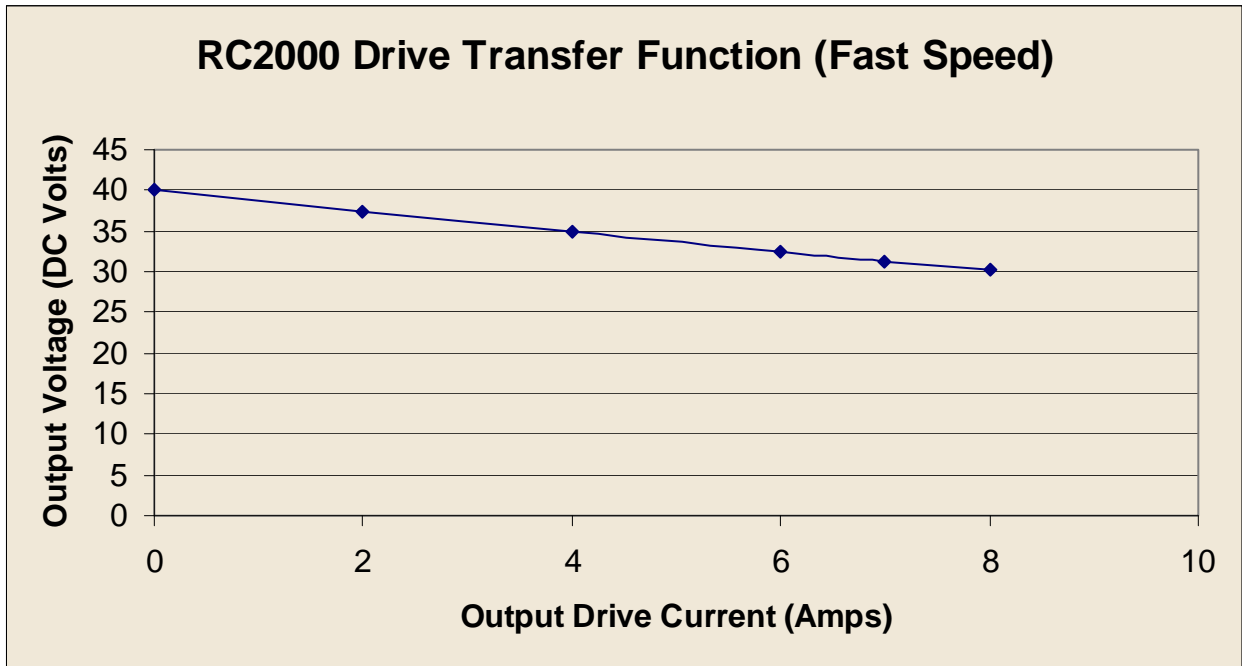
A C program has been written which allows a user to exercise the RC1500. The program runs on an IBM PC (or compatible - running DOS) and was designed to aid the software developer who is writing programs to control the RC1500. All of the commands listed above can be sent to the controller. The program 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.

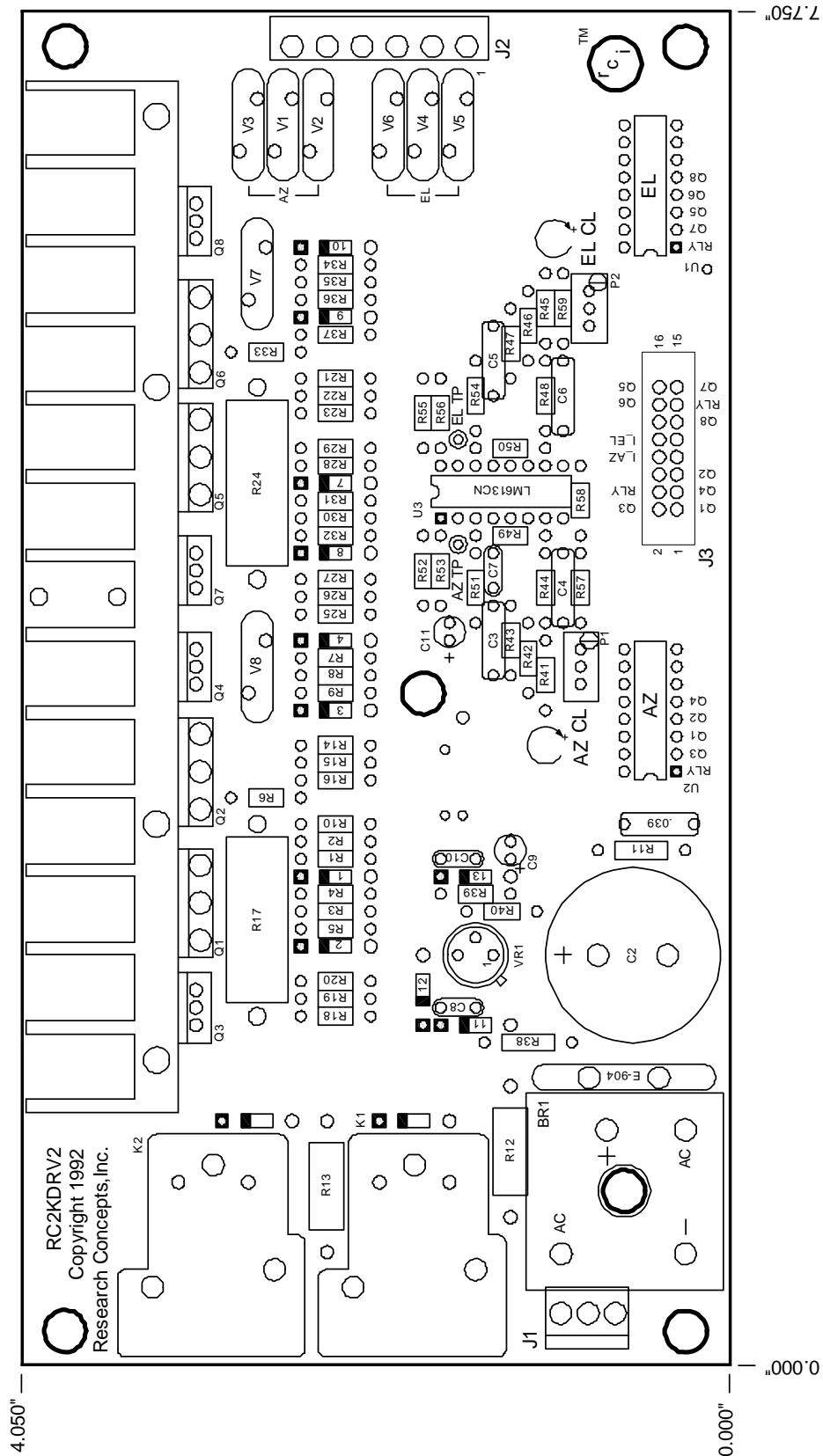
ASCII name	hex value	decimal value
STX	2	2
ETX	3	3
ACK	6	6
NAK	15	21

