APPENDIX REM – REMOTE CONTROL PROTOCOL

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 OCT 2013	Document added to version control system.	ECG
20 OCT 2013	Added Write Config Data command and notes to appropriate sections.	ECG
04 NOV 2013	Added local jog alarm. Added feed index to status reply.	ECG
03 DEC 2013	Update special axis limits to match change to ACU scheme.	ECG
22 JAN 2014	Added indication that some commands return the status reply.	ECG
01 APR 2014	Added TLNB support to miscellaneous command.	ECG
24 APR 2014	Corrected error with Remote Store command.	ECG
04 JUN 2014	Corrected movement status descriptions. Add feed slider control.	ECG
20 MAY 2015	Corrected extended status reply tables.	ECG
26 MAY 2015	Update axis status to show presence of auto move and alarm conditions.	ECG
12 JUN 2015	Updated band enumeration values.	ECG
15 JUN 2015	Changed Remote Store command to Remote Track.	ECG
18 SEPT 2015	Added Off-Axis Alarm to query status.	ECG
15 OCT 2015	Added remote PEAKUP to miscellaneous command.	ECG
14 JAN 2016	Updated write/read beacon data command.	ECG
08 OCT 2016	Updated Extended Query Status command enumeration tables.	ECG
09 DEC 2016	Updated TRACK mode states and Query Status command.	ECG
16 DEC 2016	Update write/read DVB data command.	ECG
08 AUG 2018	Updated alarm indexes for version 2.10+	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. In the detailed command descriptions that follow, 'A' should be replaced by the address value.

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 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

Every message that is received generates a reply. After sending a command, the master should wait for a reply before sending a subsequent command. All replies will be sent within 500 milliseconds.

The NAK or ACK reply does not signify that an operation 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.

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.

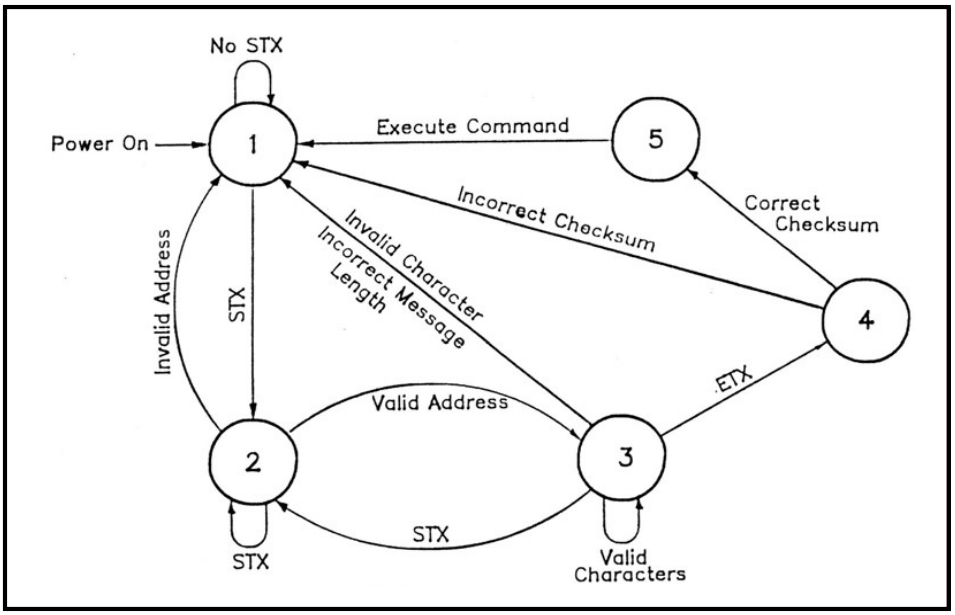

Figure 2 – SA Bus Protocol State Diagram

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.

Serial Communications Parameters

When the RC4000 is 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
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 a 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

IP Communication Parameters

When the RC4000 is controlled via an IP network, the above parameters are not available. In this case, the address is fixed at 50. Read appendix IP for additional configuration steps.

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 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	

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	

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	3.1
31	Device Status	3.2
32	Auto Move	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[1]	3.9
3A	Read Satellite Data	3.10
3B	Write Two Line Element Data[1]	3.11
3C	Read Two Line Element Data	3.12
3D	Write Beacon Data[1]	3.13
3E	Read Beacon Data	3.14
3F	Read Pulse Count	3.15
40	Extended Device Status	3.16
41	Remote Locate	3.17
42	Remote Track	3.18
43	Write DVB Data[1]	3.19
44	Read DVB 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	Write Config Data[1]	3.25
4A	Reserved	
4B	Custom Device Status[2]	3.26
4C	Reserved	
4D	Write Track Table Data[2]	3.27
4E	Read Track Table Data[2]	3.28
	1 – requires flash save via Write Config Data	
	2 – experimental	

3.1 Device Type Query Command

This command returns the six-byte device type string. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	30h	command code
byte 3	ETX	
byte 4	Checksum	

The reply to this command will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	30h	command code
bytes 3-7	Device Type	The device type identifier. This field will start with “RC4K” for RC4000 antenna controllers. Left-justified and padded with blanks.
bytes 8-12	Version	The device version number descriptor. This field will contain the software version in the format “vA.BC”.
byte 13	ETX	
byte 14	Checksum	

3.2 Device Status 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 command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	31h	command code
byte 3	ETX	
byte 4	Checksum	

The reply will consist of 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 response will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	31h	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	Reserved	

Device Status Command (continued)

byte 14-19 Azimuth Position
byte 20-25 Elevation Position
byte 26-31 Polarization Position

These fields will contain the formatted azimuth, elevation, and polarization position from -180.0 to 180.0.
If an error is detected, this field will contain '******'.

byte 32 Azimuth Limits – binary data
byte 33 Elevation Limits – binary data
byte 34 Polarization Limits – binary data

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

These fields contain azimuth, elevation, and polarization limit information. Bits 'A', 'B', and 'C' indicate the limit status. 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. The bit position to limit is defined as:

.

A – Maximum Limit (CW, UP, CW)
B – Minimum Limit (CCW, DOWN, CCW)
C – Stow Limit

byte 35 Polarization equipment and display status code – binary data

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

Where 'XX' is defined as:

00 – rotating feed is not present in the system
01 – single port rotating feed is present in the system
10 – dual port rotating feed is present in the system.

