APPENDIX REM – REMOTE CONTROL PROTOCOL

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This appendix describes the configuration required and the commands used to implement the remote control interface for the RC4000 antenna controller. It is provided as a supplement to the "baseline" RC4000 manual. Sections in the baseline RC4000 manual are referred to when data specific to the remote control option are described.

NOTE: RC4000 software is built on a per-mount basis. Some commands may not be available on all devices.

Revision History

01 FEB 2014	Document added to version control system.	ECG
09 FEB 2014	Added move to nominal angle command for polarization.	ECG

1.0 THEORY OF OPERATION

Overview

The RC4000 supports a variety of remote monitor and control commands. The controller functions as a slave device within a network. The network is expected to consist of one master and multiple slaves communicating over a single interface (or “bus”). Each slave is internally configured with a unique address.

Message Protocol

Message format and protocol over the bus is a derivative of IBM's binary synchronous communications protocol (BISYNC). The master station sends a command over the bus to all slave devices. The device whose address is specified in the command message carries out the requested commands, and then replies with a response message containing the result. A device does not respond if the command does not containing its address. This prevents bus contention caused by more than one remote device communicating over the bus at the same time. NOTE: Even if the antenna controller is the only device on the network, it still must be addressed.

Data Format

All data should be in 7-bit ASCII format. The control character subset 00-1F (hex) is reserved for message control. The printable ASCII characters 20-7F (hex) are used for address, command and data characters.

Message Format

Command messages begin with the STX (Start-of-text) byte followed by a remote address, a command byte and multiple data bytes. The ETX (End-of-text) byte is sent following the last data byte, and the message is terminated by a Checksum character. Response messages are identical to command messages in format with the exception of the ACK (Acknowledge) or NAK (Not Acknowledge) byte at the start of the message instead of STX. Figure 1 illustrates the format of the command and response messages. A command or reply message may have a variable length.

Command Message

STX	ADDR	CMD	D_1	D_2	D_3	…	D_N	ETX	CHKSUM

Response Message – Command Acknowledged

ACK	ADDR	CMD	D_1	D_2	D_3	…	D_N	ETX	CHKSUM

Response Message – Command Not Acknowledged (Unable To Execute or Incorrect Command)

NAK	ADDR	CMD	ETX	CHKSUM

Figure 1 – Message Format

Message Delimiters

A command message begins with STX (02 hex). A reply begins with ACK (06 hex) or NAK (15 hex) depending on the result of the command execution. All messages end with the ETX (03 hex), the ASCII End-of-text control character, followed by the Checksum byte.

Address Byte

The device address (ADDR) must be a valid ASCII printable character between 49 (31 hex) and 111 (6F hex); thus, 63 addresses are possible.

Command Byte

The command byte (CMD) immediately follows the device address and specifies one of several possible commands for a particular device.

Checksum Byte

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

Message Timing

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

Command Restrictions

All RC4000 devices will respond to a command "0" (30 hex) with 6 data bytes of ASCII characters in the following form:

ACK	ADDR	30h	4	K	D_1	.	D_2	D_3	ETX	CHKSUM

where $D_1.D_2D_3$ are ASCII characters representing a software version number (e.g. 1.12).

State Diagram

The state diagram illustrated below presents the implementation of the slave device that guarantees the proper transfer and processing of communication messages sent by a master controller. Each state that the device can assume is represented graphically as a circle. A single-digit number is used within the circle to identify the state. All transitions between states are represented graphically by arrows between them. Each transition is qualified by conditions that must be true in order for the transition to occur.

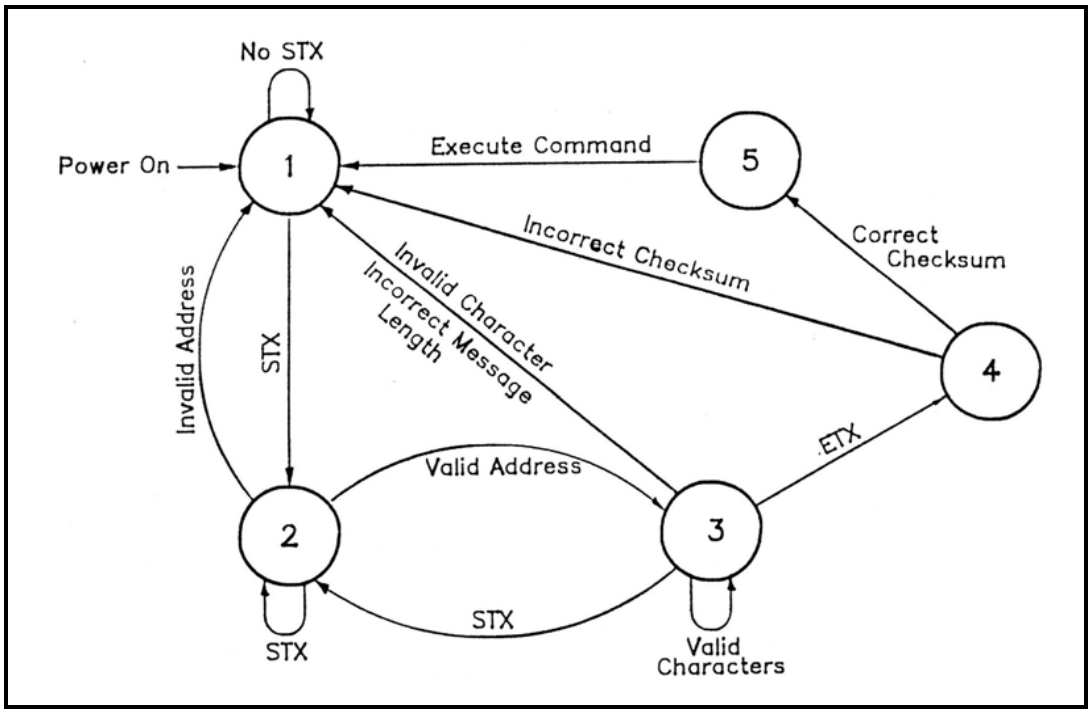

Figure 2 – SA Bus Protocol State Diagram

State Descriptions

- State 1 – Idle State
  - The device is ready to receive a new message. A device always powers on in State 1.
  - The device will enter State 2 only if the STX byte is received.
- State 2 – Addressed State
  - The device is waiting to receive the address byte.
  - The device will enter:
    - State 3 if the received address byte is correct.
    - State 1 if the received address is not correct.
  - The device will stay in State 2 if the STX byte is received.

- State 3 – Data State
    - The device is engaged in receiving the command data from the master.
    - The device will enter:
        - State 4 if the ETX byte is received signifying the end of data in the message.
        - State 1 if the STX byte, an invalid byte, or the incorrect number of data bytes is received.
- State 4 – Data Error State
    - The device is waiting to receive a Checksum byte.
    - A slave will enter:
        - State 5 if the received Checksum byte equals the LRC value computed during message reception.
        - State 1 if the received Checksum byte does not equal the LRC value computed during message reception.
- State 5 – Command Execute State
    - The device begins execution of the received command.
    - The device begins sending the appropriate response message to the master.
    - The device will enter State 1 only when the entire response has been transmitted.

2.0 CONFIGURATION

Electrical Interface

The RC4000 can interface with a variety of physical interfaces including Ethernet, RS-232, or RS-422. Refer to section 2.1.2.3.9 of the baseline RC4000 manual and supplemental appendix IP for more information on interfacing with an Ethernet network. Refer to section 2.1.2.2.4 of the baseline RC4000 manual for more information on interfacing with a serial network.

Communications Parameters

When the RC4000 is expected to be controlled via a RS-232 or RS-422 network, the controller's baud rate and address must be set. These values can be specified via the REMOTE CONTROL configuration screen.

```
  ENABLED:1                CONFIG-REMOTE
  ADDRESS: 50       MODE:1
BAUD_RATE:6          JOG:20
REMOTE CONTROL <0>DISABLED <1>ENABLED
```

ENABLED: **REMOTE CONTROL <0>DISABLED <1>ENABLED**

This item allows the user to disable the ability to remotely control the RC4000. This may prove useful if the user wants to only operate from the front panel.

ADDRESS: **BUS ADDRESS <49-111>**

This item allows the user to specify an unique bus address for the RC4000. The default address is 50.

