APPENDIX REM - REMOTE CONTROL PROTOCOL

Software Version: 3.00

This appendix describes the remote commands available to monitor and control the RC4000 antenna control unit (ACU). It is provided as a supplement to the baseline RC4000 manual. Sections in the baseline manual are cited where additional information may be found.

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

Revision History

DATE	MODIFICATION	INITIALS
03 MAY 2016	Initial document migrated from remote control protocol version 2.00.	ECG
01 APR 2019	Added NAK reply error codes (Section 3.3). Removed Query Name and Extended Device Status commands. Renamed Read Pulse Count command to Read Count Sensor. Changed format of the following commands/replies: - Device Status - Auto Move - Write/Read Satellite Data - Write/Read Beacon Data - Remote Locate/Track - Write/Read DVB - Write/Read Navigation Data - Write/Read Track Table Added Write Date/Time command. Updated Custom Device Status reply definitions.	ECG
26 APR 2019	Initial release of for ACU version 3.00+.	ECG
01 AUG 2019	Added Write/Read Location Data commands. Change Write/Read Navigation Data to use signed lat/lon values.	ECG
17 SEP 2019	Corrected indexes of Write/Read Beacon Data commands.	ECG
29 NOV 2022	Removed COB fields from Write/Read Satellite Data commands.	ECG

1 Introduction

1.1 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.

1.2 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 contain its address. This prevents bus contention caused by more than one 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.

1.2.1 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.

1.2.2 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 except an ACK (Acknowledge) or NAK (Not Acknowledge) byte replaces the STX at the start of the message. Figure 1 illustrates the format of the command and response messages. A command or reply message may have a variable length.

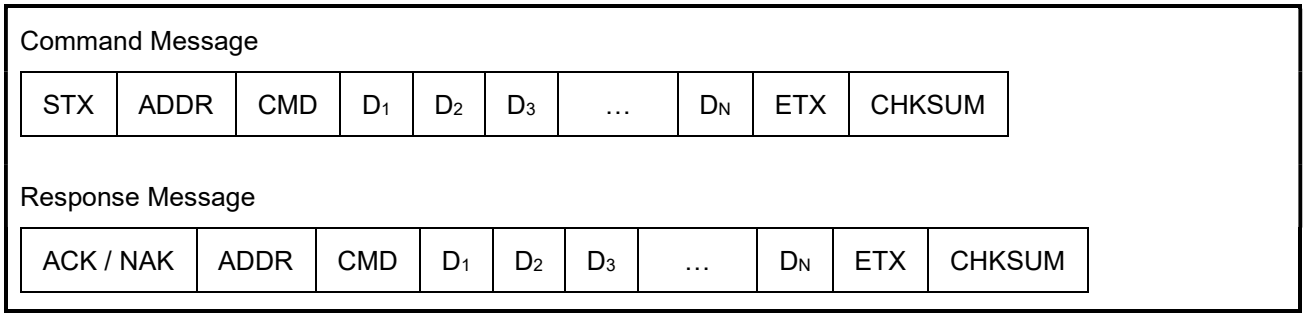

Figure 1 – Message Format

1.2.3 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.

1.2.4 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.

1.2.5 Command Byte

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

1.2.6 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.

1.2.7 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.

NOTE: The NAK or ACK reply does not signify that an operation has taken place; only that the message was received and understood. The user should query the controller later to see if the command is still in progress.

1.3 State Diagram

The state diagram illustrated below presents the implementation of the slave device. Each state that the device can assume is represented by a numbered circle. Transitions between states are represented by an arrow. Each arrow is labeled with the conditions that must be true to move between states.

