

Addendum - RC2000X v2.4x Software

1.0 Introduction

RC2000X v2.4x adds support for tracking satellites operating at C, Ku, X, or Ka bands. Previous versions of the RC2000 ACU supported tracking inclined orbit satellites operating at two bands

The RC2000X is derived from the Research Concepts RC2000C software.

This document describes the differences between the RC2000X and the RC2000C. The new features introduced with this revision will be noted by *RC2000X v2.4x*.

1.1 Software Enhancements

Here are the major software features supported by the RC2000X v2.4x software relative to the RC2000C. The section of this document that describes each feature is referenced in parenthesis.

1. In Setup mode, when the user specifies an inclined orbit satellite the user is prompted to select one of four satellite bands, C, Ku, X, or Ka (4.6). The reply to the remote status query command properly reports the satellite band when tracking an inclined orbit satellite (5.7).
RC2000X v2.4x
2. The two AGC 'Threshold Config mode items have been redefined. One threshold value is now associated with the AGC1 analog input, the other threshold value is associated with the AGC2 input. On ACU's that include a beacon receiver, the beacon receiver output is routed to AGC2 and the AGC threshold prompt is 'BEACON RX THRESHOLD' (4.7). *RC2000X v2.4x*
3. The software implements the keystuff and display reflect protocol. This allows the controller to 'receive' front panel keystrokes via the serial port and reflect the contents of the controller's LCD (5.2).
4. The controller does not switch to Remote mode when a Query Status command is received (5.1).
5. In CONFIG mode, any user has access to CONFIG items that contain invalid data.
6. The Track Menu View function allows a user to edit the Az/EI positions in the track table (4.1).
7. If the controller is left in the Track Menu sub mode and a key is not depressed for 60 seconds the controller will exit the menu sub mode and resume tracking operations (4.2).
8. The Track Manual Search has been modified so that the controller will automatically start Step Track operation if a signal is present and the user has not manually jogged the antenna (4.3)
9. The user can configure the controller to step track anytime signal strength is available. Control will transfer to the Program (memory) Track or Search submodes whenever signal strength is not available (4.4).
10. From SETUP mode, the user can specify an inclined orbit satellite with an inclination of zero. This will cause the controller to remain in the Step Track submode and periodically peakup the antenna if signal strength is available. Control will not transfer to the Search or Program (memory) Track submodes (4.5).

11. The software can be compiled to support tracking C, K, and X band satellites. The standard RC2000C software supports tracking at C, K, and L bands. Section 2.0 describes how to identify versions of the software that support X band tracking.
12. The software can be compiled to support an az/el speed select bit. Section 2.0 describes how to identify versions of the software that support this feature (see Output_Bit).

1.2 Limitations Relative to the RC2000C Software

The RC2000X software does not support the Polarotor 3 wire PWM servo based polarization control system.

2.1 EPROM Labeling and Source File Names

The label on Eprom devices used in RC2000X controllers will contain the software version number and suffix, the date the software was compiled, as well as the checksum of the software.

An example of an Eprom source file name for RC2000X software would be '2X0U__K.HEX' where '2X' indicates RC2000X, '0' is the software Sub Version number, and 'UT__K' is the software suffix.

3.0 Differences Between the RC2000X Software and the RC2000C Documentation

An Operator's Manual specific to the RC2000X software has not been produced. This section describes the differences between the operational characteristics of the RC2000X software and RC2000C software.

3.1 Polarization Control Equipment

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The default polarization control scheme for the RC2000C is the Polarotor based 3 wire servo. The Polarotor is a pulse width modulated (PWM) based open loop polarization control scheme. The Polarotor rotates a wire probe in the antenna feed horn (receive only) to select antenna polarization. The controller sends a PWM waveform to the Polarotor device to control the orientation of the wire probe. Polarization control with a Polarotor is open loop - the Polarotor sends no position feedback information to the controller.

If the optional RC2KPOL daughter board is installed in the controller, the RC2000C can also interface with a rotating feed powered by a low voltage DC motor that employs a potentiometer. An installer specifies which type of polarization control scheme is present in a given system via the Rotating Feed Present CONFIG mode item. If Rotating Feed Present is set to 0 the controller assumes that a Polarotor based polarization control device is present. If Rotating Feed Present is set to 1 the controller assumes that the RC2KPOL daughter board is installed.

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The RC2000X does not support a Polarotor. It only supports the RC2KPOL daughter board. The Rotating Feed Present CONFIG mode item of the RC2000C has been replaced with the Pol Control Equipment Code. The permissible values for this item are 0 for No Polarization, 1 for Single Port Motorized Feed, and 2 for Dual Port Motorized Feed.

If the Pol Control Equipment Code is set to 0, the controller assumes that the daughter board is not installed.

