

RC2000A version 2.6x Addendum

1.0 Introduction

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

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

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

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

Minor changes to the software include ...

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

a) None – no polarization control device,

b) Chaparral type Polarotor servo polarization control device,

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

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

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

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

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

1.1 Version Identification

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

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

v 2.6xd

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

x is referred to as the software minor version number:

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

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

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

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

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

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

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

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

1.2 Organization of this Addendum

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

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

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

2.0 Signal Strength

To implement the peaking algorithm, the controller requires an analog input which indicates the strength of the received signal. Such a voltage is generated within a satellite receiver, and is referred to as an AGC signal (Automatic Gain Control). On many receivers this signal is available at a terminal on the back of the receiver. On satellite receivers this signal may also be referred to as a 'Signal Strength' or 'Tuning Meter' output. An AGC output typically varies in proportion to the received power of the transponder which the receiver is currently tuned to.

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

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

1. **AGC Polarity Flag** - This flag indicates to the controller whether a stronger satellite signal corresponds to a higher AGC voltage (positive polarity) or a lower AGC voltage (negative polarity). Both AGC channels must have the same polarity. Each AGC channel contains an internal pull down resistor. This means that if one of the AGC channels is unused, its input is pulled to ground. This can cause problems if the *AGC Polarity Flag* specifies negative polarity, because an input of zero volts (ground potential) corresponds to the strongest possible satellite signal. For this case the installer must place a jumper from connector J1, pin 11, to the unused AGC input channel and adjust that channel's potentiometers (after negative polarity has been specified) so that its signal strength value is 0. J1 - pin 11 has a potential of 5.7 volts.
2. **AGC C Band Threshold** - When the receiver is tuned to a C band satellite and the signal strength is above this value, it is assumed that a satellite signal is present. The same threshold is applied to both AGC channels.
3. **AGC K Band Threshold** - This is similar to the *C Band Threshold* described above, except it pertains to Ku Band. If the signal strength is above this value when the receiver is tuned to a Ku band satellite, the controller assumes that a satellite signal is present.

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

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

2.1 Controller AGC Potentiometer Adjustment

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

2.1.1 Single Frequency Band Potentiometer Adjustment

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

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

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

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

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

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

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

4. If the AGC voltage associated with the 'on satellite' case is greater than that of the 'off satellite' case, the receiver has POSITIVE AGC polarity (otherwise the receiver has NEGATIVE AGC polarity). Go to CONFIG mode and use the SCROLL keys to bring up the *AGC Polarity Flag* item. Key in the proper polarity using either the 0 or 1 key, and terminate the entry with the ENTER key.
- 5a. If two receivers are interfaced to the controller proceed to step 6. If the receiver's AGC has NEGATIVE polarity, go to step 5b. If the receiver's AGC has POSITIVE polarity, from MANUAL mode use the Scroll Up/Scroll Down keys to examine the signal strength for the AGC channel which was NOT selected in step 3. If the signal strength reading for that channel is greater than 10, adjust the OFFSET and GAIN for that channel until the signal strength reading for that channel is less than 10. To lower the displayed signal strength turn the OFFSET pot clockwise and the SCALE pot counter-clockwise. Proceed to step 6.

5b. If the receiver's AGC has NEGATIVE polarity and only one receiver is interfaced to the controller, connect a jumper from the controller's unused AGC input channel to connector J1, pin 11. From MANUAL mode use the Scroll Up/Down keys to examine the signal strength for the AGC channel which was not selected in step 3 above. If the signal strength reading for that channel is greater than 10, adjust the OFFSET and GAIN pots for that channel until the signal strength reading for that channel is less than 10. To lower the displayed signal strength value, turn the OFFSET pot counter-clockwise and the SCALE pot clockwise. When this is accomplished proceed to step 6.

6. In the next few steps of the procedure, the OFFSET and GAIN pots of the AGC channel(s) connected to the receiver's AGC output are adjusted so that the 'off satellite' signal strength value is between 50 and 100 and the 'on satellite' signal strength value is between 600 and 700. The adjustments are made from MANUAL mode.