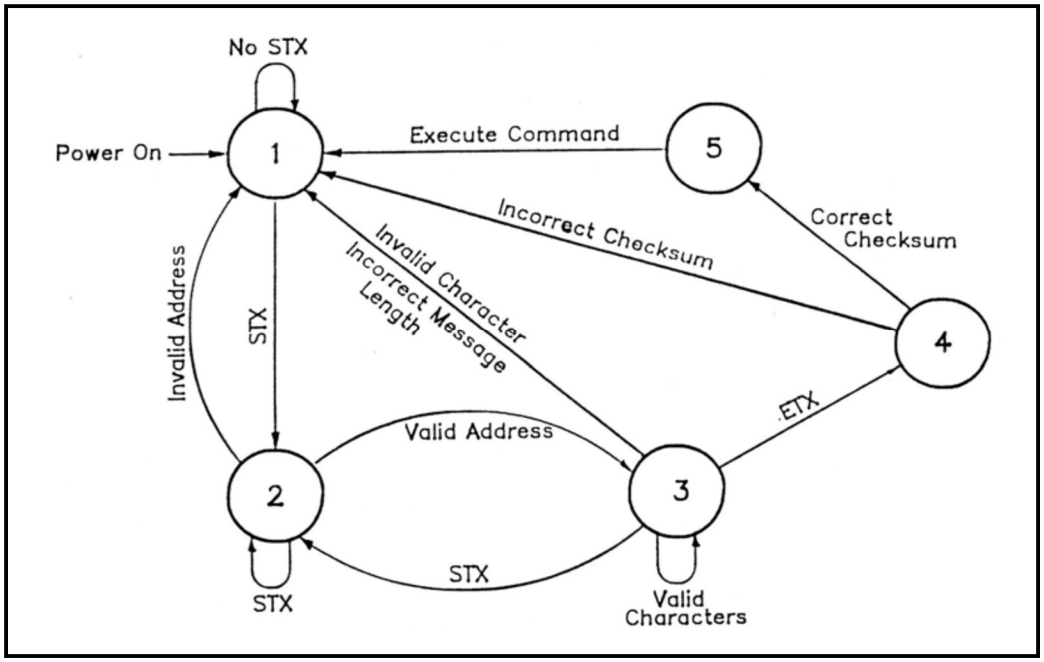

Figure 2 – SA Bus Protocol State Diagram

- 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 byte 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 byte equals the LRC value computed during message reception.
    - State 1 if the received byte does not equal the LRC value computed.
- 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 Configuration

2.1 Electrical Interface

The device can use 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.