If the Pol Control Equipment Code is set to 1, the controller assumes that a motorized feed is present in the system and the feed cannot simultaneously receive horizontally and vertically polarized signals. When programming a satellite into the controller's memory the user is prompted to specify both horizontal and vertical polarizations. When performing an automatic move to a satellite the user is prompted to select either horizontal or vertical polarization.

If the Pol Control Equipment Code is set to 2, the controller assumes that a motorized feed is present in the system and the feed can simultaneously receive horizontally and vertically polarized signals. When programming a satellite into the controller's memory the user is prompted to specify a single

polarization position. During an automatic move to a preset satellite, the user is not prompted to specify a polarization.

3.2 Runaway Sensing

The RC2000 antenna controllers are designed to interface to single phase (as opposed to quadrature) pulse encoders. An azimuth or elevation runaway alarms occurs when a position pulse is accumulated by the controller when the antenna has not been commanded to move and is not in the coast interval immediately following Az or EI movement. The RC2000 has a 'back door' method to allow the user to disable runaway errors via the Az/EI Fast Deadband CONFIG mode item.

RC2000C

Section 7.3 – Operational Troubleshooting Tips of the RC2000C manual describes the method employed by the RC2000C to disable runaway alarms.

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If the value assigned to the Az/EI 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. Examples of Az/EI Fast Deadband values that disable runaway sensing are 2040 and 940.

If the value assigned to the Az/EI 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 Az/EI Fast Deadband CONFIG mode item has a value of 1845 six runaway position counts must be accumulated before an azimuth runaway alarm is triggered.

Runaway Sensing for the Prodelin 3.8 Meter Antenna

Special versions of the RC2000C (and 'X') software were created for the Prodelin 3.8 meter antenna. RC2000C and 'X' software version numbers that end in '4' indicate that the software was customized for use with the Prodelin 3.8 meter antenna. For example, RC2000C version 1.34 is optimized for use with the Prodelin 3.8 meter antenna.

In both the RC2000C and RC2000X software, for the Prodelin 3.8 meter antenna, the azimuth and elevation runaway thresholds are fixed at a value of 4 and they cannot be changed via the Az/EI Fast Deadband CONFIG mode item.

3.3 Access to CONFIG Mode Items

For the RC2000C, user access to certain CONFIG mode items is dependent on the state of the Expert Access Flag and the values of other CONFIG mode items. With the RC2000C, if a CONFIG Mode item contains invalid data the user might have to enable Expert Access or adjust the values of other CONFIG Mode items to access the CONFIG mode item that contains invalid data. For the RC2000X, any user has access to any CONFIG Mode item that contains invalid data.

3.4 Speed Select Output Bit

Starting with version 1.7x of the RC2000X software, the software can be compiled to support a speed select bit. See section 2.0 (Output Bit) to identify software versions that support the speed select bit. The speed select output bit is at RC2000 connector J1-10 labeled PULSE.

For az/el fast speed, 5.7 volts will be present on this output. The output impedance is 570 ohms. For az/el slow speed, the 'output' bit is pulled to ground via a 100 ohm resistor. This output is compatible with the PULSE input (J3-2) of the FB-2KINT circuit board used in the Research Concepts 2K90INT-1 and 2K90INT-2 90 volt DC antenna interface units.

The voltage applied to the output terminal should not exceed 6 volts.

The RC2000X can be configured to support simultaneous az/el movement via the CONFIG mode Simultaneous Az/EI Enable item. When enabled, simultaneous az/el movement will occur during automatic moves at fast speed. When making an automatic move to a target position with simultaneous az/el movement enabled, if the azimuth and elevation separation between the starting position and target position is greater than Az/EI Fast Slow Threshold (a CONFIG mode item) position counts, azimuth and elevation movement will occur at fast speed. When either axis gets within Az/EI Fast Slow Threshold of the target position, simultaneous azimuth and elevation motion will cease. The controller will next position the antenna in azimuth and then elevation.

4.0 RC2000X Tracking Enhancements

4.1 Track Table Edit

The Track Table contains the Azimuth and Elevation positions used by the controller when Memory Track is active. With the RC2000X, the user can edit the Track Table via the Menu – View function. A track table entry that is not initialized has azimuth and elevation values of 65535.

4.2 Track Menu Mode Timeout

With the RC2000X software, if the controller is left in the Track Menu sub mode and a key is not depressed for 60 seconds, the controller will exit the menu sub mode and resume tracking operations. With the RC2000C code, tracking operations cease when the Track Menu is active.

4.3 Manual Search

When Track Manual Search is active, if the user has not hit a key and signal strength above threshold is detected, the controller will automatically transition to the Step Track sub mode.