BAUD RATE: **BAUD <1-3 2-6 3-12 4-24 5-48 6-96>(x100)**

This item allows the user to choose one of six possible baud rates from 300 to 9600. The default baudrate is 9600.

MODE: **REMOTE MODE <0-RS232 1-RS422>**

This item allows the user to select RS232 or RS422/RS485 operation. The RC4000 is shipped from the factory configured for RS-232 operation

JOG: **REMOTE JOG HOLD <1-40>**

This configuration item exists to allow the RC4000 to adjust to the required key repeat rate from the computer sending the remote front panel commands. This value will have to be adjusted to match the latency of different computers implementing a "remote front panel" scheme.

The REMOTE JOG HOLD value is used to jog movements when the RC4000 is operating in MANUAL mode and being commanded via a remote front panel. The entered number multiplied by 1/40 of a second represents how long a remote front panel jog command will last. For example, a value of 20 corresponds to a hold period of 0.5 seconds.

If the value is too low, manual movements will be jerky as the operator holds down a jog key from the remote front panel. In this case the RC4000 sees a jog key from the remote front panel but the hold timer expires before another jog key command is received.

3.0 DETAILED OPERATION

RC4000 Online/Offline Reply

The RC4000 software must include a remote control option to process commands. If remote control is not available, and a valid message is received (correct format, address, Checksum, etc.), the offline reply is sent to the host. This reply has the following format:

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	CC	command code of the received message
byte 3	'F'	ASCII 'F', for offline.
byte 4	ETX	
byte 5	Checksum	

RC4000 Unrecognized Commands – NAK Reply

If a valid message is received but the command code is unrecognized or unavailable, or if an error occurred while processing the command data, a NAK reply is sent to the host. Additional failure information may be available for specific commands. The NAK reply has the following format:

byte 0	NAK	
byte 1	A	RC4000 address
byte 2	CC	command code of the unrecognized message
byte 3	ETX	
byte 4	Checksum	

RC4000 Command Acknowledged – ACK Reply

In many cases, if a command is received but no response is required, a standard ACK reply is sent to the host. The standard ACK reply has the following format:

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	CC	command code of the acknowledged message
byte 3	ETX	
byte 4	Checksum	

Command Set

The following table lists the available RC4000 remote commands.

Each command is detailed in the paragraphs listed below.

Table 1 – Command Set List

CODE (hex)	COMMAND	PARAGRAPH
30	Device Type Query	3.1
31	Device Status Poll	3.2
32	Auto Move[2]	3.3
33	Azimuth / Elevation / Polarization Jog	3.4
34	Polarization	3.5
35	Query Name	3.6
36	Miscellaneous	3.7
37	Reflect Display	3.8
38	Reserved	
39	Write Satellite Data	3.9
3A	Read Satellite Data	3.10
3B	Write Two Line Element Data	3.11
3C	Read Two Line Element Data	3.12
3D	Write IESS-412 Data[1]	3.13
3E	Read IESS-412 Data[1]	3.14
3F	Read Pulse Count	3.15
40	Extended Device Status Poll	3.16
41	Remote Locate	3.17
42	Remote Store	3.18
43	Write Signpost Data	3.19
44	Read Signpost Data	3.20
45	Read Navigation Data	3.21
46	Write Navigation Data	3.22
47	Jog with Minimal Reply	3.23
48	Remote Key Press	3.24
49	Reserved	
4A	Reserved	
	1 – not yet implemented in RC4000	
	2 – implemented in software version 0.05	

Each command is detailed in paragraphs 3.1 on. The next few paragraphs describe characteristics common to all RC4000 commands.

3.1 Device Type Query Command

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

byte 0	STX	
byte 1	A	RC4000 address
byte 2	30h	30 hex – the device type query command code
byte 3	ETX	
byte 4	checksum	

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

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	30h	the device type query command code
bytes 3,4	“4K”	controller type
bytes 5-8	'”A.BC”	version number – example: 1.22
byte 9	ETX	
byte 10	checksum	

3.2 Device Status Poll Command

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

byte 0	STX	
byte 1	A	RC4000 address
byte 2	31h	the status poll query command code
byte 3	ETX	
byte 4	checksum	

The response to this command will consist of 52 bytes, which will be a combination of ASCII and binary data fields. The binary data will be placed in the lower nibble of a byte whose higher nibble will be initialized to a value which will make the result an ASCII character. The idea with this response is to be able to reproduce the information presented on the LCD to the user when manual mode is active. The format of the response is:

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	31h	the status poll query command code
bytes 3-12	sat_name	This field will contain the satellite name in upper case letters. If the name does not occupy the entire field the name will be left justified and the string will be padded with blanks. If a satellite name is not currently displayed, this field will contain blanks.
byte 13	not used	reserved for future use, currently initialized to 0100$0000b.

Device Status Poll Command (continued)

byte 14-19 azimuth position

This field will contain the formatted azimuth position -180.0 to 180.0. If the analog to digital converter detects an error this field will contain '******'.

NOTE: If the primary azimuth sensor is the fluxgate compass, this field will display a value from 0.0 to 359.9 in bytes 14-18. Byte 19 will display either a "M" or "T" to indicate whether the value in bytes 14-18 represent a M(agnetic) or T(rue) heading value.

byte 20-25 elevation position

This field will contain the formatted elevation position, -180.0 to 180.0. If the analog to digital converter detects an error this field will contain '******'.

byte 26-31 polarization position

This field will contain the formatted polarization position -180.0 to 180.0. If the analog to digital converter detects an error this field will contain '******'.

byte 32 azimuth limits -- binary data

```
7 6 5 4   3 2 1 0
0 1 0 0 $ 0 A B C
```

A '0' in a bit position implies that the antenna is not at the limit, a '1' in the bit position implies that the antenna is at the limit. Here is the mapping of bit positions to the limits ...

.

A – Azimuth Clockwise
B – Azimuth Counterclockwise
C – Azimuth Stow

byte 33 elevation limits -- binary data

```
7 6 5 4   3 2 1 0
0 1 0 0 $ 0 A B C
```

A '0' in a bit position implies that the antenna is not at the limit, a '1' in the bit position implies that the antenna is at the limit. Here is the mapping of bit positions to the limits ...

.

A – Elevation Up
B – Elevation Down
C – Elevation Stow

Device Status Poll Command (continued)

byte 34 polarization limits -- binary data

```
 7 6 5 4   3 2 1 0
 0 1 0 0 $ 0 A B C
```

A ‘0’ in a bit position implies that the antenna is not at the limit, a ‘1’ in the bit position implies that the antenna is at the limit. Here is the mapping of bit positions to the limits ...

.

A – Polarization Clockwise
B – Polarization Counterclockwise
C – Polarization Stow

byte 35 polarization equipment and display status code – binary data

```
 7 6 5 4   3 2 1 0
 0 1 X X $ Y Z Z Z
```

where ‘XX’ is ...

00 if a rotating feed is not present in the system
01 if a single port rotating feed is present in the system
10 if a dual port rotating feed is present in the system. A dual port rotating feed can simultaneously receive both horizontally and vertically polarized signals.

where ‘Y’ is ...

0 if polarization movements are not allowed.
1 if polarization movements are allowed.

Discussion – The ‘Y’ field described above only contains meaningful data when TRACK mode is active. Polarization movement is not allowed during a TRACK mode peaking operation. If a polarization operation occurs while peaking the antenna the peak obtained may not be reliable. If a ‘go to’ H or V polarization command is received via the serial port the controller will execute the command after the peaking operation is completed. The reply to the ‘go to’ command will be an ACK.

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

where ‘ZZZ’ is ...
000 if the ‘H' polarization code is displayed
001 if the 'h' polarization code is displayed
010 if the 'V' polarization code is displayed
011 if the 'v' polarization code is displayed
100 if no polarization code is displayed

Device Status Poll Command (continued)

byte 36 azimuth movement/alarm status – binary data
byte 37 elevation movement/alarm status – binary data
byte 38 polarization movement/alarm status – binary data

```
7 6 5 4   3 2 1 0
0 1 0 S $ X X X X
```

where ‘S’ is ...
0 if the axis is configured for slow speed movement
1 if the axis is configured for fast speed movement

where ‘XXXX’ is ...
0000 no alarms or movement
0010 ccw jog movement pending
0011 cw jog movement pending
0100 ccw automatic movement in progress
0101 cw automatic movement in progress
0111 remotely commanded auto move is in progress

1000 off axis alarm active. This alarm code is reported if an elevation runaway alarm is active.