Where 'YYY' is defined as:

000 – no polarization code is displayed
001 – 'h' polarization code is displayed
010 – 'H' polarization code is displayed
011 – 'v' polarization code is displayed
100 – 'V' polarization code is displayed

Device Status 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 $ A A A A

Where 'S' is defined as:
0 – Axis Is Configured For Slow Speed Movement
1 – Axis Is Configured For Fast Speed Movement

Where 'AAAA' is defined as:
0000 – No Alarms or Movement
0010 – Negative Jog Movement (CCW, DOWN, CCW)
0011 – Positive Jog Movement (CW, UP, CW)
01xx – Auto Move In Progress
0110 – Negative Automatic Movement (CCW, DOWN, CCW)
0111 – Positive Automatic Movement (CW, UP, CW)
1xxx – Alarm Active
1010 – Runaway Alarm
1011 – Jammed Alarm
1100 – Motor Drive Alarm
1101 – Off-Axis Alarm

Higher value status codes have priority over lower value ones. If as part of an auto move command the antenna is moving clockwise the status will be reported as 'Positive Automatic Movement' rather than 'Auto Move In Progress'.

Device Status Command (continued)

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. NOTE: Some software versions have mount-specific alarm codes.

For ACU software version 2.00-2.09, the following codes are possible:

0 – No Alarm Active
1 – Flash Version Mismatch
2 – Flash Data Corrupt
3 – NVRAM Version Mismatch
4 – NVRAM Data Corrupt
5 – Low Battery
6 – Time/Date Error
7 – Azimuth Jammed
8 – Azimuth Runaway
9 – Elevation Jammed
10 – Elevation Runaway
11 – Polarization Jammed
12 – Polarization Runaway
13 – Limits Inactive Warning
14 – Drive Error
15 – Emergency Stow
16 – Maintenance Interlock
17 – Movement Interlock
18 – Local Jog Connected

For ACU software version 2.10+, the following codes are possible:

0 – No Alarm Active
1 – Flash Version Mismatch
2 – Flash Data Corrupt
3 – NVRAM Version Mismatch
4 – NVRAM Data Corrupt
5 – Low Battery
6 – Time/Date Error
10 – Azimuth Jammed
11 – Azimuth Runaway
12 – Reserved
13 – Azimuth Sync Warning
20 – Elevation Jammed
21 – Elevation Runaway
22 – Reserved
23 – Elevation Sync Warning
30 – Polarization Jammed
31 – Polarization Runaway
32 – Reserved
33 – Polarization Sync Warning
40 – Limits Inactive Warning
41 – Drive Error
42 – Emergency Stow
43 – Maintenance Interlock
44 – Movement Interlock
45 – Local Jog Connected

Device Status Command (continued)

byte 40 Track Mode track submode status and frequency band – binary data

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

Where ‘SSSS’ is defined as:

0000 – Track Mode Not Active
0001 – Track Setup Sub-Mode Active
0010 – Track Auto Mode Entry
0011 – Step Track Sub-Mode Active
0100 – Track Auto Search Sub-Mode Active
0101 – Program Track Sub-Mode Active
0110 – Track Manual Search Sub-Mode 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
1110 – Track Checksum Error

bytes 41-44 AGC Level Current AGC channel voltage from 0 and 4095, right justified and padded with blanks (on the left).

byte 45 AGC Channel Current 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 defined as:

000 – RF
001 – SS1
010 – SS2
011 – DVB
1xx – reserved

Where ‘L’ is defined as:

1 – lock indicated
0 – no lock indicated

Device Status Command (continued)

byte 46 HPA Relay/Feed ID Status – binary data

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

Where ‘AA’ is defined as:

00 – HPA Relay Disabled by ACU Software
01 – HPA Relay Disabled by External TX Mute
10 – HPA Relay Enabled
11 – Reserved

The bit field ‘BBB’ indicates the current feed id index which will be a value between 0 and 7. The value will be 0 if feed id bits are not supported.

byte 47 Special Axis Limits/Movement Status – binary data

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

Where ‘S’ is defined as:

0 – Axis Not Moving
1 – Axis Auto Move Is In Progress

Where A, B, C, and D indicate the current special axis limit state as:

SPECIAL AXIS	STATE DESCRIPTION	LIMIT CONDITION
Waveguide	Horizontal (pos 1)	B = 1
	Vertical (pos 2)	C = 1
RF Switch	Path 1	A = 0
	Path 2	A = 1
Polarization Mode	Linear mode	B = 1
	Circular mode	C = 1
Fairing Control	Deploy	B = 1
	Stow	C = 1
	Maintenance	D = 1
Feed Slider	Feed 1	B = 1
	Feed 2	D = 1
	Stow	C = 1

bytes 48–49 Reserved

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 has the following format:

byte 0	STX	
byte 1	A	address
byte 2	32h	command code
byte 3	Polarization	' ‘ (blank), 'C', ‘A’, ‘E’, 'P', ‘+’, ‘S’
byte 4-13	Position	target satellite name or position data
byte 14	ETX	
byte 15	Checksum	

The Auto Move command has several forms:

Form 1: Automates the RC4000 RECALL mode. If the 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. NOTE: The satellite name specified in the command must exactly match a satellite name.

With this form of the command, the polarization field may contain either 'H', 'V', or ' ‘ (blank). If '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 or vertical 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 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 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 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 zeros. For example, a 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" sensors (pulse or resolvers), the antenna will move to the count values specified. For example, a 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” sensor is available, a NAK reply will be sent to the host.

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 zeros. 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 that if one hundredth of a degree resolution is not available, the hundredth place digit will be ignored.

Auto Move Command (continued)

Form 2D: If the 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 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 zeros. For example, a position field value of '-152500456' specifies an azimuth position of -152.5 degrees and an 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 polarization first and azimuth 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.

SPECIAL AXIS	AXIS CODE	DIRECTION CODE
Waveguide	W	H – horizontal (pos 1) V – vertical (pos 2)
RF Switch	R	1 – path 1 2 – path 2
Polarization Mode	P	C – circular mode L – linear mode
Fairing Control	F	D – move to deploy S – move to stow M – move to maintenance
Feed Slider	E	1 – feed 1 2 – feed 2 S – move to stow

The ACK reply to this command will be in the same format as the Device Status Command. If the command specifies polarization movement but the Polarization Type is set to CIRCULAR, ACK will be received, but no polarization movement will occur.

3.4 Azimuth/Elevation/Polarization Jog Command

This command jogs the antenna in azimuth, elevation, or polarization. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	33h	command code
byte 3	Direction	This field can specify one of the following: E – Azimuth Counter Clockwise W – Azimuth Clockwise D – Elevation Down U – Elevation Up O – Polarization Counter Clockwise L – Polarization Clockwise X – Stop All Movement
byte 4	Speed	Specifies the jog speed, either 'F' (Fast) or 'S' (Slow). This field must contain a valid value even if the direction field specifies 'X' (Stop).
bytes 5-8	Duration	Length to continue the jog milliseconds from '0000' to '9999'. This field must contain a valid value even if the direction field specifies 'X' (Stop). NOTE: The resolution of the timer used to make the move is approximately 10 milliseconds. All durations converted to the closest multiple.
byte 9	ETX	
byte 10	Checksum	

The ACK reply to this command will be in the same format as the Device Status Command.