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

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

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

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

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

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

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

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

9. Position the antenna 'off satellite'. If the signal strength is between 50 and 100, proceed to step 11. If the signal strength is less than 50 or greater than 100 perform steps 8 and 9 again.

10. Position the antenna 'on satellite'. Jog the antenna off of the satellite until the picture is just barely watchable. Note the signal strength value. Go to CONFIG mode and

use the SCROLL keys to bring up either the *AGC C Band Threshold* item or the *AGC K Band Threshold* item, whichever is appropriate for the frequency band that the user has chosen to operate at (and has adjusted the pots at). Key in the signal strength value noted above. Terminate the entry with the ENTER key.

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

2.1.2 Dual Frequency Band Potentiometer Adjustment

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

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

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

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

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

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

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

4. If the AGC voltage associated with the 'on satellite' case is greater than that of the 'off satellite' case, the receiver has POSITIVE AGC polarity (otherwise the receiver has NEGATIVE AGC polarity). Go to CONFIG mode and use the SCROLL keys to

bring up the *AGC Polarity Flag* item. Key in the proper polarity using either the 0 or 1 key, and terminate the entry with the ENTER key.

- 5a. If two receivers are interfaced to the controller proceed to step 6. If the receiver's AGC has NEGATIVE polarity, go to step 5b. If the receiver's AGC has POSITIVE polarity, from MANUAL mode use the Scroll Up/Scroll Down keys to examine the signal strength for the AGC channel which was NOT selected in step 3. If the signal strength reading for that channel is greater than 10, adjust the OFFSET and GAIN for that channel until the signal strength reading for that channel is less than 10. To lower the displayed signal strength turn the OFFSET pot clockwise and the SCALE pot counter-clockwise. Proceed to step 6.
- 5b. If the receiver's AGC has NEGATIVE polarity and only one receiver is interfaced to the controller, connect a jumper from the controller's unused AGC input channel to connector J1, pin 11. From MANUAL mode use the Scroll Up/Down keys to examine the signal strength for the AGC channel which was not selected in step 3 above. If the signal strength reading for that channel is greater than 10, adjust the OFFSET and GAIN pots for that channel until the signal strength reading for that channel is less than 10. To lower the displayed signal strength value, turn the OFFSET pot counter-clockwise and the SCALE pot clockwise. When this is accomplished proceed to step 6.
6. In the next few steps of the procedure, the OFFSET and GAIN pots of the AGC channel(s) connected to the receiver's AGC output are adjusted so that the 'off satellite' signal strength value is between 50 and 100 and the 'on satellite' signal strength value is between 600 and 700. The adjustments are made from MANUAL mode. Note that the GAIN and OFFSET adjustments are implemented using 20 turn pots. A lot of turns may be required.

To adjust the potentiometers, several quantities have to be identified for each receiver.

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

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

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

If both controller AGC inputs are utilized, record similar values for 'RCV1 – on satellite – strong band' _____ (C or Ku band) and 'RCV1 – off satellite – weak band' _____ (C or Ku band). If both controller AGC inputs are utilized steps 7

through 9 must be performed for each AGC channel. Use the Scroll Up/Down keys to view the AGC channel whose pots are being adjusted.

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

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

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

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

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

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

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

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

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

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

9. Position the antenna 'RCVx - off satellite – weak band'. If the signal strength is between 50 and 100, proceed to step 11. If the signal strength is less than 50 or greater than 100 perform steps 8 and 9 again.

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

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

2.2 Checking the AGC Pot Adjustments

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

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

Three possible problems can be encountered ...

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

2.2.1 AGC Above Threshold for Noise Input Test

To insure that (i) is unlikely to occur tune the antenna away from any satellite. Tune the receiver over all transponders on any frequency bands of interest. Watch the displayed

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

2.2.2 AGC Input Below Threshold for Active Satellite Transponder Test

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

Align the antenna with a weak satellite.

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

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

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

2.2.3 AGC Input Saturated for Active Satellite Transponder Test

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

Align the antenna with a strong satellite.

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

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

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

2.2.4 What to do if Problems are Found

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

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

If problems persist the usual culprit is gain flatness. An amplifier's gain vs. frequency characteristic, or gain flatness, is the variation of the amplifier's gain with changing

frequency. The ideal response is to have a flat gain characteristic (the gain does not vary with frequency).