1001 sensor direction alarm active
1010 runaway alarm active
1011 jammed alarm active
1100 drive alarm active. This is triggered by an over current condition.

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

byte 39 alarm code – binary data

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

where A5–A0 specify the alarm code (0-63). Alarm messages flash on the bottom row of the display. The following alarm codes which have been defined:

0 – No Alarm Active
1 – Low Battery
2 – Azimuth Jammed
3 – Azimuth Runaway
4 – Elevation Jammed
5 – Elevation Runaway
18 – Time/Date Error
22 – Polarization Jammed
24 – Limits Inactive Warning
27 – Emergency Stop
32 – Antenna Halt

Device Status Poll Command (continued)

byte 40 current track status – binary data

```
7 6 5 4   3 2 1 0
0 B B B $ S S S S
```

where ‘BBB’ is ...
001 – X band
010 – Ka band
011 – S band
100 – C band
101 – Ku band
111 – L band

and where ‘SSSS’ is ...
0000 – track mode not active
0001 – track setup submode active
0010 – track auto mode entry
0011 – step track submode active
0100 – track auto search submode active
0101 – program track submode active
0110 – track manual search submode active
1000 – track jammed error
1001 – track limit error
1010 – track drive error
1011 – track peak limit error
1100 – track geo position error
1101 – track system error track
1110 – track checksum error

bytes 41-44 AGC Level The AGC channel voltage is represented internally by a numeric value between 0 and 4095. This numeric value is converted to an ASCII string. The string will be right justified and padded with blanks (on the left).

byte 45 AGC Channel The AGC channel and lock status – binary data

```
7 6 5 4   3 2 1 0
0 1 0 L $ 0 C C C
```

where ‘CCC’ is ...
000 – RF
001 – SS1
010 – SS2
011 – DVB
1xx – reserved

where ‘L’ is …
1 – lock indicated
0 – no lock indicated

Device Status Poll Command (continued)

byte 46 current internal relay status – binary data

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

where ‘AA’ is ...
00 – HPA relay disabled by ACU software
01 – HPA relay disabled by external TX mute
10 – HPA relay enabled
11 – reserved

byte 47 special axis limits/movement status -- binary data

```
7 6 5 4   3 2 1 0
0 1 0 S $ 0 A B C
```

Bit ‘S’ indicates axis movement status as follows:
0 – axis not moving
1 – axis automove is in progress

Bits ‘A’, ‘B’, and ‘C’ indicate the limit status. A ‘0’ in a bit position implies that the axis is not at the limit, and a ‘1’ implies that the axis is at the limit.

bytes 48–49	Reserved	At this time these bytes are initialized to 0100$0000b.
byte 50	ETX	
byte 51	checksum	

3.3 Auto Move Command

This command causes the controller to automatically position the antenna in azimuth, elevation, and polarization. The command contains 16 bytes formatted as follows:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	32h	the auto move command code
byte 3	polarization	'H', 'V', ' ' (blank), 'C', 'A', 'a', 'E', 'P', 'p', '+', 'S'
byte 4-13	sat_name/position	satellite name or a target azimuth, elevation, or polarization position
byte 14	ETX	
byte 15	checksum	

The normal reply to this command will be the same as the reply to the status poll query except that the command code field will be '32h'. Note that if the satellite name is not found or target positions for a move to a target position are not specified properly a NAK reply will be sent to the host. If the command specifies polarization movement but the Polarization Type is set to CIRCULAR (no polarization control device present), and ACK will be received, but the command will be ignored.

The Auto Move command has several forms:

Form 1. If the sat_name/position field contains the name of a satellite saved via the controller's STORE mode the controller will position the antenna at the azimuth and elevation positions associated with that satellite. The satellite name should be in capital letters, left justified and padded on the right with blanks in the sat_name/position field. Note that the satellite name specified in the command must exactly match a satellite name stored in the controller's non-volatile memory. Form 1 automates the RC4000 RECALL mode.

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

Form 2A. If the sat_name/position field contains a valid pair of azimuth and elevation sensor positions (scaled by 10), the antenna will move to the position specified. The first 5 characters of the sat_name/position field specify the azimuth position (azimuth sub-field) and the last five characters specify the elevation position (elevation sub-field). Within each of the sub-fields the position must be right justified and left padded with zeroes. For example, a sat_name/position field value of '-152500456' specifies an azimuth position of -152.5 degrees and an elevation position of 45.6 degrees. For this form of the auto move command, only the ' ' (blank) character is accepted in the polarization field. If the simultaneous azimuth/elevation drive option is not enabled, the controller will move elevation first and azimuth second.

Form 2B. If the antenna system is equipped with "count"-type sensors (pulse or resolvers), this form can be used to move to a pair of pulse or resolver counts. For example, a sat_name/position field value of '1105012152' specifies an azimuth pulse position of 11050 and an elevation pulse position of 12152. The polarization field should contain a 'C'. Note that if no "count"-type sensor is available, a NAK reply will be sent to the host.

Auto Move Command (continued)

Form 2C. For systems that are capable of generating azimuth, elevation, or polarization position feedback to the one hundredth of a degree resolution, form 2C provides the capability to command either an azimuth or an elevation movement to a target specified within one hundredth of a degree. To command an azimuth, elevation, or polarization move, insert 'A', 'E', or 'P' into byte 3. Bytes 4 to 9 contain the target azimuth, elevation, or polarization position. As with form 2A, the position must be right justified and left padded with zeroes. Bytes 10 to 13 should be filled with blanks. For example, if byte 3 is 'A' and bytes 4 – 9 contain '-12345', an azimuth auto move to the target of -123.45 will be initiated.

NOTE: If one hundredth of a degree resolution is not available, the hundredth place digit will be ignored.

Form 2D. If the sat_name/position field contains a valid pair of azimuth and polarization sensor positions (scaled by 10), the antenna will move to the position specified simultaneously. The first 5 characters of the sat_name/position field specify the azimuth position (azimuth sub-field) and the last five characters specify the polarization position (polarization sub-field). Within each of the sub-fields the position must be right justified and left padded with zeroes. For example, a sat_name/position field value of '-152500456' specifies an azimuth position of -152.5 degrees and a polarization position of 45.6 degrees. For this form of the auto move command, only the '+' character is accepted in the polarization field. If the simultaneous azimuth/polarization drive option is not enabled, the controller will move azimuth first and polarization second.

Form 3. This form is only available on mount types where the antenna system is equipped with a special "fourth axis" of motion. The polarization field should contain an 'S'. Byte 4 will contain the special axis code. Byte 5 will contain the target position. The possible combinations for bytes 4 and 5 are shown below. Bytes 6 to 13 should be filled with blanks.

NOTE: The remote status command can be used to get the current position if limit switch feedback is available. If a limit active, a '1' will be preset in the bit position indicated below (A, B, or C). If a limit is not active, a '0' will be preset instead.