2.2 Communications Parameters

When the device is controlled via RS-232 or RS-422, an additional configuration screen allows several parameters to be specified.

```
  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 enable/disable remote control. This may prove useful if the user wants to only operate from the front panel. The default value is enabled.

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

This item allows the user to specify a unique bus address. The default address is 50.

BAUD RATE: **BAUD <1-48 2-96 3-192 4-384 5-560>(x100)**

This item allows the user to choose one of five possible baud rates from 4800 to 56000. The default baud rate is 9600.

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

This item allows the user to select RS232 or RS422/RS485 operation. The default value is RS-232 operation.

3 Detailed Operation

3.1 Online/Offline Reply

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

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

3.2 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	address
byte 2	CC	command code
byte 3	ETX	
byte 4	Checksum	

3.3 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. The NAK reply has the following format:

byte 0	NAK	
byte 1	A	address
byte 2	CC	command code
byte 3	Error	'1' – command not implemented '2' – command length incorrect '3' – local jog connected '4' – illegal parameter
byte 4	ETX	
byte 5	Checksum	

3.4 Command Set

The following table lists the available remote commands. Each command is detailed in the paragraph listed.

Table 1 – Command Set List

CODE (hex)	COMMAND	PARAGRAPH
30	Device Type	3.4.1
31	Device Status	3.4.2
32	Auto Move	3.4.3
33	Azimuth/Elevation/Polarization Jog	3.4.4
34	Polarization	3.4.5
35	Reserved	
36	Miscellaneous	3.4.6
37	Reflect Display	3.4.7
38	Reserved	
39	Write Satellite Data[1]	3.4.8
3A	Read Satellite Data	3.4.9
3B	Write Two-Line Element Data[1]	3.4.10
3C	Read Two-Line Element Data	3.4.11
3D	Write Beacon Data[1]	3.4.12
3E	Read Beacon Data	3.4.13
3F	Read Count Sensor	3.4.14
40	Reserved	
41	Remote Locate	3.4.15
42	Remote Track	3.4.16
43	Write DVB Data[1]	3.4.17
44	Read DVB Data	3.4.18
45	Read Navigation Data	3.4.19
46	Write Navigation Data	3.4.20
47	Azimuth/Elevation/Polarization Jog (with minimal reply)	3.4.21
48	Remote Key Press	3.4.22
49	Write Config Data[1]	3.4.23
4A	Reserved	
4B	Custom Device Status	3.4.24
4C	Reserved	
4D	Write Track Table Data	3.4.25
4E	Read Track Table Data	3.4.26
4F	Write Date/Time	3.4.27
50	Write Location Data[1]	3.4.28
51	Read Location Data	3.4.29
	1 – requires flash save via Write Config Data	
	2 – experimental	

3.4.1 Device Type 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 8-16	Version	The device version number descriptor. The software version in the format: “vA.BB.CCC” Left-justified and padded with blanks.
byte 17	ETX	
byte 18	Checksum	

3.4.2 Device Status Command

This command returns general device 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 response will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	31h	command code
bytes 3-4	Satellite Index	The index of the currently selected satellite. This field will contain ‘**’ if no satellite is selected. Right-justified and padded with blanks.
bytes 5-14	Satellite Name	The name of the currently selected satellite. Left-justified and padded with blanks.

Device Status Command (continued)

byte 15-21	Azimuth Position	+/-200.00 degrees
byte 22-28	Elevation Position	-20.00 to +120.00 degrees
byte 29-35	Polarization Position	+/-100.00 degrees

The current angular position.
+ddd.dd (decimal-degrees format)
Filled with '*' if sensor value is invalid
Right-justified and padded with blanks

byte 36 Azimuth Limits – binary data
byte 37 Elevation Limits – binary data
byte 38 Polarization Limits – binary data

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

Where bits 'A', 'B', and 'C' are defined as:

.

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

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.

byte 39 Feed Type/Polarization 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
01 = Single-Port Rotating Feed Is Present
10 = Dual-Port Rotating Feed Is Present

Where 'YYY' is defined as:

000 = No Polarization Code Displayed
001 = 'h' Polarization Code
010 = 'H' Polarization Code
011 = 'v' Polarization Code
100 = 'V' Polarization Code

Device Status Command (continued)

byte 40 Azimuth Movement/Alarm Status – binary data
byte 41 Elevation Movement/Alarm Status – binary data
byte 42 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
1001 = Sensor Alarm
1010 = Runaway Alarm
1011 = Jammed Alarm
1100 = 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’.

byte 43 Alarm Code – binary data

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

Where ‘AAAAAA’ 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.

0 = No Alarm Active
1 = Flash Version Mismatch
2 = Flash Data Corrupt
3 = NVRAM Version Mismatch
4 = NVRAM Data Corrupt
5 = Low Battery
6 = Invalid Time/Date