NOTE 1: 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, the azimuth jog will terminate regardless of the duration specified for the remote azimuth jog.

NOTE 2: The controller will automatically switch to MANUAL mode to execute this command.

3.5 Polarization Command

This command moves the polarization to the specified calculated position. 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. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	34h	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	

The ACK reply to any form of this command will be in the same format as the Device Status Command.

NOTE: This command is only available while MANUAL or TRACK mode is active.

3.6 Query Name Command

This command can be used to retrieve the name of a satellite saved via the controller's STORE mode. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	35h	command code
bytes 3-4	Index	The index of the satellite name being requested. (01–XX, XX=Count)
byte 5	ETX	
byte 6	Checksum	

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	35h	command code
bytes 3-4	Index	The index of the satellite name being requested. (01–XX, XX=Count)
bytes 5-6	Count	The total number of satellite names contained in the list.
bytes 7-16	Sat Name	This field will contain the satellite name. The name will be in capital letters and left justified.
byte 17	ETX	
byte 18	Checksum	

The NAK reply will be received if the entry does not exist in the list (or if the list has no entries).

3.7 Miscellaneous Command

This command performs miscellaneous functions. The command has the following format:

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

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

'X' = 'R'	This sub-command is used to reset the azimuth, elevation, or polarization drives. The sub-command parameter 'Y' must be 'A', 'E', or 'P' (for azimuth, elevation, or polarization respectively).
'X' = 'T'	This sub-command is used to clear tracking errors and restart TRACK mode. The sub-command parameter 'Y' must be 'R'. The reply will be a NAK if TRACK mode is not active. NOTE: If a system error is active (an error message flashing on the bottom row of the display) the error condition must be rectified or the controller will immediately return to the TRACK mode ERROR sub-mode.
'X' = 'S'	This sub-command is used to initiate an automatic antenna STOW command.
'X' = 'D'	This sub-command is used to initiate an automatic antenna DEPLOY command.
'X' = 'P'	This sub-command is used to initiate an automatic antenna PEAKUP command.
'X' = 'L'	This sub-command is used to manually select the band range of a tunable LNB (TLNB). Set parameter 'Y' = '0', '1', '2', or '3' to select mute, low, middle, or high band. NOTE: This sub-command is only available on systems that include TLNB support.

The ACK reply to this command will be in the same format as the Device Status Command.

3.8 Reflect Display Command

This command requests contents of the 4x40 LCD. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	37h	command code
byte 3	ETX	
byte 4	Checksum	

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	37h	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 164-165	Cursor Column	cursor column (01–40)
byte 166	Cursor Status	0 = cursor off, blink off 1 = cursor off, blink on 2 = cursor on, blink off 3 = cursor on, blink on
byte 167	ETX	
byte 168	Checksum	

NOTE: The reply to this command is very lengthy and should be limited to a frequency less than 2 Hz.

3.9 Write Satellite Data Command

This command downloads satellite data into the RC4000 list of preset satellites. Storage for 20 satellites is available. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	39h	command code
byte 3-4	Index	Preset satellite table index (01–20)
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	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
byte 24	Ephemeris	0 = None, 1 = TLE
bytes 25-29	Pol Offset	Polarization Offset -90.0 to 90.0 negative = counterclockwise Left Justify and pad with blanks
byte 30	Default Pol	Default polarization for remote LOCATE command (H = Horizontal, V = Vertical, X = None)
byte 31		ETX
byte 32		Checksum

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

NOTE: Data written with this command must be saved to persist between power cycles. The Write Config Data Command should be executed after all changes have been made. Refer to section 3.25 of this document for more information.

3.10 Read Satellite Data Command

This command uploads a stored set of satellite data to the RC4000. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	3Ah	command code
byte 3-4	Index	Preset satellite table index (01–20)
byte 5		ETX
byte 6		Checksum

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	3Ah	command code
byte 3-4	Index	Preset satellite table index (01–20)
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	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
byte 24	Ephemeris	0 = None, 1 = TLE
bytes 25-29	Pol Offset	Polarization Offset -90.0 to 90.0 negative = counterclockwise Left Justify and pad with blanks
byte 30	Default Pol	Default polarization for remote LOCATE command (H = Horizontal, V = Vertical, X = None)
byte 31	ETX	
byte 32	Checksum	

3.11 Write Two Line Element Data Command

This command writes NORAD Two Line Element (TLE) ephemeris data into the RC4000. The index must be the same as the associated sat preset data index. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	3Bh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
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.

Data written with this command must be saved to persist between power cycles. The Write Config Data Command should be executed after all changes have been made. Refer to section 3.25 of this document for more information.

3.12 Read Two Line Element Data Command

This command reads a stored set of Two Line Element (TLE) data. The index must be the same as the associated sat preset data index. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	3Ch	command code
bytes 3-4	Index	Preset satellite table index (01–20)
byte 5	ETX	
byte 6	Checksum	

The ACK reply will be in the following format:

byte 0	ACK or NAK	
byte 1	A	address
byte 2	3Ch	command code
bytes 3-4	Index	Preset satellite table index (01–20)
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 Beacon Data Command

This command writes beacon tuning data into the RC4000. The index must be the same as the associated sat preset data index. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	3Dh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-10	Longitude	Nominal satellite longitude -179.9 to 180.0 (West longitude negative) Left Justify and pad with blanks
byte 11	Polarization	H=horizontal, V=vertical
byte 12	Band	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
byte 13	Enable Flag	0 – Do not use this entry 1 – Use as signpost 2 – Use for confirmation only
bytes 14-21	Frequency (ddddd.dd)	Beacon frequency (MHz) in the format
byte 22	Demodulation	0 = CW, 1 = BPSK
bytes 23-31	Reserved	fill with zeros or blanks
byte 32	ETX	
byte 33	Checksum	

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

Data written with this command must be saved to persist between power cycles. The Write Config Data Command should be executed after all changes have been made. Refer to section 3.25 of this document for more information.