There are four places in a satellite receiving system that may have gain flatness problems that can affect the peakup operation. These are the LNB, the coaxial cable connecting the LNB to the receiver, line amps (or bullet amps) inserted in the 950 - 1750 MHz IF, and the receiver's IF or AGC stages. If a spectrum analyzer is connected into the receiver's block IF line, the gain flatness of the LNB and any line amps present can be observed. When the antenna is pointed away from any satellite, the spectrum analyzer displays the received noise, which should be constant with frequency. If the display is not horizontal then some gain variation with frequency is present. The type (i) test above is essentially a test of gain flatness.

Most gain flatness problems can be traced to a problem with the coaxial cable connecting the antenna to the receiver (sometimes called a 'suck-out') or to bullet amplifiers. Some bullet amplifiers have been observed to have really terrible gain flatness characteristics.

3.0 Signal Strength Peakup

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

3.1 Enabling Peakups and Configuring Peakup Parameters

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

3.1.1 Enabling Peakups

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

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

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

3.1.2 Peakup Holdoff

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

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

3.1.3 Peakup Step Sizes

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

3.2 Peakup Algorithm

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

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

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

3. If the signal strength measured at the conclusion of the upward movement (measured in step 2) is greater than the signal strength measured at the starting position (measured in step 1) the controller will make another step upward and again

measure the signal strength. This process will continue until the controller makes a step that results in weaker signal strength or an error occurs (errors are described in section 3.3). When weaker signal strength is detected the controller backup one step – the peakup of the elevation axis is complete.

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

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

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

3.3 Peakup Errors

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

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

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

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

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

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

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

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

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

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

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

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

Signal Fading

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

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

AGC Noise

The controller's signal strength input is an analog signal typically generated by a receiver's AGC output circuits. A certain amount of noise is present in any analog

signal. The noise voltage is summed with the signal. The noise typically has an average value of zero volts. To minimize the affect of noise the controller's averaging interval can be increased. Note that an increase of the signal averaging time interval leads to an increased probability of a bad peaking decision due to signal fading as described in the previous section.

Mechanical Hysteresis

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

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

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

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

3.5 Step Size Selection

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

3.5.1 Azimuth and Elevation Step Size Calculation

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

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

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

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

Mathematically, this is represented as ...

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

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

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

Mathematically, this is represented as ...

Az Step Size (position counts) =

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

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

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

Antenna_Pointing_Error (deg) =

[SQRT[Signal_Loss (dB)] x 5.55] / [Antenna_Diameter (meters) x frequency (GHz)]

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

Antenna Diameter	C Band (degrees) 0.5 dB / 1.0 dB Pointing Loss	K Band (degrees) 0.5 dB / 1.0 dB Pointing Loss
2.4 meters	0.41 / 0.58	0.14 / 0.19

3.1 meters	0.32 / 0.45	0.11 / 0.15
3.8 meters	0.26 / 0.36	0.09 / 0.12
4.5 meters	0.22 / 0.31	0.07 / 0.10
6 meters	0.16 / 0.23	0.05 / 0.08

3.5.3 Determining The Antenna Azimuth and Elevation Count per Degree Characteristic

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

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

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

Satellite Location (longitude)	Azimuth Position Count	Elevation Position Count	Antenna True Heading (degrees from true north)	Antenna Elevation Heading (degrees)
87° West	1455	1639	136.0	25.4
99° West	2110	2167	149.5	30.7

The columns labeled 'azimuth position count' and 'elevation position count' represent the position of the satellite in the controller's non-volatile memory. The data in the columns labeled 'Antenna True Heading' and 'Antenna Elevation Heading' is obtained from the ANTENNA.EXE program.

Here is a screen shot of the ANTENNA.EXE program for the satellite located at 87° West. Note that for geostationary satellites, the Inclination field in ANTENNA.EXE should be set to 0.0.

Antenna Location

Latitude: 47.40
Longitude: -122.30
Mag Variation: -18.73

Satellite Data

Longitude: -87.00
Inclination: 0.00

Pointing Solution (in degrees)

Elevation: 25.4
True Heading: 136.0
Mag Heading: 117.3

Here are the calculations for the antenna azimuth and elevation count per degree characteristics for the data in the table above.