10 = Azimuth Sensor
11 = Azimuth Jammed
12 = Azimuth Runaway
16 = Azimuth Sync
20 = Elevation Sensor
21 = Elevation Jammed
22 = Elevation Runaway
26 = Elevation Sync
30 = Polarization Sensor
31 = Polarization Jammed
32 = Polarization Runaway
36 = Polarization Sync
40 = Limits Inactive Warning
41 = Drive System Error
42 = Emergency Stop Active
43 = Maintenance Interlock Active
44 = Movement Interlock Active
45 = Local Jog Connected

Device Status Command (continued)

byte 44 Track Status – 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 = Setup Active
0010 = Recall Active
0011 = Step-Track Active
0100 = Wait Active
0101 = Search Active
0110 = Memory-Track Active
0111 = TLE-Track Active
1001 = ACU Alarm Error
1010 = Checksum Error
1011 = TLE Data Error
1100 = Peak Limit Error

bytes 45-48 AGC Level Current AGC channel voltage
-999 to 5000
This field will contain ‘****’ if level error.
Right-justified and padded with blanks.

byte 49 AGC Channel/Lock Status – binary data

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

Where ‘L’ is defined as:

1 = Lock Indicated
0 = No Lock Indicated

Where ‘CCCC’ 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)

Device Status Command (continued)

byte 50 HPA Relay/Feed ID Status – binary data

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

The bit field ‘AAA’ 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.

Where ‘BB’ is defined as:

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

byte 51 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 (Position 1)	B = 1
	Vertical (Position 2)	C = 1
RF Switch	Path 1	A = 0
	Path 2	A = 1
Polarization Mode	Linear Mode	B = 1
	Circular Mode	C = 1

bytes 52-59 Reserved

byte 60 Current Mode
byte 61 Current State
byte 62 Last Mode
byte 63 Last State

ACU mode and mode state indicators; see section 5.3 for possible values.

byte 64 ETX
byte 65 Checksum

3.4.3 Auto Move Command

This command causes the controller to automatically position the antenna in azimuth, elevation, and polarization. This command has several forms.

Form 1: This form of the command is currently not implemented.

Form 2: With this form of the command, the controller will position the antenna at the azimuth, elevation, and polarization positions specified. The axis mask field controls which axes will move.

This command has the following format:

byte 0	STX		
byte 1	A	address	
byte 2	32h	command code	
byte 3	Form Code	'2'	
byte 4	Sensor	'A' = angular sensor, 'C' = count sensor	
byte 5	Axis Mask	'0' = No Axis	'4' = Pol
		'1' = Azim	'5' = Azim & Pol
		'2' = Elev	'6' = Elev & Pol
		'3' = Azim & Elev	'7' = Azim & Elev & Pol
bytes 6-12	Azimuth Position	+/-200.00 degrees	0 to 65535 counts
bytes 13-19	Elevation Position	-20.00 to 120.00 degrees	0 to 65535 counts
bytes 20-26	Polarization Position	+/-100.00 degrees	0 to 65535 counts
		When using angular sensors: +ddd.dd (decimal-degrees format) Right-justified and padded with blanks	
		When using count sensors: ddddd (unsigned-integer format) Right-justified and padded with blanks	
byte 30	ETX		
byte 31	Checksum		

The ACK reply to this command will be in the same format as the Device Status Command. If the simultaneous drive option is not enabled, the controller will move elevation, azimuth, then polarization. If the command specifies polarization movement but the feed type is set to CIRCULAR, ACK will be received, but no movement will occur. The NAK reply will be received if any parameter is invalid.

Auto Move Command (continued)

Form S: This form is only available on mount types where the antenna system is equipped with a special "fourth axis" of motion.

This command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	32h	command code
byte 3	Form Code	'S'
byte 4	Axis Code	
byte 5	Direction Code	

Where special axis and direction codes are defined as follows:

SPECIAL AXIS	AXIS CODE	DIRECTION CODE
Waveguide	'W'	'H' – Horizontal (Position 1) 'V' – Vertical (Position 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

byte 6	ETX
byte 7	Checksum

The ACK reply to this command will be in the same format as the Device Status Command. If the command generates polarization movement but the feed type is set to CIRCULAR, ACK will be received, but no movement will occur. The NAK reply will be received if any parameter is invalid.

3.4.4 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 are 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. The NAK reply will be received if any parameter is invalid.

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.

3.4.5 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 must 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. The NAK reply will be received if any parameter is invalid.

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

3.4.6 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’ = ‘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 respectively. 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. The NAK reply will be received if any parameter is invalid.