APPENDIX G Drive Transfer Function

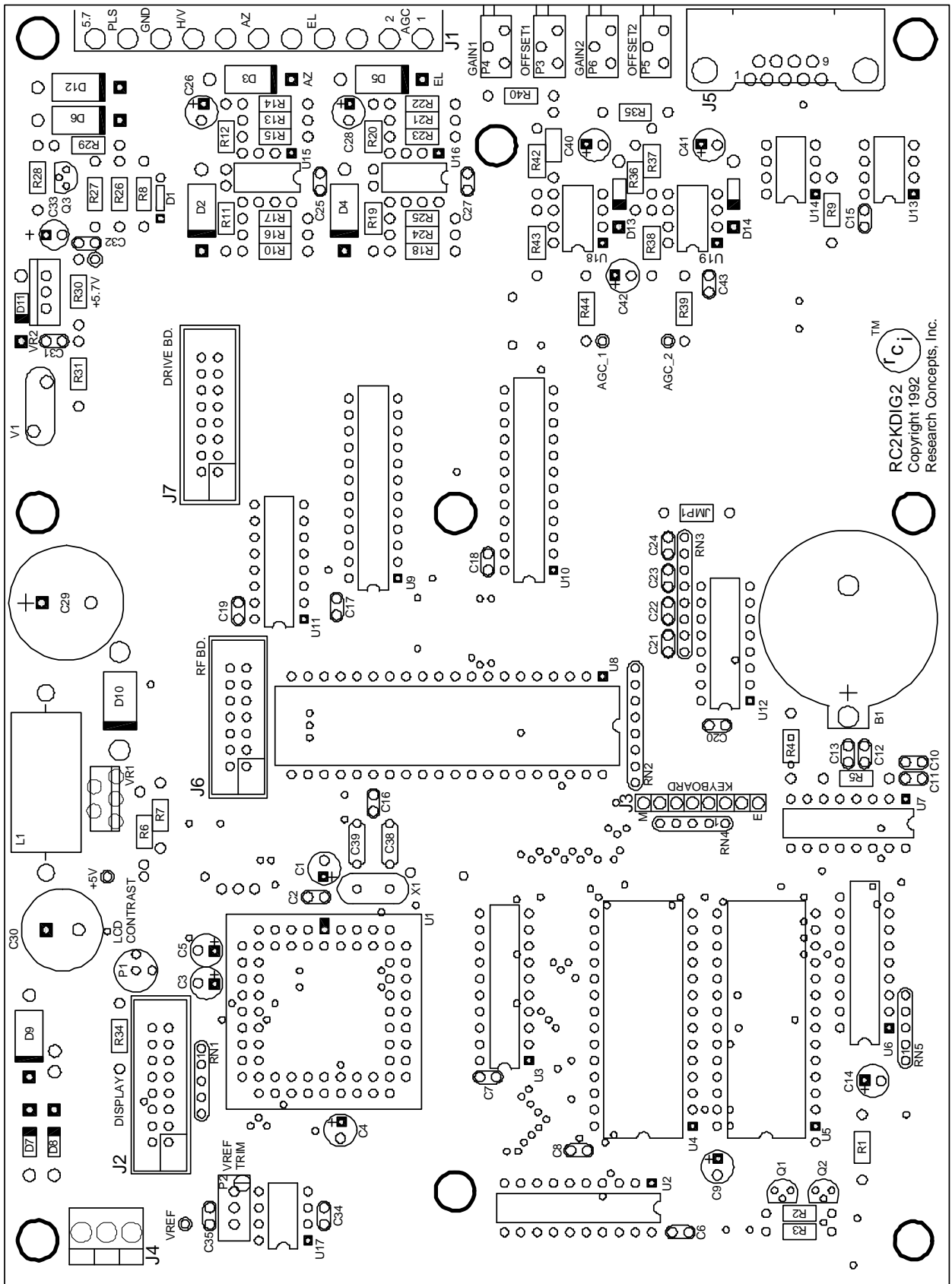


APPENDIX H Electrical Diagrams

Drive Board Layout

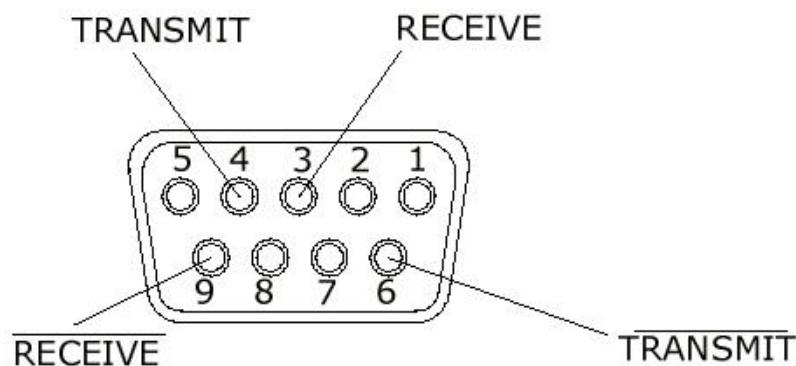


Processor Board Layout

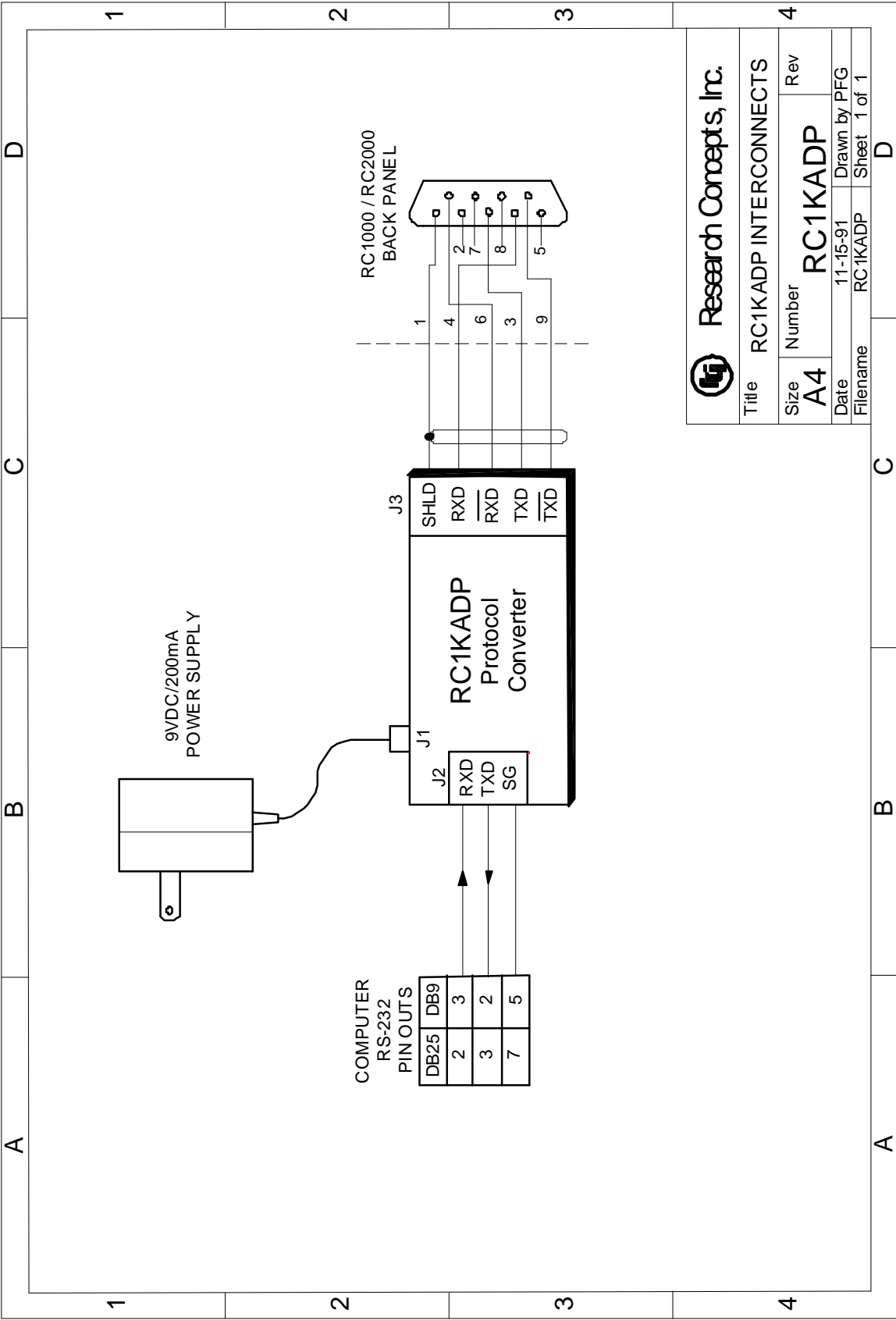


Comm Port Wiring Legend