SPECIAL AXIS	AXIS CODE	DIRECTION CODE	LIMIT
Waveguide 1	W	H – horizontal	A
		V – vertical	B
Waveguide 2	*G	H – horizontal	A
		V – vertical	B
RF Switch	R	1 – path 1	A
		2 – path 2	B
		*3 – path 3	C
Polarization Mode	P	L – linear mode	A
		C – circular mode	B
Fairing Control	F	D – move to deploy	A
		S – move to stow	B
		*M – move to maintenance	C

* - Future Implementations

3.4 Azimuth/Elevation/Polarization Jog Command

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

byte 0	STX	
byte 1	A	RC4000 address
byte 2	33h	the command code
byte 3	direction	This field can specify 'E', 'W', 'D', 'U', O, L, or 'X' where ... E refers to azimuth Counter clockwise, W refers to azimuth clockWise, D refers to elevation Down, U refers to elevation Up, O refers to polarization cOunter clockwise, L refers to polarization cLockwise, and X means stop all movement.
byte 4	speed	This field specifies the jog speed, either 'F' (Fast) or 'S' (Slow). Note that this field must contain a valid value even if the direction field specifies 'X' (Stop).
bytes 5-8	duration	This field specifies the duration of the jog command in milliseconds. The valid range of values for this field is '0000' to '9999'. As a practical matter, the resolution of the timer used to time the move is approximately 50 milliseconds, so any move will be for a time interval equal to a multiple of approx. 50 milliseconds. Note that this command must contain a valid value even if the direction field specifies 'X' (Stop).
byte 9	ETX	
byte 10	checksum	the checksum

If this command can be executed, the reply to this command will be the same as the reply to the status poll query command except the command code will be '33h'. A NAK reply will be sent to the host if the direction specifies C, W, U, D, O, or L and the limit input associated with the axis and direction specified by the command is asserted (only for versions of the controller which support individual limits). Note that the controller can only support a remote jog about a single axis. For example, if a remote jog is in progress about the azimuth axis and a remote elevation jog command is received (that can be executed – i.e. no limits or alarms are active), the azimuth jog will terminate regardless of the duration specified for the remote azimuth jog. A NAK reply will also be sent to the host if polarization movement is specified and the Polarization Type CONFIG mode item is set to 0 (Circular Polarization). If the direction byte contains ‘X’ all antenna movement will stop. If TRACK mode is active and the direction byte specifies ‘X’, ‘C’, ‘W’, ‘D’, or ‘U’ REMOTE mode will receive control and all tracking will cease. If TRACK mode is active and a peaking or search operation is in progress the NAK reply will be returned to the host.

3.5 Polarization Command

The following command specifies a move to a polarization position. There are multiple forms of this command. The reply to any form of this command will be the same as the reply to the status poll query command except the command code will be 34h.

Form 1. The command contains 6 bytes. The format of the command is as follows:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	34h	the command code
byte 3	'X'	this field will specify either ‘H’, ‘V’, or ‘X’ where: H/V -- moves the polarization to the horizontal/vertical polarization position associated with the last auto move target satellite X -- moves the polarization 90 degrees from the current polarization position
byte 4	ETX	
byte 5	checksum	

If the Polarization Type is set to DUAL (2 Port Feed) either the ‘H’ or ‘V’ argument will result in a move to the single polarization position associated with the satellite.

If TRACK mode is active and a peaking or search operation is in progress this command will not be executed until after the peaking or search operation terminates. If this occurs the normal acknowledgment will be sent to the host.

Form 2. The command contains 6 bytes. The format of the command is as follows:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	34h	the command code
byte 3	' ‘	this field must be 20h (blank)
bytes 4-9	Position	Target polarization position, +/-180.0 degrees Left Justify and pad with blanks
byte 10	ETX	
byte 11	checksum	

This form of the command will move the polarization to a normalized position within the range of motion. For example, if the polarization axis has limits of +/-90 degrees, and the value specified in the position field is -100 degrees, this command will move to the equivalent position of +80 degrees. Conversely, if the value specified is -55 degrees, this command will move the polarization position to -55 degrees.

NOTE: Form 2 is not available while TRACK mode is active.

3.6 Query Name Command

This query command instructs the RC4000 to send back to the host computer the name of a satellite stored in non-volatile memory (via the controller's STORE mode) and the total number of satellites stored in non-volatile memory. The command contains the index of the desired entry in the satellite list. A maximum of 50 satellites can be stored in memory.

This query command contains 7 bytes and the format is:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	35h	the query name command code
bytes 3,4	'XX'	where XX is the index of the satellite name being requested. Normally this would be '01' the first time through and then incremented until the 'YY' (YY being the last entry in the list) satellite name is read. The maximum possible range for XX and YY is 1 through 50.
byte 5	ETX	
byte 6	checksum	the checksum

The response to this command contains 19 bytes and the format is:

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	35h	the query name command code
bytes 3,4	'XX'	where XX is the index of the satellite name being requested.
bytes 5,6	'YY'	where YY is the total number of satellite names contained in the list. Repeat this command YY times to download the names of all stored satellites.
bytes 7-16	sat name	This field will contain the satellite name. The name will be in capital letters and normally be left justified. The only time the satellite name will not be left justified is if the user selected the USER entry from STORE mode and manually entered blank characters before the satellite name.
byte 17	ETX	
byte 18	checksum	the checksum

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

3.7 Miscellaneous Command

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

byte 0	STX	
byte 1	A	RC4000 address
byte 2	36h	the miscellaneous command code
byte 3	'X'	the sub-command code
byte 4	'Y'	the sub-command parameter
byte 5	ETX	
byte 6	checksum	

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

'X' = 'R' This specifies the azimuth or elevation drive reset command. This accomplishes the same function as the DRIVE RESET mode of the RC4000: it allows the user to reset the azimuth, elevation, or polarization alarms. 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 Pol Control Equipment Code CONFIG mode item is set to 1 (ONE PORT) or 2 (TWO PORT).

'X' = 'T' This sub-command is used to reset track mode errors (sub-command parameter 'Y' = R). When the TRACK mode ERROR sub-mode is active this command will cause the ERROR sub-mode to terminate. The controller will react as if TRACK mode was activated via RECALL mode. Note that if a system error is active (an error message flashing on the bottom row of the display) the condition which generated the system error must be rectified or the controller will probably return to the TRACK mode ERROR sub-mode. This sub-command can also be used to switch frequency bands when a dual band satellite is being tracked. A sub-command parameter of 'C' will specify C band and a sub-command parameter of 'K' will specify K band. The reply to this command will be a NAK if TRACK mode is not active, the satellite being tracked was not specified as a dual band satellite (when the track was initiated via SETUP mode), or if track polarization movement is not allowed (see byte 32 of the device status poll command). If polarization movements are not allowed the controller is either peaking the antenna or performing a search. Changing the band during a peaking operation or search can cause the antenna to not accurately peak the antenna.

‘X’ = ‘S’ This sub-command is used to initiate an automatic antenna STOW via the RC4000. NOTE: On mounts with no stow function, reply to this subcommand will be a NAK.

‘X’ = ‘D’ This sub-command is used to initiate an automatic antenna DEPLOY via the RC4000. NOTE: On mounts with no deploy function, reply to this subcommand will be a NAK.

Miscellaneous Command (continued)

‘X’ = ‘A’ This sub-command is used to initiate an automatic search pattern via the RC4000. The sub-command parameter 'Y' must be either an 'E' to initiate an expanding spiral or 'F' to initiate a "flat" spiral pattern. NOTE: Be sure the RC4000 is configured correctly for automatic searching.

‘X’ = ‘K’ The Keypad Input sub-command sends a keypad value to the RC4000. The RC4000 will react to the keypad value as if the corresponding key on the RC4000 front panel was pushed. The required values for the 'Y' subcommand are:

'Y'	30-39h 41-47h	key codes as defined in the following table

CODE	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
42h	+/-/BKSP
43h	Mode
44h	Scroll Up/Yes
45h	Scroll Dn/No
46h	Enter
47h	Mode Group Change*

*the 47h key code can be used to initiate a RC4000 mode group change which normally requires the Mode key to be held down for five seconds continuously.

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

3.8 Reflect Display Command

This command requests the RC4000 to send the 160 (4 rows x 40 columns) characters currently displayed on the LCD. The command format is:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	37h	reflect display command code
byte 3	ETX	
byte 4	checksum	

The response to this command will be to send the 160 displayed characters in ASCII format plus cursor status. The response format is:

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	37h	reflect display command code
byte 3-42	row 1	40 characters displayed on row 1 of the LCD
byte 43-82	row 2	40 characters displayed on row 2 of the LCD
byte 83-122	row 3	40 characters displayed on row 3 of the LCD
byte 123-162	row 4	40 characters displayed on row 4 of the LCD
byte 163	cursor row	cursor row position (1-4)
byte 164	cursor col_tens	tens digit of cursor column (0 if column <10)
byte 165	cursor col_ones	ones digit of cursor column
byte 166	cursor status	0 = cursor not blinking, 1 = cursor blinking
byte 167	ETX	
byte 168	checksum	

Since the reply is lengthy, the request to reflect the display should be limited to a frequency less than 1 Hz. This will make the reflected display at the M&C software a little “jumpy” but should allow the operator to see what is happening at the RC4000.