3.4.7 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
bytes 3-42	Row 1	40 characters displayed on row 1 of the LCD
bytes 43-82	Row 2	40 characters displayed on row 2 of the LCD
bytes 83-122	Row 3	40 characters displayed on row 3 of the LCD
bytes 123-162	Row 4	40 characters displayed on row 4 of the LCD
byte 163	Cursor Row	cursor row position (1–4)
bytes 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.

3.4.8 Write Satellite Data Command

This command is used to write preset satellite data into the controller memory. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	39h	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
bytes 5-14	Name	10-characters maximum Left-justified and padded with blanks
bytes 15-20	Longitude	+/-180.0 degrees (West longitude negative) Right-justified and padded with blanks
bytes 21-22	Inclination	0 to 19 degrees Right- justified and padded 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 Skew	+/-90.0 degrees (CCW negative) Right-justified and padded with blanks
byte 30	Polarization	‘H' = Horizontal, 'V' = Vertical, 'X' = None
bytes 31-42	Reserved	
byte 43	ETX	
byte 44	Checksum	

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

NOTE: Data written with this form 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 3.4.23 of this document for more information.

3.4.9 Read Satellite Data Command

This command reads preset satellite data from the controller memory. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	3Ah	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
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
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
bytes 5-14	Name	10-characters maximum Left-justified and padded with blanks
bytes 15-20	Longitude	+/-180.0 degrees (West longitude negative) Right-justified and padded with blanks
bytes 21-22	Inclination	0 to 19 degrees Right-justified and padded 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 Skew	+/-90.0 degrees (CCW negative) Right-justified and padded with blanks
byte 30	Polarization	'H' = Horizontal, 'V' = Vertical, 'X' = None
bytes 31-42	Reserved	Fill with zeros or blanks
byte 43	ETX	
byte 44	Checksum	

3.4.10 Write Two-Line Element Data Command

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

byte 0	STX	
byte 1	A	address
byte 2	3Bh	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
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

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 3.4.23 of this document for more information.

3.4.11 Read Two-Line Element Data Command

This command reads a set of Two-Line Element (TLE) data from the controller memory. The index must be the same as the associated preset satellite index. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	3Ch	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
byte 5	ETX	
byte 6	Checksum	

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	3Ch	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
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	

3.4.12 Write Beacon Data Command

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

byte 0	STX	
byte 1	A	address
byte 2	3Dh	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
bytes 5-12	Frequency	ddddd.dd (decimal MHz) Right-justified and padded with blanks
byte 13	Modulation	0 = CW, 1 = BPSK
bytes 14-22	Reserved	Fill with zeros or blanks
byte 23	Polarization	‘H' = Horizontal, 'V' = Vertical
byte 24	Locate Flag	0 = Do not use this entry 1 = Use as signpost 2 = Use for confirmation only
byte 25	ETX	
byte 26	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 3.4.23 of this document for more information.

3.4.13 Read Beacon Data Command

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

byte 0	STX	
byte 1	A	address
byte 2	3Eh	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
byte 5	ETX	
byte 6	Checksum	

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	3Eh	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
bytes 5-12	Frequency	ddddd.dd (decimal MHz) Right-justified and padded with blanks
byte 13	Modulation	0 = CW, 1 = BPSK
bytes 14-22	Reserved	
byte 23	Polarization	‘H' = Horizontal, 'V' = Vertical
byte 24	Locate Flag	0 = Do not use this entry 1 = Use as signpost 2 = Use for confirmation only
byte 25	ETX	
byte 26	Checksum	

3.4.14 Read Count Sensor Command

This command returns the current pulse or resolver count value for azimuth, elevation, and polarization. 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 3-8	Azimuth Count	0 to 65535
bytes 9-14	Elevation Count	0 to 65535
bytes 15-20	Polarization Count	0 to 65535

Pulse sensor or resolver count value
dddddd (unsigned integer format)
Filled with '*' if sensor value is invalid
Right-justified and padded with blanks

byte 21	ETX	
byte 22	Checksum	

3.4.15 Remote Locate Command

This command requests the ACU to perform a LOCATE operation using the data provided. 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 – binary data	