3.14 Read Beacon Data Command

This command reads beacon tuning data from the RC4000. The index must be the same as the associated sat preset data index. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	3Eh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
byte 5	ETX	
byte 6	Checksum	

The ACK reply will be in the following format:

byte 0	ACK or NAK	
byte 1	A	address
byte 2	3Eh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-10	Longitude	Nominal satellite longitude -179.9 to 180.0 (West longitude negative) Left Justify and pad with blanks
byte 11	Polarization	H = horizontal, V = vertical
byte 12	Band	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
byte 13	Locate Flag	0 – Do not use this entry 1 – Use as signpost 2 – Use for confirmation only
bytes 14-21	Frequency (ddddd.dd)	Beacon frequency (MHz) in the format
byte 22	Demodulation	0 = CW, 1 = BPSK
bytes 23-31	Reserved	
byte 32		ETX
byte 33		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 command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	3Fh	command code
byte 3	ETX	
byte 4	Checksum	

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	3Fh	command code
bytes 3-7	Az Count	Azimuth pulse or resolver count value
bytes 8-12	El Count	Elevation pulse or resolver count value
byte 13	ETX	
byte 14	Checksum	

3.16 Extended Device Status Command

This command is an extension of the Device Status Command. The reply to this command provides all the information of the Device Status Command along with additional information including the current mode and state of the RC4000. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	40h	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	address
byte 2	40h	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 5.3 of this document for more information about the available values for this field.

Extended Device Status Command (continued)

byte 51	Current State	This byte contains a value reflecting the current state within the current mode. See section 5.3 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 5.3 of this document for more information about the available values for this field.
byte 53	Last State	This byte contains a value reflecting the previous state of the previous mode. See section 5.3 of this document for more information about the available values for this field.
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	
byte 59	ETX	
byte 60	Checksum	

3.17 Remote Locate Command

This command requests the RC4000 to perform a LOCATE operation. The ACU will automatically begin locating the specified satellite using the data provided.

NOTE: The M&C system is required to have confidence that the preset data is programmed correctly. This includes satellite data and associated receiver parameters.

The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	41h	command code
byte 3	Preset Flag & Preset Index Tens 7 6 5 4 3 2 1 0 0 1 A A $ 0 0 B B	Where 'AA' is defined as: 00 – use data supplied in bytes 5-28 01 – use preset data stored in the ACU 10 – use data from the last LOCATE operation Where 'BB' is the tens digit of preset index, or zero if not specifying a preset satellite.
byte 4	Index Ones	Ones digit of preset index, or zero if not specifying a preset satellite
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	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
bytes 24-28	Pol Offset	Satellite Polarization Offset (relative to equatorial plane) -90.0 to 90.0 (CCW negative) Left Justify and pad with blanks

Remote Locate Command (continued)

byte 29	Polarization	H – Horizontal V – Vertical N – Neutral X – None D – Use default stored in preset list NOTE: This value is ignored if feed type is circular.
byte 30	Position Update	A – Automatically determine missing mount position data U – Force an update of all mount position data
byte 31	Locate Source 7 6 5 4 3 2 1 0 0 1 0 A $ B B B B	Where 'A' is defined as: 0 – use locate source config value 1 – use source specified by lower nibble Where 'BBBB' is defined as: 0000 – None 0001 – Receiver 1 (or external beacon) 0010 – Receiver 2 (or internal beacon) 0101 – RF 0110 – DVB (if available) 0111 – Remote (if available)
bytes 32-34	Reserved	fill with zeros or blanks
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 Track Command

This command requests the RC4000 start a TRACK operation. The ACU will automatically begin tracking the specified satellite using the data provided.

NOTE 1: The M&C system is required to have confidence that the preset data is programmed correctly. This includes satellite data and associated receiver parameters.

NOTE 2: It is assumed that the satellite has been positively identified and is currently peaked up in azimuth, elevation, and polarization prior to performing this operation.

The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	42h	command code
byte 3	Preset Flag & Preset Index Tens 7 6 5 4 3 2 1 0 0 1 A A $ 0 0 B B	 Where 'AA' is defined as: 00 – use data supplied in bytes 5-28 01 – use preset data stored in the ACU 10 – use data from the last LOCATE operation Where 'BB' is the tens digit of preset index, or zero if not specifying a preset satellite.
byte 4	Index Ones	Ones digit of preset index, or zero if not specifying a preset satellite
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	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
bytes 24-29	Reserved	fill with zeros or blanks

Remote Track Command (continued)

byte 30	Position Update	A – Automatically determine missing mount position data U – Force an update of all mount position data
byte 31	Track Source 7 6 5 4 3 2 1 0 0 1 0 A $ B B B B	
		Where 'A' is defined as: 0 – use locate source config value 1 – use source specified by lower nibble Where 'BBBB' is defined as: 0000 – None 0001 – Receiver 1 (or external beacon) 0010 – Receiver 2 (or internal beacon) 0101 – RF 0110 – DVB (if available) 0111 – Remote (if available)
byte 32	Track Options	0 – recall previous track (if available) 1 -- start new track
bytes 33-45	Reserved	fill with zeros or blanks
byte 46		ETX
byte 47		Checksum

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

3.19 Write DVB Data Command

This command writes DVB tuning data into the RC4000. The index must be the same as the associated sat preset data index. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	43h	command code
bytes 3-4	Index	Preset satellite table index (01–20)
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 0 = Auto, 1 to 9 = N/N+1 Note: Set to “Auto” for DVB-S2
byte 22	Polarization	H = horizontal, V = vertical
bytes 23-28	Reserved	fill with zeros of blanks
byte 29	Enable Flag	0 – Do not use this entry 1 – Use as signpost 2 – Use for confirmation only
byte 30	Standard	1= DVB-S1, 2 = DVB-S2
byte 31	Modulation	0 = Auto, 1 = QPSK Note: Set to “Auto” for DVB-S2
byte 32	Band	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
byte 33	Reserved	fill with zero or blank
byte 34	ETX	
byte 35	Checksum	

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

Data written with this command must be saved to persist between power cycles. The Write Config Data Command should be executed after all changes have been made. Refer to section 3.25 of this document for more information.

3.20 Read DVB Data Command

This command reads DVB tuning data from the RC4000. The index must be the same as the associated sat preset data index. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	44h	command code
byte 3-4	Index	Signpost data table index (01–20)
byte 5	ETX	
byte 6	Checksum	

The ACK reply will be in the following format:

byte 0	ACK or NAK	
byte 1	A	address
byte 2	44h	command code
bytes 3-4	Index	Preset satellite table index (01–20)
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 0 = Auto, 1 to 9 = N/N+1 Note: Set to “Auto” for DVB-S2
byte 22	Polarization	H = horizontal, V = vertical
bytes 23-28	Reserved	
byte 29	Enable Flag	0 – Do not use this entry 1 – Use as signpost 2 – Use for confirmation only
byte 30	Standard	1 = DVB-S1, 2 = DVB-S2
byte 31	Modulation	0 = Auto, 1 = QPSK Note: Set to “Auto” for DVB-S2
byte 32	Band	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
byte 33	Reserved	fill with zero or blank
byte 34	ETX	
byte 35	Checksum	

3.21 Read Navigation Data Command

This command uploads the current values of navigation data. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	45h	command code
byte 3	ETX	
byte 4	Checksum	