DB-9 Receptacle at J3

RC2000 Communications Port
Wiring Legend

RC1KADP Conversion



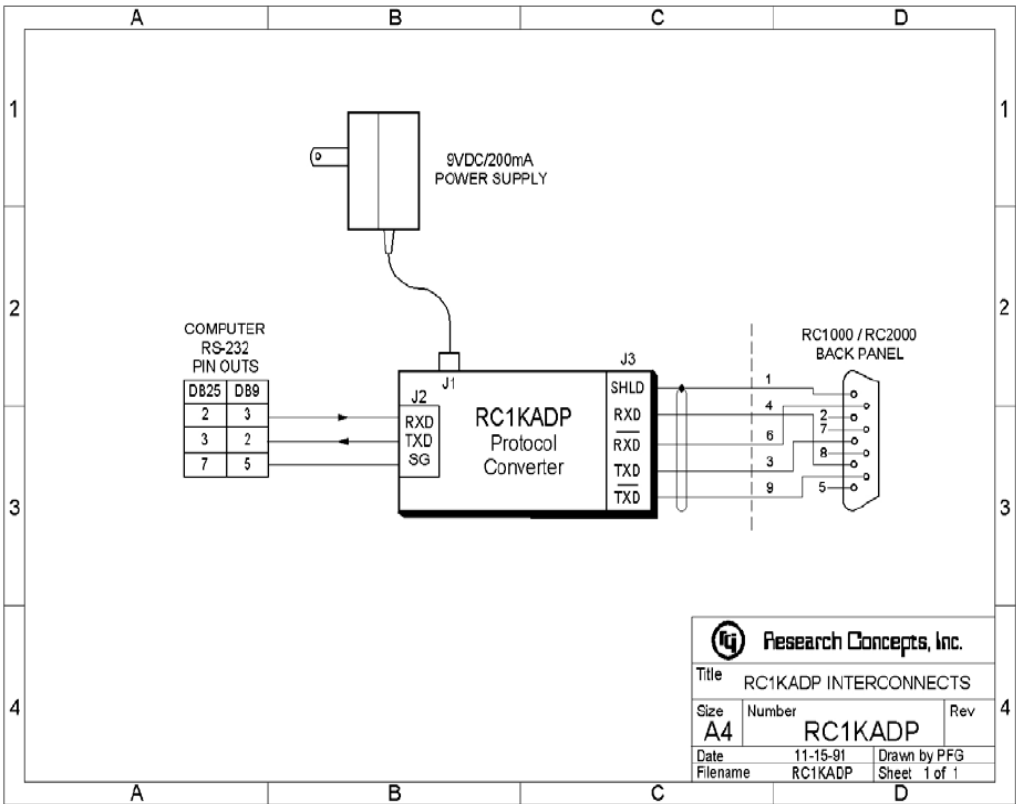
RC1KADP INTERCONNECTS			
Title	Size	Number	Rev
	A4	RC1KADP	
Date	11-15-91	Drawn by	PFG
Filename	RC1KADP	Sheet 1 of	1