```
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 5-42
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	Name	10-characters maximum Left-justified and padded with blanks
bytes 15-20	Longitude	+/-180.0 (West longitude negative) Right-justified and padded with blanks
bytes 21-22	Inclination	0 to 19 degrees Right- justified and padded with blanks
byte 23	Band	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
byte 24	Reserved	Fill with zeros or blanks
bytes 25-29	Pol Skew	+/-90.0 degrees (CCW negative) Right-justified and padded with blanks
byte 30	Polarization	‘H' = Horizontal, 'V' = Vertical, 'X' = None This value is ignored if feed type is circular.

Remote Locate Command (continued)

bytes 31-36	COB Latitude	+/-90.0 degrees (South latitude negative) Right-justified and padded with blanks
bytes 37-42	COB Longitude	+/-180.0 degrees (West longitude negative) Right-justified and padded with blanks
byte 43	Position Update	'A' = Automatically determine missing navigation data 'U' = Force an update of all navigation data
byte 44	Signal Source – binary data	

```
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 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 LOCATE operation will be initiated. Progress may be monitored via the Device Status command. NAK implies an error in the supplied satellite data

3.4.16 Remote Track Command

This command requests the ACU to perform a TRACK operation using the data provided.

NOTE: 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 – binary data 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 5-42 01 = use preset data stored in the ACU 10 = use data from the last TRACK 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	Name	10-characters maximum Left-justified and padded with blanks
bytes 15-20	Longitude	+/-180.0 (West longitude negative) Right-justified and padded with blanks
bytes 21-22	Inclination	0 to 19 degrees Right- justified and padded with blanks
byte 23	Band	0 = C, 1 = Ku, 2 = L, 3 = X, 4 = Ka, 5 = S
byte 24	Reserved	Fill with zeros or blanks
bytes 25-29	Pol Skew	+/-90.0 degrees (CCW negative) Right-justified and padded with blanks
byte 30	Reserved	Fill with zeros or blanks

Remote Track Command (continued)

bytes 31-36	COB Latitude	+/-90.0 degrees (South latitude negative) Right-justified and padded with blanks
bytes 37-42	COB Longitude	+/-180.0 degrees (West longitude negative) Right-justified and padded with blanks
byte 43	Position Update	'A' = Automatically determine missing navigation data 'U' = Force an update of all navigation data
byte 44	Signal Source – binary data	

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

Where 'A' is defined as:

0 = use track 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 45	Track Options	0 = recall previous track (if available) 1 = start new track
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. Progress may be monitored via the Device Status command. NAK implies an error in the supplied satellite data

3.4.17 Write DVB Data Command

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

byte 0	STX	
byte 1	A	address
byte 2	43h	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
byte 5	Standard	1= DVB-S1, 2 = DVB-S2
bytes 6-10	Frequency	10700 to 12750 MHz Right-justified and padded with blanks
byte 11-15	Symbol Rate	1000 to 40000 kS/sec Right-justified and padded with blanks
byte 16	FEC	Forward Error Correction 0 = Auto, 1 to 9 = N/N+1 Note: Set to “Auto” for DVB-S2
bytes 17-23	Reserved	Fill with zeros or blanks
byte 24	Polarization	‘H' = Horizontal, 'V' = Vertical
byte 25	Locate Flag	0 = Do not use this entry 1 = Use as signpost 2 = Use for confirmation only
byte 26	ETX	
byte 27	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 3.4.23 of this document for more information.

3.4.18 Read DVB Data Command

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

byte 0	STX	
byte 1	A	address
byte 2	44h	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
byte 5	ETX	
byte 6	Checksum	

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	44h	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
byte 5	Standard	1= DVB-S1, 2 = DVB-S2
bytes 6-10	Frequency	10700 to 12750 MHz Right-justified and padded with blanks
byte 11-15	Symbol Rate	1000 to 40000 kS/sec Right-justified and padded with blanks
byte 16	FEC	Forward Error Correction 0 = Auto, 1 to 9 = N/N+1
bytes 17-23	Reserved	
byte 24	Polarization	‘H' = Horizontal, 'V' = Vertical
byte 25	Locate Flag	0 = Do not use this entry 1 = Use as signpost 2 = Use for confirmation only
byte 26	ETX	
byte 27	Checksum	