Azimuth Counts per Degree =

$$[2110 - 1455] / [149.5 - 136.0] = 375 / 13.3 = 48.5 \text{ counts per degree}$$

Elevation Counts per Degree =

$$[2167 - 1639] / [30.7 - 25.4] = 355 / 5.3 = 99.6 \text{ counts per degree}$$

Here are some count per degree characteristics that have been tabulated for

3.5.4 Azimuth Step Size Correction Factor (for Elevation over Azimuth Antenna Mounts)

The azimuth step size calculation requires a Correction Factor that relates antenna movement about the azimuth axis to the change in antenna pointing angle. The azimuth step size should correspond to a change in the antenna pointing angle that will reduce the received signal strength by 0.5 or 1.0 dB. In section 3.5.1, pointing angle change required to produce a 0.5 and 1.0 dB drop in signal strength is calculated. The Correction Factor is required because when the antenna is not at zero degrees elevation (pointing at the horizon) a one degree change in azimuth angle changes the antenna pointing angle by an amount less than one degree.

The Correction Factor is the number of degrees of azimuth movement required to produce one degree of antenna pointing angle change. The Correction Factor is a function of elevation angle. The Correction Factor is larger for higher elevation angles.

Correction Factor vs. Elevation Angle

Antenna Elevation Angle	10 deg	20 deg	30 deg	40 deg	50 deg	60 deg	70 deg	80 deg
-------------------------	--------	--------	--------	--------	--------	--------	--------	--------

Correction Factor	1.02	1.05	1.15	1.31	1.46	2.00	2.92	5.78
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An antenna with an elevation over azimuth mount works over a range of elevation values. The exact range is a function of earth station latitude and the difference in longitude between the earth station and the satellite.

The following table lists elevation look angles vs. antenna latitude for i) satellites located at the same longitude as the antenna, and ii) satellites whose longitude is 50 degrees away from that of the antenna. The table also includes a recommended value for the Correction Factor used for antennas located at that antenna latitude.

Antenna Latitude	25°	30°	35°	40°	45°	50°
Elevation Angle for satellite whose longitude value is the same antenna.	60.8°	55.0°	49.4°	43.7°	38.2°	32.7°
Elevation Angle for satellites separated from the antenna by 50 degrees longitude.	28.0°	26.0°	23.8°	21.4°	18.8°	16.1°
Recommended Correction Factor	1.75	1.50	1.40	1.30	1.25	1.10

3.5.5 Recommended Step Sizes for Various Antennas

In the following tables, the first value in each field corresponds to a step size that will result in a 0.5 dB drop in received signal strength (assuming that the antenna was perfectly aligned with the satellite before the antenna movement occurred). The second value in each field is the step size that will correspond a drop in received signal strength of 1.0 dB.

Antenna Type: EASi 4.5 meter ViaSat reflector, Baird mount, 90 volt DC Az/EI Motors

Azimuth and Elevation Step Sizes

Band	Elev Step Size	Azimuth Step Size vs. Antenna Site Latitude (0.5 dB steps/1.0 dB steps)					
		25 degrees latitude	30 degrees latitude	35 degrees latitude	40 degrees latitude	45 degrees latitude	50 degrees latitude
C Band	22/31	19/27	16/23	15/22	14/20	14/19	12/17
Ku Band	7/10	6/9	5/8	5/7	5/7	5/6	4/6

3.6 Specifying the Satellite Band When Upgrading From a Previous Version of the Software

Most previous versions of the RC2000A software (all versions before v2.4x) did not prompt the user to specify the satellite band when a satellite was programmed into non-volatile memory via SETUP mode. The peaking feature of the controller requires band information to select the az/el stepsize before the peakup operation can occur. To accommodate upgrades of these controllers a Band Edit mode has been created. To enter Band Edit mode enter 1984 at the controller's Expert Access prompt. This will immediately cause control to transfer to the Band Edit mode (which is actually a sub-set of AUTO mode).