3.9 Write Satellite Data Command

This command downloads basic satellite data into the RC4000 list of user defined satellites. Storage for 20 satellites is available.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	39h	Write sat data command code
byte 3	Index Tens	Tens digit of sat data index (0 if index < 10)
byte 4	Index Ones	Ones digit of sat data index
bytes 5-14	Sat Name	10 character satellite name
bytes 15-20	Longitude	Nominal satellite longitude -179.9 to 179.9 (West longitude negative) Left Justify and pad with blanks
bytes 21-22	Inclination	Satellite inclination 0 to 19 Left Justify and pad with blanks
byte 23	Band	RF Band (0-C, 1-Ku, 2-C/Ku, 3-L, 4-X, 5-Ka, 6-S)
byte 24	Ephem	Ephemeris Data Present (0-none, 1-TLE, 2-IESS-412)
bytes 25-29	Pol Offset	Polarization Offset -90.0 to 90.0 negative = counterclockwise Left Justify and pad with blanks
byte 30	ETX	
byte 31	Checksum	

The reply to this command will be the standard ACK or NAK reply.

3.10 Read Satellite Data Command

This command uploads a stored set of satellite data to the RC4000.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	3Ah	Read Satellite Data command code
byte 3	Index Tens	Tens digit of sat data index (0 if index < 10)
byte 4	Index Ones	Ones digit of sat data index
byte 5	ETX	
byte 6	Checksum	

The reply to this command is as follows:

byte 0	ACK or NAK	
byte 1	address	
byte 2	3Ah	
byte 3	Index Tens	Tens digit of sat data index (0 if index < 10)
byte 4	Index Ones	Ones digit of sat data index
bytes 5-14	Sat Name	10 character satellite name to be associated with index
bytes 15-20	Longitude	Nominal satellite longitude -179.9 to 179.9 (West longitude negative) Left Justify and pad with blanks
bytes 21-22	Inclination	Satellite inclination 0 to 19 Left Justify and pad with blanks
byte 23	Band	RF Band (0-C, 1-Ku, 2-C/Ku, 3-L, 4-X, 5-Ka, 6-S)
byte 24	Ephem	Ephemeris Data Present (0-none, 1-TLE, 2-IESS-412)
bytes 25-29	Pol Offset	Polarization Offset -90.0 to 90.0 negative = counterclockwise Left Justify and pad with blanks
byte 30	ETX	
byte 31	Checksum	

3.11 Write Two Line Element Data Command

This command downloads NORAD Two Line Element (TLE) ephemeris data into the RC4000. The index must be the same as the associated sat data index.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	3Bh	Write TLE Data command code
byte 3	Index Tens	Tens digit of TLE data index (0 if index < 10)
byte 4	Index Ones	Ones digit of TLE data index
bytes 5-73	TLE Line 1	69 characters (including checksum) of TLE Line 1
bytes 74-142	TLE Line 2	69 characters (including checksum) of TLE Line 2
byte 143	ETX	
byte 144	Checksum	

The reply to this command will be the standard ACK or NAK reply.

3.12 Read Two Line Element Data Command

This command uploads a stored set of Two Line Element (TLE) data.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	3Ch	Read TLE Data command code
byte 3	Index Tens	Tens digit of TLE data index (0 if index < 10)
byte 4	Index Ones	Ones digit of TLE data index
byte 5	ETX	
byte 6	Checksum	

The reply to this command is as follows:

byte 0	ACK or NAK	
byte 1	address	
byte 2	3Ch	
byte 3	Index Tens	Tens digit of TLE data index (0 if index < 10)
byte 4	Index Ones	Ones digit of TLE data index

NOTE: Bytes 3 & 4 will contain 7Fh when no valid data is stored for the requested index.

bytes 5-73	TLE Line 1	69 characters (including checksum) of TLE Line 1
bytes 74-142	TLE Line 2	69 characters (including checksum) of TLE Line 2
byte 143	ETX	
byte 144	Checksum	

3.13 Write IESS Data Command

This command downloads IESS-412 ephemeris data into the RC4000. The index must be the same as the associated sat data index.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	3Dh	Write IESS data command code
byte 3	Index Tens	Tens digit of IESS data index (0 if index < 10)
byte 4	Index Ones	Ones digit of IESS data index

--- TBD

byte TBD	ETX	
byte TBD	Checksum	

The reply to this command will be the standard ACK or NAK reply.

3.14 Read IESS Data Command

This command uploads a stored set of IESS data.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	3Eh	Read IESS Data command code
byte 3	Index Tens	Tens digit of IESS data index (0 if index < 10)
byte 4	Index Ones	Ones digit of sat data index
byte 5	ETX	
byte 6	Checksum	

The reply to this command is as follows:

byte 0	ACK or NAK	
byte 1	address	
byte 2	3Eh	
byte 3	Index Tens	Tens digit of IESS data index (0 if index < 10)
byte 4	Index Ones	Ones digit of stored TLE index

NOTE: Bytes 3 & 4 will contain 7Fh when no valid data is stored for the requested index.

---- TBD

byte TBD	ETX
byte TBD	Checksum

3.15 Read Pulse Count Command

The Read Pulse Count command returns the current value of azimuth and elevation pulse or resolver counts. The message format for this command will be:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	3Fh	3F hex – the read pulse count command code
byte 3	ETX	
byte 4	checksum	

The reply to this query will consist of 15 bytes ...

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	3Fh	the read pulse count command code
bytes 3-7		Azimuth pulse or resolver count
bytes 8-12		Elevation pulse or resolver count
byte 13	ETX	
byte 14	checksum	

3.16 Extended Device Status Poll Command

This command is an extension of the Device Status Poll Command. The reply to this command provides all the information of the Device Status Poll Command along with information about the current mode and state of the RC4000.

The Extended Device Status Poll command consists of 5 bytes with the following format:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	40h	the extended device status poll query command code
byte 3	ETX	
byte 4	checksum	

The response to this command will consist of 52 bytes, which will be a combination of ASCII and binary data fields. The binary data will be placed in the lower nibble of a byte whose higher nibble will be initialized to a value that will make the result an ASCII character. The format of the response is:

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	40h	Extended status poll query command code
bytes 3-49	Status Reply	These bytes are identical to bytes 3-49 of the Device Status reply. See paragraph 3.2 for detail on the fields contained in this section.
byte 50	Current Mode	This byte contains a value reflecting the current mode with control of the RC4000. See section A.3 of this document for more information about the available values for this field.
byte 51	Current State	This byte contains a value reflecting the current state within the current mode. See section A.3 of this document for more information about the available values for this field.
byte 52	Last Mode	This byte contains a value reflecting the previous mode that had control of the RC4000. See section A.3 of this document for more information about the available values for this field.
byte 53	Exit Condition	This byte contains a value reflecting the reason the last mode was terminated and control switched to the current mode. See section A.3 of this document for more information about the available values for this field.

Extended Device Status Poll Command (continued)

byte 54	Extended Azimuth Position	For mounts with the ability to generate azimuth position to 0.01 degrees, this byte contains the digit for the one hundredth of a degree. This digit is to be added to the rest of the azimuth position contained in bytes 14-19.
byte 55	Extended Elevation Position	For mounts with the ability to generate elevation position to 0.01 degrees, this byte contains the digit for the one hundredth of a degree. This digit is to be added to the rest of the elevation position contained in bytes 20-25.
bytes 56-58	Reserved	Reserved for future use, all bytes filled with 40h.
byte 59	ETX	
byte 60	Checksum	

3.17 Remote Locate Command

This command requests the RC4000 to perform a LOCATE operation based on the satellite data supplied. The command is designed to allow an M&C system to simulate entering satellite data manually or selecting a satellite from the user's preset list stored in the RC4000.

NOTE: The M&C system is required to have confidence that the preset list is programmed correctly. The Write Satellite Data command (39h) and Read Satellite Data command (3Ah) may be used to gain confidence that the preset satellite list is correct.

The RC4000 will automatically sequence through the LOCATE operation. Any action that normally requires user action from the front panel will be automatically initiated.

The command contains 37 bytes with the following format:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	41h	Remote Locate command code
byte 3	Preset Flag & Preset Index Tens	

```
7 6 5 4   3 2 1 0
0 1 0 A $ 0 0 0 B
```

A – 1 = perform LOCATE to an indexed satellite from the user preset list stored in the RC4000.
Bytes 5-28 may be left blank.
NOTE: this option is required to reference an inclined orbit satellite that has ephemeris data associated with it.