3.4.19 Read Navigation Data Command

This command returns 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	
byte 1	A	address
byte 2	45h	command code
byte 3	Latitude/Longitude Source – binary data	

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

Where ‘F’ is defined as:

0 = Lat/Lon formatted as degrees-minute
1 = Lat/Lon formatted as decimal-degrees

Where ‘XXX’ is defined as:

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 4-12	Latitude	+dddmm (degrees-minute format) or +ddd.dddd (decimal-degrees format) +/-90.0 degrees (South latitude negative) Right-justified and padded with blanks Blank if not available
bytes 13-21	Longitude	dddmm (degrees-minute format) or ddd.dddd (decimal-degrees format) +/-180.0 degrees (West longitude negative) Right-justified and padded with blanks Blank if not available
bytes 22-28	Reserved	

Read Navigation Data Command (continued)

byte 29 True Heading Source – binary data

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

Where 'XXX' is defined as:

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 degrees Right-justified and padded with blanks True Heading of mount at azimuth = 0.0
byte 35	Magvar Status	0x41 = ready (calculated) 0x40 = not ready
bytes 36-41	Magnetic Variation	+ddd.d (decimal-degrees format) +/-100.0 degrees (West negative) Right-justified and padded with blanks Blank if not available

byte 42 Platform Tilt Source – binary data

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

Where 'XXX' is defined as:

001 = Currently no tilt data
010 = Automatically determined tilt data
011 = User entered manual tilt data
100 = Remotely entered tilt data

bytes 43-47	Platform Pitch	+dd.d (decimal-degrees format) +/-90.0 degrees (Down negative) Right-justified and padded with blanks Blank if not available
bytes 48-52	Platform Roll	+dd.d (decimal-degrees format) +/-90.0 degrees (CCW negative) Right-justified and padded with blanks Blank if not available
byte 53	Reserved	
byte 54	ETX	
byte 55	Checksum	

3.4.20 Write Navigation Data Command

This command can be used to modify the current values of navigation data. The command has the following format:

byte 0	ACK	
byte 1	A	address
byte 2	46h	command code
byte 3	Update Latitude/Longitude – binary data	
	7 6 5 4 3 2 1 0 0 1 0 0 $ 0 0 X X	
	Where 'XX' is defined as: 00 = Do not change values 01 = Get values from sensor 10 = Use values from fields below	
bytes 4-12	Latitude	+dddmm (degrees-minute format) or +ddd.dddd (decimal-degrees format) +/-90.0 degrees (South latitude negative) Right-justified and padded with blanks Blank if not available
bytes 13-21	Longitude	+dddmm (degrees-minute format) or +ddd.dddd (decimal-degrees format) +/-180.0 degrees (West longitude negative) Right-justified and padded with blanks Blank if not available
bytes 22-28	Reserved	Fill with zeros or blanks

Write Navigation Data Command (continued)

byte 29 Update Heading – binary data

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

Where ‘XX’ is defined as:

00 = Do not change value
01 = Get values from sensor
10 = Use values from fields below

bytes 30-34	True Heading	ddd.d (decimal degrees format) 0.0 to 359.9 degrees Right-justified and padded with blanks True Heading of mount at azimuth = 0.0
byte 35-41	Reserved	Fill with zeros or blanks

byte 42 Update Platform Tilt – binary data

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

Where ‘XX’ is defined as:

00 = Do not change values
01 = Get values from sensor
10 = Use values from fields below

bytes 43-47	Platform Pitch	+dd.d (decimal-degrees format) +/-90.0 degrees (Down negative) Right-justified and padded with blanks
bytes 48-52	Platform Roll	+dd.d (decimal-degrees format) +/-90.0 degrees (CCW negative) Right-justified and padded with blanks
byte 53	Position Update	‘A’ = determine missing navigation data when required ‘U’ = immediately determine missing navigation data (moves antenna if necessary)
byte 54	ETX	
byte 55	Checksum	

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

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

This command jogs the antenna in azimuth, elevation, or polarization. It is functionally the same as the command described in section 3.4.4 but with a much shorter reply.

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 are converted to the closest multiple.
byte 9	ETX	
byte 10	Checksum	

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	47h	command code
byte 3	Axis	The axis that is being jogged: 'A' = Azimuth 'E' = Elevation 'P' = Polarization