In Band Edit mode the satellite band will be displayed to the right of the satellite name. The user can hit the 0, 1, or 2 keys to specify the satellite band. The value entered by the user is stored in non-volatile memory. To exit the Band Edit mode use the Mode key to change the mode. Peakups can still be performed via the front panel if the satellite band has not been defined. In this case the user will be prompted to specify either C or Ku band. Remote commands that initiate a peakup specify the band.

4.0 Other Features Introduced with the RC2000 v2.6x

In addition to the optional peakup capability described earlier, several other modifications were introduced with the RC2000A version 2.6x software.

These include

1. The RC2000 can service remote Device Status Poll commands without transferring control to REMOTE mode.
2. The RC2000A communication protocol now supports the upload/download of all configuration and satellite data. The additions to the controller's communications protocol is described in section 5.
3. The CONFIG mode system has been modified to allow a user to access any corrupt CONFIG mode item as long as Expert Access is enabled.
4. A sticky key jog feature that is useful during system setup or when cutting antenna patterns. See section 4.1 for more information.
5. The controller now displays signal strength information received via the AGC1 (automatic gain control channel 1) and AGC2 inputs. In MANUAL mode the user can use the Scroll Up/Down keys to display either the signal present at the AGC1 input, the AGC2, or the strongest signal on AGC1/AGC2. See section 4.2 for more information.
6. The following CONFIG mode items have been added ...

AGC Polarity Flag, AGC C Band Threshold, AGC K Band Threshold – these items are related to signal strength display (section 2) and the peakup system (section 3),

Peakup Enable, C Band Az Step Size, C Band El Step Size, K Band Az Step Size, K Band El Step Size, Peakup Holdoff Interval – these items configure the peakup system (section 3),

Polarization Motor CCW Limit, Polarization Motor CW Limit, Azimuth CW Limit, Azimuth Position, Elevation Up Limit, and Elevation Position. See section 4.3 for more information on these CONFIG mode items.

7. Enhanced support for various types of polarization control devices. See section 4.4.
8. With version 1.6x of the RC2000A software, a feature was added that allows the user to disable azimuth and elevation runaway alarms. That feature is documented in section 4.5.

Section 4.6 provides information for users upgrading from a previous version of the software.

4.1 Sticky Key Jog

The controller has been modified to support a feature referred to as Sticky Key Jog. This feature is sometimes useful during antenna setup and while cutting antenna patterns. With Sticky Key Jog, in MANUAL mode, an az/el jog is initiated by hitting the Az CCW, Az CW, El Down, or El Up keys. Once a sticky key jog is initiated it will continue until the user hits the Stop key, the antenna encounters a limit, or the controller exits MANUAL mode.

To activate a Sticky Key Jog, at the CONFIG mode Expert Access prompt enter 50562. Control will immediately transfer to MANUAL mode. The Sticky Key Jog will be enabled until the user exits MANUAL mode by hitting the Mode key, the controller is powered down, or a remote command is received that causes activation of REMOTE mode.

4.2 Signal Strength Display From Manual Mode

The controller now displays signal strength in MANUAL, SETUP, LIMIT, and REMOTE modes. The signal strength value is derived from the analog voltages presented to the controller's AGC1 and AGC2 inputs. Section 2 of this addendum describes the configuration and calibration of the controller's signal strength display.

Normally, the controller displays the signal strength of the AGC input with the greatest signal strength. In MANUAL mode the Scroll Up/Down keys can be hit to select the quantity displayed to the right of the 'S:' banner. The controller accepts two channels of AGC input, referred to as AGC1 and AGC2. Hitting the Scroll Up or Scroll Down keys causes the S: banner to toggle between '1:' (AGC1 channel displayed), '2:' (AGC2 channel displayed), and 'S:' (the greater of AGC1 or AGC2 displayed).

4.3 New CONFIG Mode Items

Several new CONFIG mode items have been defined to support the upload and download of the controller's non-volatile memory. All of the following CONFIG items specify data that can be entered via other modes.

Pol CCW Limit and Pol CW Limit

These items can also be specified via POL LIMITS mode if a rotating feed is present (Pol Control set to One Port or Two Port).