B – Tens digit of preset satellite index (if applicable)
(0 if index < 10): index value may be between 0 to 19

A – 0 = perform LOCATE to a satellite using name, longitude, inclination and band data supplied in bytes 5-28.

byte 4	Index Ones	Ones digit of preset satellite index (if applicable)
bytes 5-14	Sat Name	10 character satellite name
bytes 15-20	Longitude	Nominal satellite longitude -179.9 to 179.9 (West longitude negative) Left Justify and pad with blanks
bytes 21-22	Inclination	Satellite inclination 0 to 19 Left Justify and pad with blanks
byte 23	Band	RF Band (0-C, 1-Ku, 2-C/Ku, 3-L, 4-X, 5-Ka, 6-S)

Remote Locate Command (continued)

bytes 24-28	Pol Offset	Satellite Polarization Offset -90.0 to 90.0 (relative to equatorial plane) negative = counterclockwise Left Justify and pad with blanks **NOTE: Future expansion –** **polarization offset data is not currently used.**
byte 29	Polarization	Receive Polarization Selection H – horizontal V – vertical N – neutral X – none NOTE: Not applicable if feed type is circular.
byte 30	Position Update	 A – Determine mount position (lat/lon/heading) automatically according to how the RC4000 is configured U – Force an update of position via GPS and compass
byte 31-34	Spare Bytes	-for future expansion
byte 35	ETX	
byte 36	Checksum	

The reply to this command will be the standard ACK or NAK reply. ACK implies that LOCATE operation will be initiated. Progress of the LOCATE operation may be monitored via the Extended Device Status Poll command. NAK implies an error in the supplied satellite data

3.18 Remote Store Command

This command requests the RC4000 to perform a STORE operation based on the satellite data supplied.

The RC4000 will automatically sequence through the STORE operation. Any action that normally requires confirmation from the front panel will be automatically initiated. If a particular satellite name has already been STOREd, it's data will be overwritten as a result of the Remote Store command.

NOTE: It is assumed that the satellite has been positively identified and is currently peaked up in azimuth and elevation prior to performing a STORE operation. It is also assumed that Horizontal and Vertical polarization positions have been confirmed.

The command contains 48 bytes with the following format:

byte 0	STX	
byte 1	A	RC4000 address
byte 2	42h	Remote Locate command code
byte 3	Preset Flag & Preset Index Tens	

```
7 6 5 4   3 2 1 0
0 1 0 A $ 0 0 0 B
```

A – 1 = perform STORE of a satellite defined from the user preset list stored in the RC4000.
NOTE: this option is required to reference an inclined orbit satellite that has ephemeris data associated with it.

A – 0 = perform STORE of a satellite using name, longitude, inclination and band data supplied in bytes 5- 39.

B – Tens digit of preset satellite index
(0 if index < 10): index value may be between 1 to 20

byte 4	Index Ones	Ones digit of preset satellite index
bytes 5-14	Sat Name	10 character satellite name
bytes 15-20	Longitude	Nominal satellite longitude -179.9 to 179.9 (West longitude negative) Left Justify and pad with blanks
bytes 21-22	Inclination	Satellite inclination 0 to 19 Left Justify and pad with blanks

Remote Store Command (continued)

byte 23	Band	RF Band (0-C, 1-Ku, 2-C/Ku, 3-L, 4-X, 5-Ka, 6-S)
	bytes 24-28	Pol Offset Satellite Polarization Offset -90.0 to 90.0 negative = counterclockwise Left Justify and pad with blanks **NOTE: Future expansion -** **polarization offset data is not currently used.**
byte 29		Polarization Selection C – use calculated H,V values NOTE: Requires that a LOCATE function has been preformed immediately prior to the Remote Store. S – use H,V values supplied in bytes 30-39 H – use current polarization position as Horizontal & calculate Vertical position 90 degrees away V – use current pol position as Vertical & calculate Horizontal position 90 degrees away
bytes 30-34		Horizontal Polarization Position -90.0 to 90.0
bytes 35-39		Vertical Polarization Position -90.0 to 90.0 NOTE: Polarization Selection, Horizontal and Vertical Positions are not applicable if feed type is circular
byte 40		Track Polarization Selects which Polarization position to use when TRACK initiated (applicable to inclined orbit satellites only) H – Horizontal V – Vertical
bytes 41-45	Spare Bytes	-for future expansion
byte 46 ETX		
byte 47	Checksum	

The reply to this command will be the standard ACK or NAK reply. ACK implies that STORE operation will be initiated. NAK implies an error in the supplied satellite data

3.19 Write Signpost Data Command

NOTE: This command is only applicable for controllers with the integrated DVB receiver option installed.

This command downloads signpost data into the RC4000 list of user defined signposts.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	43h	Write signpost data command code
byte 3	Index Tens	Tens digit of index that signpost data set is to be stored (0 if index < 10) NOTE: index value may be between 1 to 20
byte 4	Index Ones	Ones digit of index that signpost data set is to be stored
bytes 5-10	Longitude	Nominal satellite longitude -179.9 to 180.0 (West longitude negative) Left Justify and pad with blanks
bytes 11-15	Frequency	10700 to 12750 Left Justify and pad with blanks
bytes 16-20	Symbol Rate	1000 to 40000 Left Justify and pad with blanks
byte 21	FEC	Forward Error Correction Code type 1 – 9 1 = 1 / 2, 2 = 2 / 3, 3 = 3 / 4, 5 = 5 / 6, 6 = 6 / 7, 7 = 7 / 8, 9 = AUTO
byte 22	Polarization	H = horizontal, V = vertical L = LHCP, R = RHCP
bytes 23 – 28	Identification	6 character ID string
byte 29	Priority	0 – 9 relative search priority
bytes 30 – 33	Spare	pad with zeros
byte 34	ETX	
byte 35	Checksum	

The reply to this command will be the standard ACK or NAK reply.

3.20 Read Signpost Data Command

NOTE: This command is only applicable for controllers with the DVB receiver option.

This command uploads a stored set of signpost data.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	44h	Read Signpost Data command code
byte 3	Index Tens	Tens digit of signpost data index (0 if index < 10, NOTE: index value between 1 & 20)
byte 4	Index Ones	Ones digit of signpost data index
byte 5	ETX	
byte 6	Checksum	

The reply to this command is as follows:

byte 0	ACK or NAK	
byte 1	address	
byte 2	44h	
byte 3	Index Tens	Tens digit of signpost data index (0 if index < 10, NOTE: index value between 1 & 20)
byte 4	Index Ones	Ones digit of signpost data index

NOTE: Bytes 3 & 4 will contain 7Fh when no valid data is stored for the requested index.

bytes 5-10	Longitude	Nominal satellite longitude -179.9 to 180.0 (West longitude negative) Left Justify and pad with blanks
bytes 11-15	Frequency	10700 to 12750 Left Justify and pad with blanks
bytes 16-20	Symbol Rate	1000 to 40000 Left Justify and pad with blanks
byte 21	FEC	Forward Error Correction Code type 1 – 9 1 = 1 / 2, 2 = 2 / 3, 3 = 3 / 4, 5 = 5 / 6, 6 = 6 / 7, 7 = 7 / 8, 9 = AUTO
byte 22	Polarization	H = horizontal, V = vertical L = LHCP, R = RHCP
bytes 23 – 28	Identification	6 character ID string
byte 29	Priority	1 – 9 relative search priority
bytes 30 – 33	Spare	pad with zeros
byte 34	ETX	
byte 35	Checksum	

3.21 Read Navigation Data Command

This command uploads the current values of navigation data.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	45h	Read Navigation Data command code
byte 3	ETX	
byte 4	Checksum	

The reply to this command is as follows:

byte 0	ACK or NAK	
byte 1	address	
byte 2	45h	
byte 3	latitude/longitude source	

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

where ‘XXX’ is ...
001 – currently no lat/lon data
010 – GPS
011 – Manually Entered
100 – User Preset Location List
101 – Saved Position
111 – Remotely Entered

bytes 4-9	latitude	dd.mm(N/S) format
bytes 10-12	reserved	spare bits for additional lat seconds data set to blanks
bytes 13-19	longitude	ddd.mm(E/W) format
bytes 20-22	reserved	spare bits for additional lon seconds data set to blanks
bytes 23-28	reserved	spare bits for altitude data set to blanks