RC1KADP PROTOCOL CONVERTER WIRING

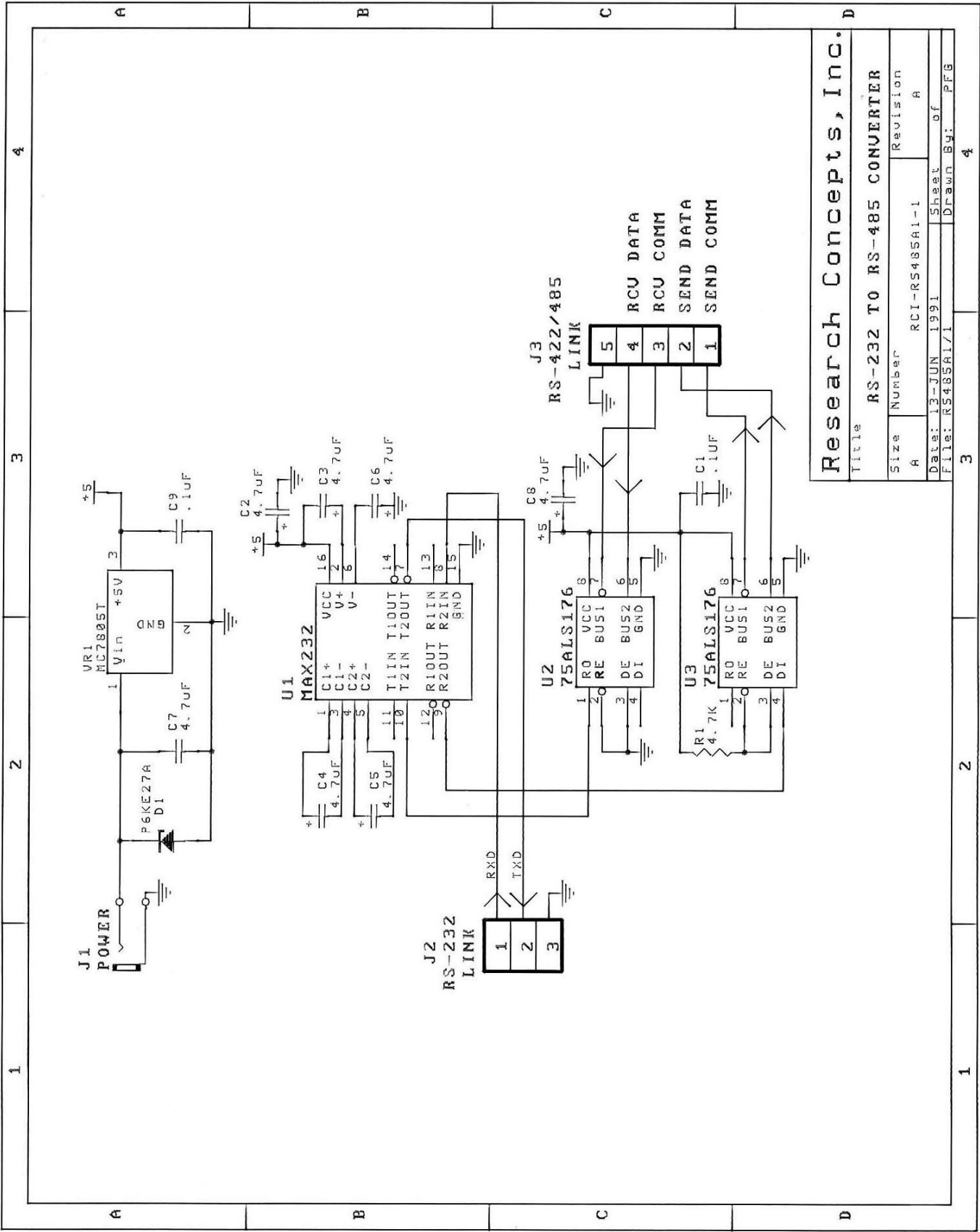
IBM PC Serial Port Signals	IBM PC Serial Port	Cable from J2 ADP	RC1KADP J2 Terminal Strip	RC1KADP J3 Terminal Strip	Cable from RC1KADP J3	RC2000 J3	RC2000 J3 Signal Name
	DB9 male	DB9 female	See note	See note	DB9 male	DB9 female	
				SHLD			
Transmit data	3	3	RXD	RXD /RXD	4 6	4 6	Transmit /Transmit
Receive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