The ACK reply will be in the following format:

byte 0	ACK or NAK	
byte 1	A	address
byte 2	45h	command code
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 – Lat/Lon data invalid 010 – Lat/Lon read from GPS 011 – User entered location 100 – User selected preset location 101 – Remotely entered lat/lon
bytes 4-8	Latitude	+ddmm (+/- degrees, minutes format) right justified, padded with blanks -9000 to +9000 or blanks if not available minus = South, positive (implied) = North 1234 = 12 degrees 34 minutes N -1234 = 12 degrees 34 minutes S
bytes 9-12	Reserved	
bytes 13-18	Longitude	+dddmm (+/- degrees, minutes format) right justified, padded with blanks -18000 to +18000 or blanks if not available minus = West, positive (implied) = East 1234 = 12 degrees 34 minutes E -1234 = 12 degrees 34 minutes W
bytes 19-28	Reserved	

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 – Heading data invalid 010 – Heading read from compass 011 – User entered magnetic heading 100 – User entered true heading 101 – Heading fixed by user 110 – Heading fixed automatically 111 – Remotely entered heading
bytes 30-34	True Heading	ddd.d (decimal degrees format) 0.0 to 359.9 or blanks if not available True Heading of mount at azimuth 0.0
byte 35	Magvar Status	0x41h if magvar ready (calculated) 0x40h if magvar not ready
bytes 36-41	Magnetic Variation	+dd.d (decimal degrees format) right justified, padded with blanks -99.9 to 99.9 or blanks if magvar not available (westerly variation negative)
byte 42-58	Reserved	
byte 59	Platform Tilt Source 7 6 5 4 3 2 1 0 0 1 0 0 $ 0 X X X	
	where 'XXX' is ...	001 – Currently no tilt data 010 – Automatically determined tilt data 011 – User entered tilt data 100 – Remotely entered tilt data
bytes 60-64	Platform Pitch	+dd.d (decimal degrees format) right justified, padded with blanks -99.9 to 99.9 or blanks if not available
bytes 65-69	Platform Roll	+dd.d (decimal degrees format) right justified, padded with blanks -99.9 to 99.9 or blanks if not available
byte 70	ETX	
byte 71	Checksum	

3.22 Write Navigation Data Command

This command downloads antenna position data into the RC4000. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	46h	command code
bytes 3-7	Latitude	+ddmm (+/- degrees, minutes format) right justified, padded with blanks -9000 to 9000 minus = South, positive (implied) = North 1234 = 12 degrees 34 minutes N -1234 = 12 degrees 34 minutes S
bytes 8-13	Longitude	+dddmm (+/- degrees, minutes format) right justified, padded with blanks -18000 to 18000 minus = West, positive (implied) = East 1234 = 12 degrees 34 minutes E -1234 = 12 degrees 34 minutes W
bytes 14-18	True Heading	ddd.d (decimal degrees format) right justified, padded with blanks 0.0 to 359.9 True Heading of mount at azimuth 0.0 12.3 = 12.3 degrees 179.4 = 179.4 degrees
byte 19	Update Lat/Lon	'A' – do not change lat/lon values 'U' – force update using GPS 'M' – use manual data from fields above
byte 20	Update Heading	'A' – do not change compass value 'U' – force update using compass 'M' – use manual data from fields above
byte 21	Update Options	
	7 6 5 4 3 2 1 0 0 1 0 X $ 0 0 0 0	
	where 'X' is ...	0 – Update source flags only 1 – Immediately move antenna to update position data (REMOTE_NAV mode)
bytes 22-26	Reserved	fill with zeros or blanks

Write Navigation Data Command (continued)

bytes 27-31	Platform Pitch	+dd.d (+/- degrees format) right justified, padded with blanks -90.0 to 90.0 12.3 = 12.3 degrees -11.4 = -11.4 degrees
bytes 32-36	Platform Roll	+dd.d (+/- degrees format) right justified, padded with blanks -90.0 to 90.0 12.3 = 12.3 degrees -11.4 = -11.4 degrees
bytes 37	Update Tilt	'A' – do not change pitch/roll values 'U' – force update of tilt 'M' – use manual data from fields above
bytes 38-40	Reserved	spare for future expansion (fill with blanks)
byte 41	ETX	
byte 42	Checksum	

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

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. Rather than sending the full status reply, only the position (at the time the command is received) of the selected axis is returned.

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	47h	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

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. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	48h	command code
byte 3	Key Code	Key code as defined below
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

NOTE: 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.

3.25 Write Config Data Command

This command writes CONFIG item values to the RC4000 memory. Data values written by some remote commands are not committed to the flash memory until the save command is sent.

Flash memory has a limited number of write times. Care should be taken to avoid unnecessary calling of this command. For example, if changing a number of preset satellites, don't call Write Config Data until all Write Satellite Data commands have been sent and acknowledged.

The save command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	49h	command code
byte 3-15	"SAVE"	Left-justified and padded with blanks
byte 16	ETX	
byte 17	Checksum	

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

NOTE: The ACU current mode will change to FLASH_SAVE_MODE temporarily while flash data is saved.

3.26 Custom Device Status Command

This command requests status information given a variable list of Object IDs. A full list of available OIDs is given in section A.4 of this document. The command has the following format:

byte 0		STX
byte 1	A	address
byte 2	4Bh	command code
byte 3-n	Object IDs	A comma-delimited list of up to 16 OIDs. Each code should be in ASCII format with no padding. Example: 1.62.0,1.62.1 requests the azimuth and elevation angles
byte n+1	ETX	
byte n+2	Checksum	

The response to this command will be a comma-delimited list of the requested OIDs and related status values in the same order as they were requested. The return values will be the ASCII representation of character, numeric, or hexadecimal data. The return type is given in section A.4 of this document.

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	4Bh	command code
byte 3-n	Object Values	A comma-delimited list of status object values. Each value will be in ASCII format with no padding. No data will be returned if a requested object ID is invalid. Example: 1.62.0=-22.3,1.62.0=47.1 is the reply containing the current azimuth angle (-22.3) and elevation angle (47.1)
byte n+1	ETX	
byte n+2	Checksum	

NOTE: This functionality is experimental and may change without notice.