Read Navigation Data Command (continued)

byte 29 true heading source

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

where ‘XXX’ is ...
001 – Currently no true heading data
010 – Automatically from fluxgate compass
011 – Manually from fluxgate compass
100 – Manually entered
101 – Fix by user
110 – Fix by DVB Receiver
111 – Remotely entered

bytes 30-34	true heading	0.0 – 359.9
byte 35	magnetic variation status	0x41h if magvar ready (calculated) 0x40h is magvar not ready
bytes 36-41	magnetic variation	-99.9 to 99.9 or blanks if magvar not ready (westerly variation negative)
byte 42	reserved	spare for time status
bytes 43-50	reserved	spare for time data
bytes 51-58	reserved	spare for date data
byte 59	reserved	spare for platform pitch/roll status
bytes 60-64	reserved	spare for pitch data
bytes 65-69	reserved	spare for roll data
byte 70	ETX	
byte 71	Checksum	

3.22 Write Navigation Data Command

This command downloads antenna position data into the RC4000.

byte 0	STX	
byte 1	A	RC4000 address
byte 2	46h	Write Navigation Data command code
bytes 3-7	Latitude	sddmm (+/-degrees/minutes) format minus = South, positive (North) implied, pad with zeros 01234 = 12 degrees 34 minutes N -1234 = 12 degrees 34 minutes S 00123 = 1 degree 23 minutes
bytes 8-13	Longitude	sdddmm (+/-degrees/minutes) format minus = West, positive (East) implied, pad with zeros 001234 = 12 degrees 34 minutes E -01234 = 12 degrees 34 minutes W 000123 = 1 degree 23 minutes E
bytes 14-18	True Heading	123.4 format (000.0 to 359.9) True Heading of mount azimuth 0.0
byte 19	Update Lat/Lon	'A' – automatically decide if GPS is needed 'U' – force update using GPS 'M' – use manually data from fields above
byte 20	Update Heading	'A' – automatically decide if compass is needed 'U' – force update using compass 'M' – use manually data from fields above
byte 21	Update Options	

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

where 'A' is ...
0 – Move antenna to update navigation data immediately
1 – Do not move antenna

bytes 22-30	reserved	spare for future expansion (fill with blanks)
byte 31	ETX	
byte 32	Checksum	

The reply to this command will be the standard ACK or NAK reply.

NOTE: Any valid lat/lon/heading data will trigger an ACK reply. Upon reception of valid data, the RC4000 will overwrite any existing position data and invalidate (DELETE) any STOREd satellites.

3.23 Azimuth/Elevation/Polarization Jog Command (with minimal reply)

This command jogs the antenna in azimuth, elevation or polarization. It is functionally the same command as described in section 3.4 but with a much shorter reply. The command contains 11 bytes and the format of the command is exactly the same as described in 3.4 except that the command code is 47h vs. 33h.

Rather than sending the full status reply, this command only sends the position (at the time the command is received) of the axis to be jogged.

The reply to this query will consist of 12 bytes ...

byte 0	ACK	
byte 1	A	RC4000 address
byte 2	47h	the command code
byte 3	"A/E/P"	Axis jogged: A(zimuth), E(levation) or P(olarization)
bytes 4-9	axis position	This field will contain the formatted axis position in the range -180.0 to 180.0. If the analog to digital converter detects an error this field will contain '******'.
byte 10	ETX	
byte 11	checksum	

3.24 Remote Key Press Command

NOTE: This command provides the same functionality as the Miscellaneous – Keypad Input sub-command (section 3.7). This command provides a minimal reply compared to the reply from the Miscellaneous command.

This command sends a keypad value to the RC4000. The RC4000 will react to the keypad value as if the corresponding key on the RC4000 front panel was pushed.

Here is the format of the command.

byte 0	STX		
byte 1	A	RC4000 address	
byte 2	48h	the Remote Keypress command code	
byte 3	key code	30-39h 41-47h	key codes as defined in the following table
byte 4	ETX		
byte 5	checksum		

CODE	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*
48h	Null Key

*the 47h key code can be used to initiate a RC4000 mode group change which normally requires the Mode key to be held down for five seconds continuously.

The reply to this command will be the standard ACK or NAK reply.

4.0 TROUBLESHOOTING

No Communication between RC4000 and the remote control computer. There are numerous situations that could cause no communication:

1) The address set in the RC4000 is not being used by the remote commands. Check the address in the REMOTE configuration screen and ensure that address is being sent with the commands. Incorrectly addressed commands will be ignored by the RC4000.

2) The baud rate set in the RC4000 is not being used by the remote commands. Check the baud rate in the REMOTE configuration screen and ensure that it is the same as being used by the remote computer. Commands sent at the incorrect baud rate will not be recognized by the RC4000.

3) The remote computer or RC4000 are not both set to RS-232 or RS-422/RS-485. The remote control system should determine whether it is to work in RS-232, -422 or -485 mode. Check the configuration of the remote jumper and the placement of the cable inside of the RC4000, as described in 2.2.11. Also check the cabling between the RC4000 and the remote computer.

4) The RS-422 adapter is not compatible with the RC4000. Occasionally it has been found that a commercially available RS-422 adapter will just not work with the RC4000. To check for this possibility, temporarily mechanize the interface via RS-232 and see if communications is established.

5) The remote computer is not actually transmitting through the intended communication port. To check for this possibility, mechanize a “loop back” right at the communication port of the remote computer. The receive mode of the remote control software should see an exact reflection of the transmitted command.

Unreliable Communications or ACU Reset. There are some situations that may cause the remote control communications to be unreliable (such as a garbled status reply) or in the extreme situation to cause the ACU to reset.

1) The general recommendation is not to send commands (particularly status requests) at a rate greater than once a second.

2) Don't repeatedly ask for "static" information such as navigation or satellite data.

3) Allow a previous command to ACK or NAK before sending another command.

A.0 REFERENCE INFORMATION

A.1 MESSAGE DELIMITERS

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

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

A.2 ASCII TABLE

As reference, the following table shows the set of ASCII codes available for use by the RC4000 remote protocol.

HEX	0_	1_	2_	3_	4_	5_	6_	7_
_0			Blank	0	@	P		p
_1			!	1	A	Q	a	q
_2	STX		"	2	B	R	b	r
_3	ETX		#	3	C	S	c	s
_4			$	4	D	T	d	t
_5		NAK	%	5	E	U	e	u
_6	ACK		&	6	F	V	f	v
_7			'	7	G	W	g	w
_8			(	8	H	X	h	x
_9			)	9	I	Y	i	y
_A			*	:	J	Z	j	z
_B			+	;	K	[	k	{
_C			,	<	L	\	l	|
_D			-	=	M	]	m	}
_E			.	>	N	^	n	
_F			/	?	O	_	o	

A.3 EXTENDEND STATUS REPLY TABLES

The following tables define the possible values for bytes 45-48 of the Extended Device Status Poll reply. Possible values are listed for the RC4000 operating modes, exit conditions, and current state per mode.