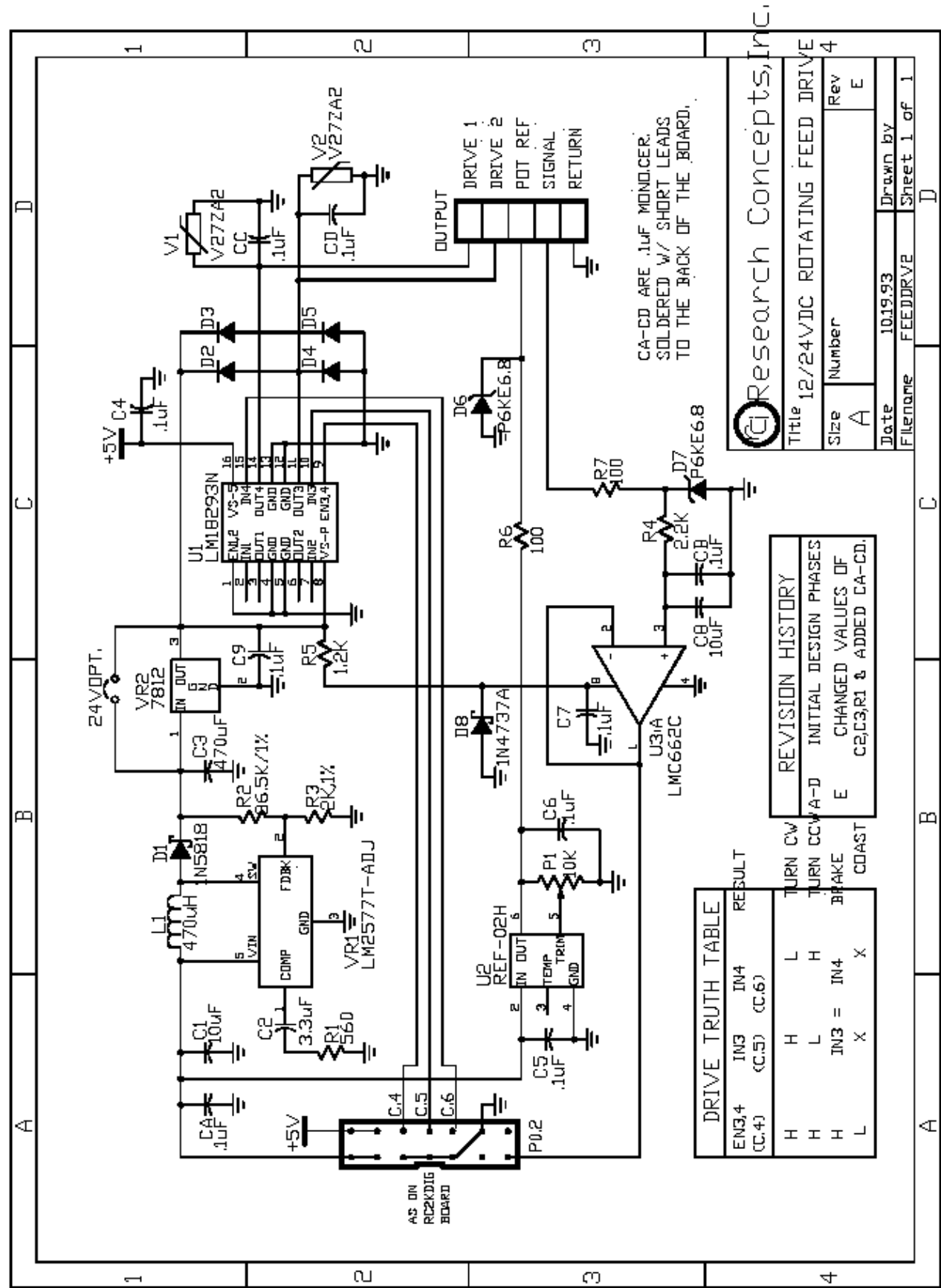
NOTE: The RC1KADP, J2/J3 connectors, are equipped with clasp type terminals. Each terminal can accommodate one two 20 AWG or smaller wires. Secure wire clasps with a 1/8" (3mm) wide straight blade screwdriver. If the RS-422 cable shielded, the shield should be connected to the SHLD terminal of connector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