On entry to Track Mode, if Track Table data is not present and auto search is disabled, the controller will perform an AutoMove to the nominal position for the satellite (the nominal position is the position stored by the user when the track was initiated via Setup Mode). This insures that if signal strength is detected it is for the correct satellite.

4.4 Step Track Whenever Signal Strength is Present

If the user sets the Track Update Check Interval to 0, stay in the Step Track sub mode anytime signal strength is present. If signal strength is not available and track table data is available, the Program (or Memory) sub mode will become active. Otherwise, the Search sub-mode will activate.

The user has access to the Track Update Check Interval item via the Track Menu Modify function.

4.5 Periodic Peaking on GeoStationary Satellites

In SETUP mode, the user can specify an inclined orbit satellite with zero inclination. When 'tracking' a satellite with zero inclination, the controller will stay in the Step Track sub mode, Search and Program (Memory) Track submodes will not be invoked. Peaking will occur if signal strength is present.

When an inclined orbit satellite with zero inclination is specified, the Search Retry TRAK mode '0-Menu' item is replaced with the following prompt ... 'PEAK INTERVAL 0-999 MIN:'. The Peak Interval specifies the time (in minutes) between Step Track peakup operations. If the user specifies a Peak Interval of 999 the controller will perform a single peakup operation when the Step Track submode is activated. If the user specifies a Peak Interval of 0, the controller will continuously peak in azimuth and elevation if signal strength is present.

4.6 Quad Band Inclined Orbit Satellite Tracking

In Setup mode, for an inclined orbit satellite the user is prompted with ... 'SELECT BAND 0-C,1-K,2-X,3-Ka:'. Note that the ACU uses the receive frequency associated with each band for step size and peakup interval.

Earlier versions of the RC2000C and RC2000X software allowed the user to specify dual band C/Ku satellites. If the user selected one of these satellites, there was a prompt for either C or Ku band in Setup, Auto, and Menu modes. With version 2.4x, the user cannot specify a dual band satellite. The Menu mode prompt has been removed.

4.7 AGC Input Channel Thresholds

With version 2.4x of the RC2000X software ...

For ACU's that do not include a tracking receiver ...

The user is prompted for either 'AGC1 Threshold' or 'Bcn Rx Threshold'.

For ACU's that include a tracking receiver ...

The output of the tracking receiver is internally routed to the ACU's AGC2 analog input.

The user is prompted for either 'AGC1 Threshold' or 'AGC2 Threshold'.

The ACU uses whichever AGC channel has the greatest signal strength. If the AGC1 level is greater than the AGC2 level, the ACU compares AGC1 to the 'AGC1 Threshold' to determine if a signal is present and the the ACU can peak. AGC2 behaves in a similar manner.

Previous versions of the RC2000X software behave in a manner identical to the RC2000C. Specifically, with these versions of the software the user is prompted the 'AGC CBand Threshold' and 'AGC KBand Threshold' values. These thresholds are applied to whichever AGC input channel has the greatest signal strength.

5.0 RC2000X Serial Interface Enhancements and Modifications

5.1 Device Status Poll Command Does Not Cause Remote Mode to Become Active

An RC2000C controller switches to Remote Mode when a Device Status Poll command is received. The RC2000X can reply to the Device Status Poll command without changing modes.

5.2 Keystuff and Display Reflect

The software now supports remote keystuff and display reflect serial commands. This allows the controller to 'receive' front panel keystrokes via the serial port and reflect the contents of the controller's LCD. With this capability a remote user can completely setup and configure an RC2000X controller that has serial communications enabled.

Prior versions of the RC2000 allowed the user to jog the antenna and recall satellites via remote commands but did not allow a user to configure the controller.

Here is a description of the keystuff and display reflect protocol ...

MISCELLANEOUS COMMAND

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

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

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

'X' = 'R'	This code specifies the azimuth, elevation, or polarization drive reset command. This accomplishes the same function as the RESET mode of the RC2000: it allows the user to reset the solid state drive circuits if an azimuth or elevation alarm has been detected. When the sub-command code is 'R', the sub-command parameter 'Y' must be either 'A', 'E', or 'P' (for azimuth, elevation, or polarization respectively) to specify which axis will be reset. If the 'P' command is specified, the command will be accepted only if the RC2000A is configured for use with the optional rotating feed.
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'X' = 'T'	This sub-command is used to reset track mode errors (subcommand 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.
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This sub-command can also be used to switch frequency bands when a dual band satellite is being tracked. A subcommand parameter of 'C' will specify C band and a subcommand 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).

'X' = 'K'

This sub-command sends a keypad value to the RC2000 (this is referred to as key-stuffing). The RC2000 will react to the keypad value as if the corresponding key on the RC2000's front panel was pushed. The command is implemented using the miscellaneous command format.