Value (hex)	Mode (byte 45 & 47)	Exit Conditions (byte 48)	MANUAL States	LOCATE States
20	MANUAL	NORMAL	INITIALIZING_MODE	ENTERING_LOCATE_MODE
21	MENU	STOP_KEY	JOG_AZIM_CCW	INITIALIZING_LOCATE_MODE
22	POSITION	MODE_CHANGE	JOG_AZIM_CW	BEGINNING_ANTENNA_DEPLOYMENT
23			JOG_ELEV_DOWN	ANTENNA_DEPLOYMENT_OPENING_FAIRING
24			JOG_ELEV_UP	ANTENNA_DEPLOYMENT_ELEV_MOVE
25	LOCATE		JOG_POL_CW	ANTENNA_DEPLOYMENT_AZIM_MOVE
26			JOG_POL_CCW	ANTENNA_DEPLOYMENT_POL_MOVE
27	STORE		AUTO_POL_MOVE	CALCULATE_MAGVAR_FOR_CALCULATE_MODE
28	TRACK		IDLE	CALCULATING_MAGNETIC_VARIATION
29				SYNCHRONIZING_SYSTEM_CLOCK_TO_UTC
2A	SPECIAL_AXIS			WAITING_FOR_LAT_LON
2B				WAITING_FOR_HEADING
2C				WAITING_FOR_SAT_DATA
2D	HEADING_FIX			UNDEFINED_PARAMETER_ERROR
2E				READY_TO_LOCATE
2F	STOW			AZIM_RANGE_ERROR
30	DEPLOY			ELEV_RANGE_ERROR
31	RECALL			PERFORMING_MANUAL_SAT_DATA_ENTRY
32	AUTO_MOVE			PERFORMING_PRESET_SAT_DATA_ENTRY
33				PERFORMING_SATLIST_DATA_ENTRY
34				WAITING_FOR_POLARIZATION_SELECTION
35				WAITING_FOR_CONFIRMATION_TO_CONTINUE
36	RESET_DRIVE			PITCH_CALCULATION_FIRST_MOVEMENT
37	DELETE			PITCH_CALCULATION_FIRST_ELEV_MOVEMENT
38	FLASH_SAVE			PITCH_CALCULATION_AZIM_MOVEMENT
39				PITCH_CALCULATION_SECOND_ELEV_MOVEMENT
3A				CALCULATING_PITCH
3B				ROLL_CALCULATION_AZIM_MOVEMENT
3C				ROLL_CALCULATION_ELEV_MOVEMENT
3D				CALCULATING_ROLL
3E				CALCULATE_NORAD_ELEV_ANGLE
3F				CALCULATE_NORAD_AZIM_ANGLE
40				FIRST_MOVEMENT
41				POL_MOVEMENT
42				AZIM_MOVEMENT
43				ELEV_MOVEMENT
44				BEGINNING_SCAN
45				MOVING_TO_INITIAL_AZIM_SCAN_POSITION
46				MOVING_TO_INITIAL_ELEV_SCAN_POSITION
47				PERFORMING_SMOOTH_AZIM_SCAN
48				ADJUST_ELEV_DURING_SMOOTH_AZIM_SCAN
49				AZIM_STEP_SCAN
4A				ADJUST_ELEV_DURING_AZIM_STEP_SCAN
4B				MOVING_TO_SCAN_PEAK
4C				NO_PEAK_FOUND_MOVING_TO_NOMINAL_AZIM
4D				SCAN_FINAL_ELEV_ADJUSTMENT
4E				SCAN_WAITING_FOR_EXIT_AFTER_NO_PEAK_FOUND
4F				BEGINNING_SPIRAL_SEARCH
50				SPIRAL_MOVING_TO_STARTING_POSITION
51				SPIRAL_SEARCH_STEPPING_CW_IN_AZIM
52				SPIRAL_SEARCH_ADJUSTING_ELEV_CW_AZIM_STEP
53				SPIRAL_SEARCH_SAMPLING_SIGNAL
54				SPIRAL_SEARCH_ADJUSTING_AZIM_DURING_UP_ELEV_STEP
55				SPIRAL_SEARCH_STEPPING_UP_IN_ELEV
57				SPIRAL_SEARCH_STEPPING_CCW_IN_AZIM
58				SPIRAL_SEARCH_ADJUSTING_ELEV_CCW_AZIM_STEP
59				
5A				SPIRAL_SEARCH_ADJUSTING_AZIM_DURING_DOWN_ELEV_STEP
5B				SPIRAL_SEARCH_STEPPING_DOWN_IN_ELEV

Value (hex)	Mode (byte 45 & 47)	Exit Conditions (byte 48)	MANUAL States	LOCATE States
5C				
5D				SPIRAL_SEARCH_NO_PEAK_MOVING_TO_NOMINAL_AZEL
5E				SPIRAL_SEARCH_NO_PEAK_MOVING_TO_AZIM
5F				SPIRAL_SEARCH_NO_PEAK_MOVING_TO_ELEV
60				
61				
62				
63				
64				
65				DETERMINE_NOISE_FLOOR
66				INITIALIZE_DVB
67				PERFORMING_PEAKUP
68				LOCATE_COMPLETE

Value (hex)	TRACK States	SPECIAL_AXIS States	STOW States
20	ENTERING_MODE	WAITING_ELEV_NOT_STOWED	INITIALIZING_MODE
21	WAITING_FOR_C_OR_KU_SELECTION	WAITING_FOR_USER_INPUT	WAITING_FOR_CONTINUE_CONFIRMATION
22	INITIALIZING_DISPLAY	OPENING_TO_CLEAR	CONTINUING_OPERATION
23	DEPLOYING_ELEV_AXIS	OPENING_TO_SERVICE	MOVING_TO_INITIAL_CW_POSITION
24	POSITIONING_POLARIZATION	CLOSING_TO_STOW	WAITING_TO_CONFIRM_INVALID_SWITCH
25	WAITING_FOR_EXIT_CONFIRMATION	CLOSING_TO_CLEAR	MOVING_TO_AZIM_STOW
26	INITIALIZING_PARAMETERS	OPENING	SEARCHING_FOR_AZIM_SWITCH
27	STEP_PEAKING	CLOSING	WAITITNG_CANNOT_FIND_AZ_SWITCH
28	STEP_WAITING_FOR_SIGNAL_TO_RETURN		MOVING_TO_POL_STOW
29	STEP_IDLE		SEARCHING_FOR_POL_SWITCH
2A	SEARCH_PERFORMING_SEARCH_PATTERN		WAITING_CANNOT_FIND_POL_SWITCH
2B	SEARCH_MOVING_TO_FOUND_PEAK		WAITING_OUTSIDE_OF_AZIM_WINDOW
2C	SEARCH_WAITING_TO_SEARCH_AGAIN		MOVING_TO_ELEV_STOW
2D	MANUAL_SEARCH_NOMINAL_AZEL_MOVE		CLOSING_FAIRING
2E	MANUAL_SEARCH_NOMINAL_ELEV_MOVE		WAITING_FAIRING_CANT_MOVE_ELEV_NOT_AT_STOW
2F	MANUAL_SEARCH_NOMINAL_AZIM_MOVE		WAITING_FAIRING_NOT_AT_STOW
30	MANUAL_SEARCH_ACTIVE		COMPLETE
31	MEMORY_IDLE		MOVING_TO_AZPL_STOW
32	MEMORY_PEAKING		
33	MEMORY_REPOSITION		
34	ERROR_CREEP_JAMMED		
35	ERROR_CREEP_LIMIT		
36	ERROR_CREEP_DRIVE		
37	ERROR_PEAK_LIMIT		
38	ERROR_SCALE_FACTOR		
39	ERROR_GEO		
3A	ERROR_SYSTEM		
3B	ERROR_CHECKSUM		
3C	ERROR_UNDEFINED_STATUS		
3D	MENU_WAITING_FOR_SELECTION		
3E	MENU_VIEW		
3F	MENU_MODIFY		
40	TLE_IDLE		
41	TLE_REPOSITION		
42	MANUAL_SEARCH_JOG_AZIM_CCW		
43	MANUAL_SEARCH_JOG_AZIM_CW		
44	MANUAL_SEARCH_JOG_ELEV_DOWN		
45	MANUAL_SEARCH_JOG_ELEV_UP		
46	MANUAL_SEARCH_JOG_POL_CW		
47	MANUAL_SEARCH_JOG_POL_CCW		
48	MANUAL_SEARCH_AUTO_POL_MOVE		
49	MANUAL_SEARCH_IDLE		

Value (hex)	DEPLOY States	RECALL States
20	INITIAIZING_MODE	ENTERING_MODE
21	WAITING_FOR_CONTINUE_CONFIRMATION	NO_SATS_STORED_WAITING_TO_EXIT
22	MOVING_ELEV	WAITING_FOR_USER_TO_SCROLL_THROUGH_LIST
23	MOVING_AZIM	WAITING_FOR_INVALID_DATA_ACKNOWLEDGEMENT
24	MOVING_AZELPL	WAITING_FOR_INITIAL_POLARIZATION_SELECTION
25	MOVING_SPECIAL_AXIS	PERFORMING_ELEV_MOVE
26	WAITING_SPECIAL_AXIS_NOT_DEPLOYED	PERFORMING_POLARIZATION_MOVE
27		PERFORMING_AZIM_MOVE
28		PERFORMING_AZEL_MOVE