Azimuth CW Limit and Azimuth Position

Setting the Azimuth CW Limit CONFIG mode item also initializes the Azimuth CCW Limit to 30. Normally these limits are set via LIMITS mode. The Azimuth Position count is normally set to 30 when the Azimuth CCW Limit is set via LIMITS mode. The Azimuth Position count can also be set via RE-SYNC mode.

Elevation Up Limit and Elevation Position

Setting the Elevation Up Limit CONFIG mode item also initializes the Elevation Down Limit to 30. Normally these limits are set via LIMITS mode. The Elevation Position count is normally set to 30 when the Elevation Down Limit is set via LIMITS mode. The Elevation Position count can also be set via RE-SYNC mode.

4.4 Polarization Control Options

In the v2.6x revision of the RC2000A software the Rotating Feed Present CONFIG mode item has been replaced with the Pol Control? CONFIG mode item. At the Pol Control CONFIG mode prompt the user can specify either None, One Port, Two Port, or Polarotor. At the Rotating Feed Present CONFIG mode prompt found in earlier versions of the software the user could specify No for polarotor control or Yes for a (one port) rotating feed.

The following paragraphs describe the various possible responses to the Pol Control? CONFIG mode prompt.

1. If the user enters None at the Pol Control? prompt the controller assumes that a polarization control device is not present in the system. Polarization jog commands are ignored and the user is not prompted to specify polarization values in SETUP mode.
2. One Port refers to a single port rotating feed powered by a DC motor that employs a potentiometer for position feedback. This type of feed can only receive a single signal (and only has one LNB). When a single port feed is looking at a satellite that transmits both horizontally and vertically polarized signals, the controller has to 'remember' both a horizontal and vertical position for each satellite. Accordingly, the user is prompted for horizontal and vertical polarization positions in SETUP mode. If this option is specified the RC2KPOL polarization control daughterboard must be installed in the controller. Setting the Pol Control? CONFIG mode item to One Port results in controller operation identical to that of older versions of the software with the Rotating Feed Present CONFIG mode item set to Yes.
3. A two port feed can receive horizontally and vertically polarized signals simultaneously. Like a one port feed, a two port feed is powered by a DC motor, employs a potentiometer for position feedback, and requires that the RC2KPOL daughterboard be installed in the controller. In SETUP mode, when a single band (either C or Ku) satellite is specified the user is only prompted to specify a single polarization. When the feed is adjusted to that position it can receive horizontally and vertically polarized signals simultaneously. In SETUP mode, when a dual band satellite is specified the user is prompted to specify both a C Band and Ku Band polarization position (they can be set to the same value).

This behaviour for dual band satellites when a two port feed is specified is designed

to accommodate the Seavey Engineering Associates ESA 124D feed. The ESA 124D feed can simultaneously receive horizontal and vertical signals for both C and Ku bands. Most satellites that include both C and Ku band transponders (also known as hybrid satellites) have identical horizontal and vertical polarization orientations for C and Ku band. Some satellites, however, do have unique H/V polarization orientations for C and Ku band.

4. A polarotor is a 3 wire servo developed by Chaparral Communications. A polarotor is a single port device (meaning it can only receive a single signal for a given band). Some polarotor based feeds can receive C and Ku band signals simultaneously.

4.4.3 RC2000 Non Volatile Memory Satellite Data Polarization Position Fields

Satellite data is stored into the RC2000A's non-volatile memory via the controller's SETUP mode. When the Pol Control? CONFIG mode item is set to something other than None, SETUP mode prompts the user to specify the band (C, Ku, or hybrid C and Ku) of each satellite stored in non-volatile memory. Each satellite data entry contains two polarization position values. One normally holds the horizontal polarization position and the other the vertical polarization position.

If the antenna is equipped with a two port feed and the user specifies either a C band satellite or a Ku band satellite (i.e. not a hybrid satellite) the user will only be prompted to supply a single polarization position. For this case, the polarization position supplied by the user is copied to both polarization positions associated with the satellite data entry.

If the antenna is equipped with a two port feed and the user specifies a hybrid satellite, SETUP mode prompts the user to specify whether or not he or she wishes to specify unique C and Ku band polarization values. If the user opts to provide unique C and Ku band polarization values the C band polarization position is stored in the location commonly employed to store the horizontal polarization position. The Ku band polarization position is stored in the location normally used to store the vertical polarization position.