3.27 Write Track Table Command

This command writes position and update data to a track table entry. The index must be the same as the associated sat preset data index. NOTE: In general, track table data should not be modified. This command is provided to allow a track table to be restored in the event that the data has been corrupted or lost. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	4Dh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-6	Table Entry	Zero-based track table entry number (00–47)
bytes 7-11	Azimuth Position	Azimuth pulse or resolver count value (0–65535)
bytes 12-16	Elevation Position	Elevation pulse or resolver count value (0–65535)
byte 17	Update Flag	'Y' – set entry update flag 'N' – clear entry update flag
byte 18	ETX	
byte 19	Checksum	

Another format to this command can be used to erase track table data of a single entry.

byte 0	STX	
byte 1	A	address
byte 2	4Dh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-17	"ERASE"	Left-justified and padded with blanks
byte 18	ETX	
byte 19	Checksum	

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

3.28 Read Track Table Command

This command reads position and update data from a track table entry. The index must be the same as the associated sat preset data index. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	4Eh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-6	Table Entry	Zero-based track table entry number (00–47)
byte 7	ETX	
byte 8	Checksum	

The ACK reply will be in the following format:

byte 0	ACK or NAK	
byte 1	A	address
byte 2	4Eh	command code
bytes 3-4	Index	Preset satellite table index (01–20)
bytes 5-6	Table Entry	Track table entry number (00–47)
bytes 7-11	Sidereal Time	Sidereal time of this entry
bytes 12-16	Azimuth Position	Azimuth pulse or resolver count value (0–65535) If data is invalid, this field will be filled with dashes.
bytes 17-21	Elevation Position	Elevation pulse or resolver count value (0–65535) If data is invalid, this field will be filled with dashes.
byte 22	Update Flag	‘Y’ – entry update flag is set ‘N’ – entry update flag is not set
byte 23	Ephemeris Flag	‘0’ – ephemeris data not used ‘1’ – ephemeris data used
byte 24-33	Reserved	fill with zeros or blanks
byte 32	ETX	
byte 33	Checksum	

//

4.0 TROUBLESHOOTING

4.1 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.

4.2 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) Allow a previous command to ACK or NAK before sending another command.
2) Don't repeatedly ask for "static" information such as navigation or satellite data.
3) The general recommendation is not to send commands (particularly status requests) at a rate greater than once a second.

5.0 REFERENCE INFORMATION

5.1 MESSAGE DELIMITERS

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

ASCII Name	Value (hex)	Value (dec)
STX	0x02	2
ETX	0x03	3
ACK	0x06	6
NAK	0x15	21

5.2 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	

5.3 EXTENDEND STATUS REPLY TABLES

The following table defines possible values for the Current/Last Mode of the Extended Device Status Poll reply. Only values listed below should be considered valid.

Table 5.3.1 – Operating Modes

Value (hex)	Value (dec)	Modes
20	32	MANUAL
21	33	MENU
22	34	POSITION
23	35	
24	36	
25	37	LOCATE
26	38	TRACK_SAT
27	39	STORE_SAT
28	40	TRACK
29	41	
2A	42	SPECIAL_AXIS
2B	43	POWERUP_MODE
2C	44	
2D	45	HEADING_FIX
2E	46	
2F	47	STOW
30	48	DEPLOY
31	49	RECALL
32	50	MOVETO
33	51	
34	52	
35	53	
36	54	RESET_DRIVE
37	55	DELETE
38	56	FLASH_SAVE
39	57	
3A	58	
3B	59	REMOTE_POS
3C	60	WIND_HOLD
3D	61	PEAKUP
3E	62	SHAKE
3F	63	

The following table defines possible values for the Current/Last State fields of the Extended Device Status Poll reply. These states are always possible regardless of the current mode.
Only values listed below should be considered valid.

Table 5.3.2 – Common Mode States

Value (hex)	Value (dec)	ALL MODES
20	32	INITIALIZING_MODE
21	33	WAITING_FOR_USER_INPUT
22	34	MOVING_TO_DEPLOY
23	35	MOVING_TO_STOW
24	36	
25	37	
26	38	MOVING_OUT_OF_DOWN
27	39	MOVING_AZIMUTH
28	40	MOVING_ELEVATION
29	41	MOVING_POLARIZATION
2A	42	MOVING_AZELPL
2B	43	MOVING_SPECIAL_AXIS
2C	44	SEARCHING_FOR_AZIM_STOW_SWITCH
2D	45	SEARCHING_FOR_POL_STOW_SWITCH
2E	46	ERROR_CANNOT_FIND_AZIM_STOW_SWITCH
2F	47	ERROR_CANNOT_FIND_POL_STOW_SWITCH
30	48	ERROR_EVEN_NOT_IN_POSITION
31	49	ERROR_SPECIAL_AXIS_NOT_IN_POSITION
32	50	ERROR_ANTENNA_NOT_AT_STOW
33	51	ERROR_ANTENNA_NOT_AT_DEPLOY
34	52	WAITING_FOR_LATLON
35	53	WAITING_FOR_HEADING
36	54	WAITING_FOR_TILT
37	55	ERROR_NO_GPS_INPUT_DETECTED
38	56	ERROR_NO_HEADING_INPUT_DETECTED
39	57	ERROR_NO_TILT_INPUT_DETECTED
3A	58	MOVING_TO_DETERMINE_LATLON
3B	59	MOVING_TO_DETERMINE_HEADING
3C	60	MOVING_TO_DETERMINE_TILT
3D	61	MOVING_TO_SYNC_PULSES
3E	62	
3F	63	

The following tables define possible values for the Current/Last State fields of the Extended Device Status Poll reply. These states are unique to their respective modes.
Only values listed below should be considered valid.

Table 5.3.3 – Unique Mode States

Value (hex)	Value (dec)	POWERUP_MODE	MANUAL	STOW	TRACK_SAT
40	64	CONFIRM_TRACK_RESTART	JOG_AZIM_CCW	STOW_COMPLETE	PRESET_DATA_ERROR
41	65	CONFIRM_SAVED_POSITION	JOG_AZIM_CW		NO_LAT_LON
42	66		JOG_ELEV_DOWN		NO_HEADING
43	67		JOG_ELEV_UP		
44	68		JOG_POL_CCW		
45	69		JOG_POL_CW		RETURNING_TO_START_POSITION
46	70		AUTO_MOVE_POL		
47	71		IDLE		
48	72				
49	73				
4A	74				
4B	75				
4C	76				
4D	77				
4E	78				
4F	79				