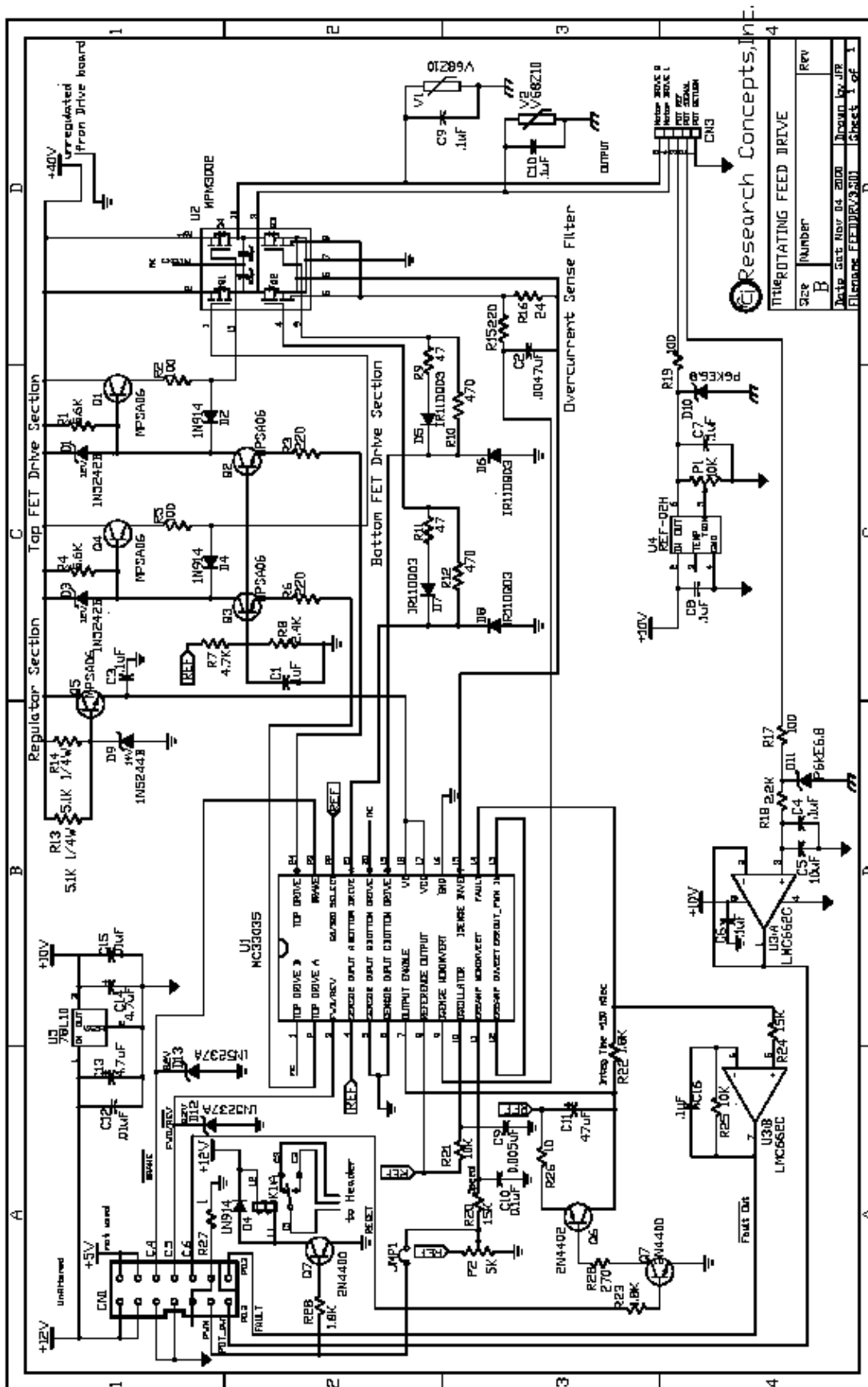
RC1KADP Schematic



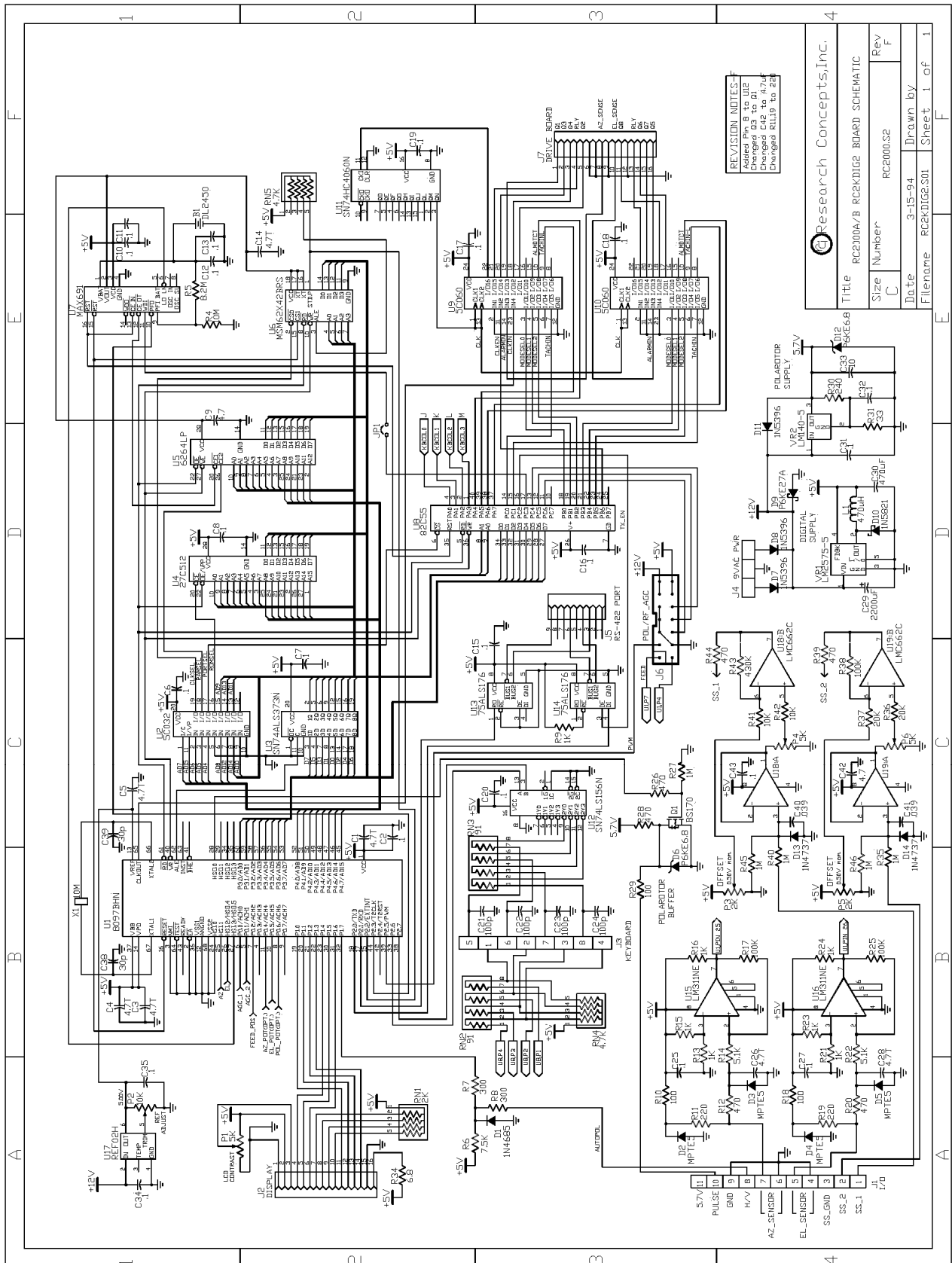
RC2KPOL Schematic



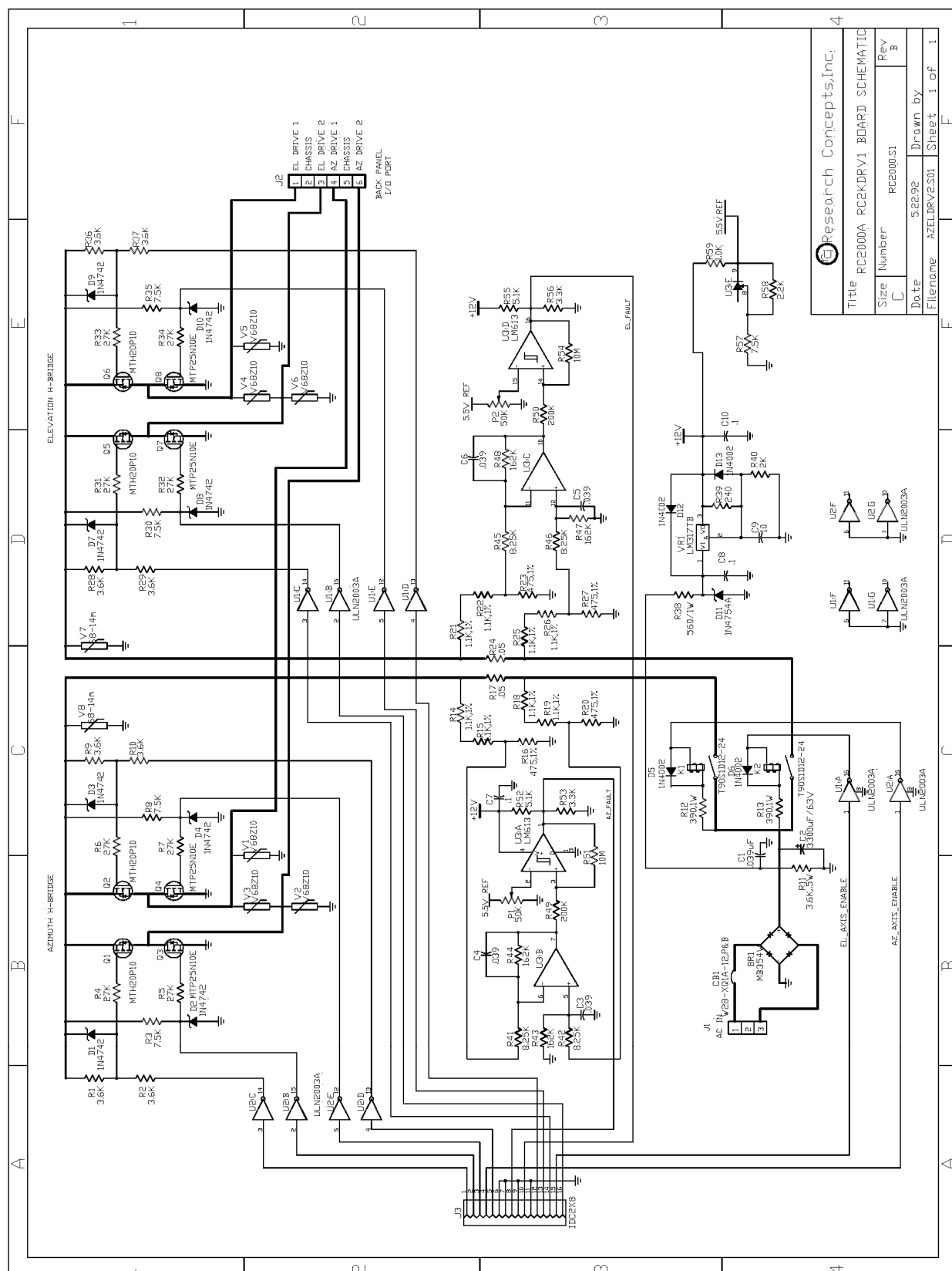
RC2KHPP Schematic



Processor Board Schematic



Drive Board Schematic



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: 5420 MARTINDALE ROAD
SHAWNEE, KANSAS 66218-9680 USA

Type of Equipment: Satellite Antenna Controllers

Model No's.: RC1500A, 1500B

Year of Manufacture: 1998

In order to meet the EMC directive, fully shielded, properly connected cable is required for all connection

I, the undersigned, hereby declare that the equipment specified above conforms to the above directives and standards.

Place: Shawnee, Kansas

James F. Ronnau, Vice-President
(Full Name, Title)

(Signature)