4.4.4 Polarization Code Display

Previous versions of the RC2000 displayed 'H', 'h', 'V', or 'v' to indicate the present polarization position. To do this the RC2000 keeps track of the satellite data entry in non-volatile memory that is closest to the current antenna az/el position. The polarization position values associated with this 'closest satellite' are compared to the current polarization position. If the current polarization position is very close to the horizontal polarization position of the satellite data entry of the 'closest satellite' an 'H' is displayed. If the current polarization position is somewhat close to the horizontal position of the closest satellite 'h' is displayed. Similarly for display of 'V' and 'v'.

With introduction of support for a Two Port feed, the pol code display scheme described above was modified in the following manner when the user has specified that the antenna is equipped with a two port feed ...

If the 'closest satellite' is specified to be either a C band or Ku band satellite (i.e. not a hybrid satellite), the polarization code displayed will be either 'X' or 'x'. For this case both the 'horizontal' polarization field and the 'vertical' polarization field associated with the satellite's entry in non-volatile memory will contain identical values. If the current

polarization position is very close to the polarization positions stored in non-volatile memory an 'X' will be displayed. Somewhat close and an 'x' is displayed.

If the closest satellite is a hybrid satellite (both C and Ku band) and the two polarization positions associated with the satellite's data entry in non-volatile memory are THE SAME, the displayed polarization codes will again be 'X' or 'x'.

If the closest satellite is a hybrid satellite (both C and Ku band) and the two polarization positions associated with the satellite's data entry in non-volatile memory are DIFFERENT the displayed polarization codes will again be 'C', 'c', 'K', or 'k'.

4.4.5 AutoPol Disabled for Dual Port Feeds

The RC2000A supports a feature called AutoPol. The AutoPol system slaves the RC2000A's polarization control output to a digital input to the controller. AutoPol is commonly enabled when the antenna is equipped with a polarotor servo type polarization control device. Many analog receivers provide provide an output for an H/V select relay. This output can often be tied directly to the RC2000's AutoPol Input. As the user selects satellite transponders with the receiver the controller commands the polarotor to the H/V values corresponding to the satellite that was the last target of an auto move (or the closest satellite if the antenna has been jogged since the last auto move). The AutoPol Enable and AutoPol Vpol Level CONFIG items enable and configure the system.

With version 2.6x of the RC2000A software, the behavior of the AutoPol system was modified. With version 2.6x, if the Pol Control? CONFIG mode items is set to Two Port the AutoPol system is disabled regardless of the state of the controller's AutoPol Enable flag. Note that previous versions of the RC2000A only allowed the user to select either a Polarotor type polarization control device or a Rotating Feed. If this altered behaviour of the AutoPol System causes a problem, set the Pol Control Equipment code to One Port even if a two port feed is connected to the system. With the Pol Control? CONFIG mode item set to One Port, version 2.6x (and later versions of the software) will behave in a manner identical to previous versions of the software with respect to the AutoPol system.

4.5 Azimuth/Elevation Axis Runaway Alarm Disable

The RC2000 is designed to interface to antenna mounts that employ pulse type position sensors on the azimuth and elevation axis. A runaway alarm occurs when the antenna controller's pulse position input circuit detects a position pulse and the antenna has not been commanded to move and is not in a coast interval immediately following a move.

The term 'coast interval' requires an understanding of the antenna controller's anti-reversal system. When a runaway alarm is triggered for a given axis the bottom row of the display will flash AZIM ALARM or ELEV ALARM and further movement about that axis is disabled. Note that an overcurrent or jammed condition can also trigger these alarms. The controller's RESET mode will allow the user to determine type of fault that triggered the alarm and also reset the alarm.