Table 5.3.4 – Unique Mode States

Value (hex)	Value (dec)	LOCATE	TRACK
40	64	ERROR_NO_LATLON	INITIALIZING_PARAMETERS
41	65	ERROR_NO_HEADING	CONFIRM_EXIT
42	66	ERROR_NO_SAT_DATA	
43	67	ERROR_FEED_BAND_MISMATCH	
44	68	ERROR_AZIMUTH_RANGE	TUNE_DVB
45	69	ERROR_ELEVATION_RANGE	TUNE_BEACON
46	70	PRESET_DATA_ERROR	TUNE_FAILURE
47	71	WAITING_FOR_MODEM	ATTENUATING_BEACON
48	72		
49	73		STEP_PEAKING
4A	74	CALCULATING_ANGLES	STEP_WAITING_FOR_SIGNAL_TO_RETURN
4B	75	CALCULATING_TLE_ANGLES	STEP_IDLE
4C	76	WAITING_FOR_POL_SELECTION	SEARCH_ACTIVE
4D	77	READY_TO_LOCATE	SEARCH_MOVING_TO_FOUND_PEAK
4E	78	LOCATE_COMPLETE	SEARCH_WAITING_TO_SEARCH_AGAIN
4F	79	LOCATE_FAILED	
50	80		SEARCH_MANUAL_ACTIVE
51	81		MEMORY_IDLE
52	82	MOVING_TO_INITIAL_SCAN_POSITION	MEMORY_REPOSITION
53	83	ERROR_NO_RF_DETECTED	MEMORY_UPDATING
54	84	DETERMING_NOISE_FLOOR	MEMORY_CHECKING
55	85	MOVING_TO_SCAN_ELEVATION	TLE_IDLE
56	86	RESCANNING_WITH_WIDER_RANGE	TLE_REPOSITION
57	87		
58	88	TUNING_DVB	
59	89	TUNING_BEACON	
5A	90	TUNE_FAILURE	
5B	91	ATTEN_BEACON	
5C	92		
5D	93	AZIMUTH_SMOOTH_SCAN	

Value (hex)	Value (dec)	LOCATE	TRACK
5E	94	AZIMUTH_STEP_SCAN	
5F	95		
60	96		ERROR_PEAK_LIMIT
61	97	SAMPLING_AGC	ERROR_ACU_ALARM
62	98	MOVING_TO_LOCK_CENTER	ERROR_CHECKSUM
63	99	MOVING_TO_PEAK	ERROR_TLE_DATA
64	100	NO_PEAK_MOVING_TO_NOMINAL	ERROR_UNDEFINED
65	101	NO_PEAK_FOUND	
66	102	BEGINNING_SPIRAL_SEARCH	
67	103	SPIRAL_MOVING_TO_START	
68	104	SPIRAL_STEPPING_CW	
69	105	SPIRAL_STEPPING_UP	
6A	106	SPIRAL_STEPPING_CCW	
6B	107	SPIRAL_STEPPING_DOWN	
6C	108		
6D	109		
6E	110		
6F	111		
70	112	MOVING_TO_TARGET_SATELLITE	
71	113	FINAL_POL_MOVE	
72	114		
73	115		
74	116	PERFORMING_PEAKUP	
75	117	PERFORMING_POL_PEAKUP	

STATUS OBJECT IDS AND RETURN VALUE TYPES

NOTE: This functionality is experimental and may change at any time without notice.

The following table defines the available status OIDs and their return value types. All values are returned as ASCII characters formatted in the manner described. Supplemental tables follow with individual item detail where indicated.

Table 5.4.1 – Object IDs

OID	Status Item	Format	Description
1.0.0	CURRENT_MODE_ITEM	Unsigned	See Section 5.3
1.1.0	CURRENT_SUBMODE_ITEM	Unsigned	See Section 5.3
1.2.0	LAST_MODE_ITEM	Unsigned	See Section 5.3
1.3.0	LAST_SUBMODE_ITEM	Unsigned	See Section 5.3
1.4.0	DATE_ITEM (future)	ASCII String	YYYY-MM-DD (10 Characters)
1.5.0	TIME_ITEM (future)	ASCII String	HH:MM:SS (8 Characters)
1.6.0	ACTIVE_ALARM_ITEM	Enumeration	Table 5.4.5
1.7.0	LOCATE_ACTIVE_ITEM	Unsigned	1=Active
1.8.0	LOCAL_JOG_CONNECTED_ITEM	Unsigned	0=Not Connected, 1=Connected
1.10.0	POS_SAVED_ITEM	Unsigned	0 = Not Saved, 1=Saved
1.11.0	POS_LOC_SOURCE_ITEM	Enumeration	Table 5.4.2
1.12.0	POS_LOC_LAT_ITEM	Signed	+DDMM (degrees/minutes)
1.13.0	POS_LOC_LON_ITEM	Signed	+DDDMM (degrees/minutes)
1.14.0	POS_LOC_ALT_ITEM (future)	Unsigned	AAAA (meters)
1.15.0	POS_HDG_SOURCE_ITEM	Enumeration	Table 5.4.2
1.16.0	POS_HDG_ITEM	Float	DDD.DD (degrees)
1.17.0	POS_TILT_SOURCE_ITEM	Enumeration	Table 5.4.2
1.18.0	POS_TILT_PITCH_ITEM	Signed	+DD.D (degrees)
1.19.0	POS_TILT_ROLL_ITEM	Signed	+DD.D (degrees)
1.20.0	SAT_SOURCE_ITEM	Enumeration	Table 5.4.3
1.21.0	SAT_PRESET_NUM_ITEM	Unsigned	0 – 19
1.22.0	SAT_NAME_ITEM	ASCII String	10 Characters
1.23.0	SAT_LON_ITEM	Float	+DDD.D (degrees)
1.24.0	SAT_INCLIN_ITEM	Signed	+DD (degrees)
1.25.0	SAT_BAND_ITEM	Enumeration	Table 5.4.3
1.26.0	SAT_POL_OFFSET_ITEM	Float	+DD.D (degrees)
1.27.0	SAT_EPHEM_ITEM	Unsigned	0=None, 1=TLE
1.28.0	SAT_POLARIZATION_ITEM	Enumeration	Table 5.4.3
1.40.0	DVB_FREQ_ITEM	Unsigned	DDDDD (Mhz)
1.41.0	DVB_SYMRATE_ITEM	Unsigned	DDDDD (kS/sec)
1.42.0	DVB_FEC_ITEM	Unsigned	1 – 7, (3=3/4)
1.43.0	DVB_STD_ITEM	Unsigned	1=S1, 2=S2
1.50.0	BCN_FREQ_ITEM	Float	DDDDDD.DD (kHz)
1.51.0	BCN_ATTEN_ITEM	Unsigned	DD (dB)
1.52.0	BCN_DEMOD_ITEM	Unsigned	0=CW, 1=BPSK
1.60.0	TARGET_AZ_ITEM	Float	+DDD.D (degrees)
1.61.0	TARGET_EL_ITEM	Float	+DDD.D (degrees)
1.62.0	TARGET_PL_H_ITEM	Float	+DDD.D (degrees)
1.63.0	TARGET_PL_V_ITEM	Float	+DDD.D (degrees)
1.64.0	TARGET_RANGE_ITEM	Unsigned	+DDDDD (miles)
1.70.0	AXIS_ANGLE_ITEM: AZ	Float	+DDD.D (degrees)
1.70.1	AXIS_ANGLE_ITEM: EL	Float	+DDD.D (degrees)
1.70.2	AXIS_ANGLE_ITEM: PL	Float	+DDD.D (degrees)
1.71.0	AXIS_COUNT_ITEM: AZ	Unsigned	0 – 65535
1.71.1	AXIS_COUNT_ITEM: EL	Unsigned	0 – 65535
1.71.2	AXIS_COUNT_ITEM: PL	Unsigned	0 – 65535
1.72.0	AXIS_LIMITS_ITEM: AZ	Hexadecimal	Table 5.4.6
1.72.1	AXIS_LIMITS_ITEM: EL	Hexadecimal	Table 5.4.6
1.72.2	AXIS_LIMITS_ITEM: PL	Hexadecimal	Table 5.4.6
1.72.0	AXIS_ALARMS_ITEM: AZ	Hexadecimal	Table 5.4.7
1.72.1	AXIS_ALARMS_ITEM: EL	Hexadecimal	Table 5.4.7
1.72.2	AXIS_ALARMS_ITEM: PL	Hexadecimal	Table 5.4.7
1.73.0	AXIS_STATE_ITEM: AZ	Unsigned	Table 5.4.5
1.73.1	AXIS_STATE_ITEM: EL	Unsigned	Table 5.4.5