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

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

Antenna jog operations are controlled by the length of time that a jog key is depressed by the user. To emulate this characteristic when jogging the controller with the Miscellaneous keystuff command, the reception of a Miscellaneous keystuff command initiates a timer. The key sent will remain 'depressed' until the timer expires. The default timer interval is one second. The user can alter this via the Pol Motor Jog Duration CONFIG mode item. If the last two digits of the 'Jog Duration parameter are between 2 and 25 the jog interval will be the value specified by the last two digits multiplied by 100 milliseconds. For example, a 'Jog Duration value of 1015 will result in a timer interval of 1500 milliseconds or 1.5 seconds.

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

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

REFLECT DISPLAY COMMAND.

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

The command contains 5 bytes ...

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

The response contains 91 bytes ...

byte 0	ACK	
byte 1	A	where A is the RC2000's address

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

5.3 Software to Exercise the Keystuff and Display Reflect Commands

A DOS program, RC2KA260.EXE, allows the user to test the display reflect and miscellaneous keystuff commands. The RC2KA260.EXE software should run on most Windows PC's that have a serial port configured as COM1 or COM2 using the standard interrupts (4 or 3, respectively).

When RC2KA260.EXE is invoked the user should first use the 'C' menu item to specify the RC2000X's remote address (50 by default).

To exercise the keystuff miscellaneous command, with the controller in Manual mode invoke the 'U' menu item. Next key in '6K4' (without the quotes) followed by the ENTER key to specify an Az CW Jog. '6' is the Miscellaneous command code (36 hex), 'K' specifies a keystuff operation, and '4' specifies the key on the RC2000 controller labeled '4 – AZ CCW – E'. When the ENTER key is hit the RC2KA260 program transmits the STX and address characters followed by the string entered by the user followed by the ETX character followed by a checksum calculated over all of the previous characters transmitted.

5.4 Query ID Command Reply

The reply to the Query ID command will be '2KX14n' where 'n' is the software sub version number defined in section 2.0.

5.5 RC2000X Alarm Codes

When a fault is detected, RC2000 controllers display a flashing alarm message on the bottom row of the LCD. Each alarm message is assigned a numeric code. This numeric code is reported as part of the reply to the Device Status Poll and Display Reflect remote commands.

Here are the numeric codes associated with each alarm message ...

- '1' LOW BATTERY'
- '2' ANT AZIM
- '3' ANT ELEV
- '4' AZIM COUNT

'5' ELEV COUNT
 '6' AZIM LIMITS
 '7' ELEV LIMITS
 '10' AZIM SLOW SPEED
 '11' ELEV SLOW SPEED
 '12' COMM PORT
 '14' TRACK CONFIG
 '15' ANT/RCVR CONFIG
 '16' TIME/DATE
 '17' AZ/EL ANGLE DISPLAY
 '18' POL OPTIONS
 '19' ANT POL
 '20' AZ/EL OPTIONS

5.6 Remote Pol Jogs While Tracking

With previous versions of the software, when Track mode was active and the controller was idle ('0-MENU' displayed when Expert Access is enabled), the controller would accept polarization jog commands from the serial port via the Remote Pol Command (34 hex, C and W sub-commands). With the RC2000X, if the Remote Pol Command is used to jog the antenna the controller will switch Remote mode.

A remote user can jog the polarization without leaving Track mode via the Keystuff Miscellaneous command.

Note that the Remote Pol Command can be used to send H/V commands to the controller while Track Mode is active.

5.7 Remote Status Query Reply Modified to Report Track Band

With support for quad band tracking a slight modifications was required to

/ Byte 33 - Track Mode state, error status, and track band. */*

```
bit => 7 6 5 4      3 2 1 0
        0 1 b1 b0 $ s s s s
```

where

```
b1 b0
0 0   c band
0 1   k band
```

1	0	X/L band
1	1	Ka band

6.0 Document Revision History

Jan 9, 2002 – Revised to include the Software Version Identification section.

Feb 5, 2002 – Revised to include a description of the Software Minor Version Number (1.n0 – ‘n’ is the minor version number).

Nov 11, 2002 – Major modification to document the keystuff/display reflect remote commands and the tracking enhancements.

August 25, 2005 – Revise the document to cover the v1.60 revision. Version 1.60 allows the user to specify a zero inclination with an inclined orbit satellite. Support was also added for X band satellites.

Nov 1, 2005 – Add support for the speed bit. Update the antenna constants for the Prodelin 3.8 meter antenna. Fix simultaneous az/el bug and X band Threshold CONFIG mode item bug.

July 22, 2014 – version 2.4x, derived from v2.2x. Modify to support quad band tracking. Associate each AGC threshold with an AGC channel. For ACU's with an internal beacon receiver, the output of the receiver is internally tied to AGC2 and the AGC2 Threshold prompt is replaced with a Beacon Rx Threshold prompt.