The anti-reversal system is controlled by the Azim Fast Deadband, Azim Slow Deadband, Elev Fast Deadband, and Elev Slow Deadband CONFIG mode items. The operation of the anti-reversal system is described by an example. Assume that the antenna is moving about the elevation axis in the upward direction at fast speed (either

as part of an automatic move or a manual jog operation). When the antenna elevation drive is released the controller will not allow the antenna to move in the downward direction until the drive has been idle for a time interval (in milliseconds) defined by the Elev Fast Deadband CONFIG mode item. This keeps the antenna from rapidly reversing direction. If the antenna was driven in the upward direction and was suddenly commanded to move in the downward direction, for a short time the antenna would continue to move in the upward direction before reversing direction and moving downward. Any elevation position pulses that occur between the time when the antenna is commanded to move downward and actually begins moving downward will not be accumulated properly. This will lead to an inaccurate elevation position count.

A 'coast interval' is the time immediately after a move in a given direction about a given axis when the controller will not allow the antenna to move in the opposite direction about that axis. To repeat, a runaway position count (for a given axis) is a position count that occurs when the antenna is not commanded to move and is not in the coast interval immediately following a move (about the axis).

Previous versions of the RC2000A software (version 1.50 and earlier) would activate a runaway alarm whenever a runaway position count was detected. The software modification described in this addendum allows the user to modify the behavior of the runaway system to either disable runaway errors or to require that more than one runaway count occur before the runaway alarm is triggered.

I-4.5.1 Configuring the Runaway Sensing System

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

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

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

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

4.6 Upgrading Controllers

This section contains information for customers with older controllers upgrading to the most current version of the software.

I-4.6.1 Precautions

To upgrade the RC2000 controller's software an EPROM has to be replaced (U4 on the controller's digital board – the digital board is the one without the large heatsink).

The memory map of this version of the software is compatible with controller's currently running software versions 1.30 and higher. This means that it is possible to update the EPROM and not corrupt the contents of the controller's non-volatile memory (current positions, limits, satellites and CONFIG mode items).

Note that whenever IC's (like the EPROM) are replaced there is a slight chance that the contents of non-volatile memory will be corrupted. For this reason we recommend that the user make a record of the contents of the controller's non-volatile memory. This includes the CONFIG mode items and satellite data. To record satellite data use AUTO mode to position the antenna on each of the satellites stored in non-volatile memory. Record the satellite name, azimuth position, elevation position, H position (horizontal polarization), and V position (vertical polarization) values for each satellite. It is also recommended that the user position the controller at the antenna's east (azim ccw) and down limit before powering the controller down to replace the EPROM.

When replacing the EPROM, make sure that the notch on the end of the IC package is aligned with the notch on the IC socket and the notch depicted on the silkscreen on the top of board. Some users remove the keyboard cable from the connector on the digital board when replacing the EPROM. If the cable is removed make sure that the cable is properly connected. If the controller powers up but the keyboard is un-responsive check the cable.

I-4.6.2 Rotating Feed Present CONFIG Mode Item Replaced

The Rotating Feed Present CONFIG mode item is not present on this version of the software. The type of polarization control device attached to the system is now specified via the Pol Control? CONFIG mode item. The Pol Control? mode item is described in section I-4.4 Polarization Control Options.

The Pol Control? CONFIG mode item allows the user to specify the following types of polarization control equipment ... i) no polarization control device, ii) one port polarization control, iii) two port polarization control, or iv) Chapparral Polarotor type three wire servo.

It is possible to have the latest software emulate the operation of previous software versions that contain the Rotating Feed Present CONFIG mode item.

To emulate the polarization control behavior of previous versions of the software where the Rotating Feed Present CONFIG mode item is set to 0 (FALSE), specify 3 – Polarotor at the Pol Control? prompt.

To emulate the polarization control behavior of previous versions of the software where the Rotating Feed Present CONFIG mode item is set to 1 (TRUE), specify 1 – One Port at the Pol Control? prompt.

Note that if Two Port polarization control is specified the controller's AutoPol feature is disabled regardless of the state of the AutoPol CONFIG mode item.

I-4.6.3 Satellite Band Data

Versions of the RC2000A software before v2.4x did not prompt the user to specify the satellite band when a satellite was programmed into non-volatile memory via SETUP mode. The peaking feature of the controller requires band information to select the az/el stepsize before the peakup operation can occur. If a peakup is specified and satellite band information is not available for a given satellite the controller will prompt the user to specify the satellite band before a peakup occurs.

It is possible to edit a satellite's band data entry in the controller's non-volatile memory. This feature is described in section I-3.6.