OID	Status Item	Format	Description
1.73.2	AXIS_STATE_ITEM: PL	Unsigned	Table 5.4.5
1.80.0	FEED_INDEX_ITEM	Unsigned	0 – 7
1.81.0	FEED_LNB_INDEX	Unsigned	0 – 2
1.89.0	HPA_ENABLE_ITEM	Unsigned	0=Disabled, 1=Tx Mute, 2=Enabled
1.90.0	SIGNAL_SOURCE_ITEM	Enumeration	Table 5.4.5
1.91.0	SIGNAL_LEVEL_ITEM	Unsigned	0 – 4095
1.92.0	SIGNAL_LOCK_ITEM	Unsigned	0=Off, 1=On, 2=None Defined
1.100.0	TRACK_STATUS_ITEM	Unsigned	Table 5.4.4
1.101.0	TRACK_ERROR_ITEM	Unsigned	Table 5.4.4

The following tables list enumerated values and descriptions for multiple status items.
Only values listed below should be considered valid.

Table 5.4.2 – Enumerated Values and Descriptions

Value (dec)	POS_LOC_SOURCE_ITEM	POS_HDG_SOURCE_ITEM	POS_TILT_SOURCE_ITEM
0	None	None	None
1	GPS	Compass	Auto
2	Manual	Manual Magnetic	Manual
3	Preset	Manual True	Remote
4	Reserved	Heading Fixed	
5	Remote	Auto Fixed	
6		Remote	
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			

Table 5.4.3 – Enumerated Values and Descriptions

Value (dec)	SAT_SOURCE_ITEM	SAT_BAND_ITEM	SAT_POLARIZATION_ITEM
0	None	C	None
1	Manual	Ku	Horizontal
2	Preset	L	Vertical
3	Longitude	X	Right-Hand
4		Ka	Left-Hand
5		S	Neutral
6			
7			

Table 5.4.4 – Enumerated Values and Descriptions

Value (dec)	TRACK_STATUS_ITEM	TRACK_ERROR_ITEM
0	Track Setup Sub-Mode Active	
1	Track Auto Mode Entry	
2	Step Track Sub-Mode Active	
3	Auto Search Sub-Mode Active	
4	Memory Track Sub-Mode Active	
5	Track Error Sub-Mode Active	
6	NORAD Track Sub-Mode Active	
7	Manual Search Sub-Mode Active	
33		Move Jammed Error
34		Move Limit Error
35		Move Drive Error
36		Peak Limit Error
37		Azim Scale Factor Error
38		Track Geo Error
39		Track System Error
40		Track Checksum Error

Table 5.4.5 – Enumerated Values and Descriptions

Value (dec)	ACTIVE_ALARM_ITEM (Version 2.00-2.09)	ACTIVE_ALARM_ITEM (Version 2.10+)	SIGNAL_SOURCE_ITEM	AXIS_STATE_ITEM
0	None	None	None	Idle
1	Flash Version Mismatch	Flash Version Mismatch	Receiver 1 (External)	Coast
2	Flash Data Corrupted	Flash Data Corrupted	Receiver 2 (Internal)	Jog Negative
3	NVRAM Version Mismatch	NVRAM Version Mismatch	Reserved	Jog Positive
4	NVRAM Data Corrupted	NVRAM Data Corrupted	Reserved	Auto Move Config
5	Low Battery	Low Battery	L-Band Power	Auto Move Negative
6	Time/Date Error	Time/Date Error	DVB	Auto Move Positive
7	Azimuth Jammed		Remote	Alarm
8	Azimuth Runaway			
9	Elevation Jammed			
10	Elevation Runaway	Azimuth Jammed		
11	Polarization Jammed	Azimuth Runaway		
12	Polarization Runaway	Reserved		
13	Limits Inactive Warning	Azimuth Sync Warning		
14	Motor Drive Error			
15	Emergency Stop Active			
16	Hand-crank Interlock			
17	Movement Interlock			
20		Elevation Jammed		
21		Elevation Runaway		
22		Reserved		
23		Elevation Sync Warning		
30		Polarization Jammed		
31		Polarization Runaway		
32		Reserved		
33		Polarization Sync Warning		
40		Limits Inactive Warning		
41		Motor Drive Error		
42		Emergency Stop Active		
43		Hand-crank Interlock		
44		Movement Interlock		
45		Local Jog Warning		

The following table lists possible values for the AXIS_LIMITS_ITEM. The hexadecimal value represents a 3-byte bitmask containing limit information. An 'x' indicates a "don't care". Any combination from 000000 to 030303 is possible.

Table 5.4.6 – AXIS_LIMITS_ITEM Mask

Value (hex)	MAX Limit	MIN Limit	STOW Limit
000000	None	None	None
01xxxx	Hard		
02xxxx	Soft		
03xxxx	Both		
xx01xx		Hard	
xx02xx		Soft	
xx03xx		Both	
xxxx01			Hard
xxxx02			Soft
xxxx03			Both

The following table lists possible values for the AXIS_ALARMS_ITEM mask. The hexadecimal value represents a 2-byte bitmask containing axis alarm information. An 'x' indicates a "don't care". Any combination from 0000 to FFFF is possible.

Table 5.4.7 – AXIS_ALARMS_ITEM Mask

Value (hex)	JAMMED	RUNAWAY	DRIVE	OFF-AXIS	HALT
xxx1	Yes				
xxx2		Yes			
xxx4			Yes		
xxx8				Yes	
x1xx					Yes

//