bytes 4-10	Axis Position	+ddd.dd (decimal-degrees format) This field will contain '*******' if sensor error. Right-justified and padded with blanks.
byte 11	ETX	
byte 12	Checksum	

3.4.22 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

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

byte 4	ETX
byte 5	Checksum

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

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

3.4.23 Write Config Data Command

This command writes CONFIG item values to the controller 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 several preset satellites, do not 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.

3.4.24 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 5.3 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 5.3 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	

The NAK reply will be received if any OID is invalid or if too many OIDs are requested.

NOTE: The first digit in the OID represents the OID tree version. In the examples above, the version is 1. A discovery process can be performed to determine the version by requesting a single OID…1.0.0, 2.0.0, 3.0.0, and so on…until an ACK is received.

3.4.25 Write Track Table Command

This command is used to manage track table data for a given stored satellite. There are three forms of this command.

NOTE: In general, track table data should not be modified. This command is provided only to allow a track table to be restored if the data has been corrupted or lost.

Form 1: This command is used to modify track table entries. This command has the following format:

byte 0	STX		
byte 1	A	address	
byte 2	4Dh	command code	
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks	
bytes 5-6	Table Entry	0 to 47 Right-justified and padded with blanks	
bytes 7-13	Azimuth Position	+/-200.00 degrees	0 to 65535 counts
bytes 14-20	Elevation Position	-20.00 to 120.00 degrees	0 to 65535 counts
	When using angular sensors: +ddd.dd (decimal-degrees format) Right-justified and padded with blanks		
	When using count sensors: ddddd (unsigned-integer format) Right-justified and padded with blanks		
byte 21	Update Flag	'Y' = set update flag 'N' = clear update flag	
byte 22	ETX		
byte 23	Checksum		

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

Write Track Table Command (continued)

Form 2: This form is used to clear track table entries. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	4Dh	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
bytes 5-6	Table Entry	0 to 47 Right-justified and padded with blanks
bytes 7-21	“CLEAR”	Clear track table data for this entry Left-justified and padded with blanks
byte 22	ETX	
byte 23	Checksum	

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

Form 3: This form is used to clear all track table entries. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	4Dh	command code
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks
bytes 5-21	“CLEAR ALL”	Clear all track table entries Left-justified and padded with blanks
byte 22	ETX	
byte 23	Checksum	

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

3.4.26 Read Track Table Command

This command reads track table data from a given stored satellite. The command has the following format:

byte 0	STX		
byte 1	A	address	
byte 2	4Eh	command code	
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks	
bytes 5-6	Table Entry	0 to 47 Right-justified and padded with blanks	
byte 7	ETX		
byte 8	Checksum		

The ACK reply will be in the following format:

byte 0	ACK		
byte 1	A	address	
byte 2	4Eh	command code	
bytes 3-4	Index	1 to 20 Right-justified and padded with blanks	
bytes 5-6	Table Entry	0 to 47 Right-justified and padded with blanks	
bytes 7-11	Sidereal Time	Sidereal time of this entry	
bytes 12-18	Azimuth Position	+/-200.00 degrees	0 to 65535 counts
bytes 19-25	Elevation Position	-20.00 to 120.00 degrees	0 to 65535 counts
		When using angular sensors: +ddd.dd (decimal-degrees format) This field will contain '-----' if data invalid Right-justified and padded with blanks	
		When using count sensors: ddddd (unsigned-integer format) This field will contain '-----' if data invalid Right-justified and padded with blanks	
byte 26	Update Flag	'Y' = entry update flag is set 'N' = entry update flag is not set	
byte 27	Ephemeris Flag	'0' = ephemeris data not used '1' = ephemeris data used	
byte 28	ETX		
byte 29	Checksum		

3.4.27 Write Date/Time Command

This command sets the date and time of the internal real-time clock. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	4Fh	command code
byte 3	'W'	
byte 4-13	Date	Date formatted as: "YYYY-MM-DD"
byte 14	'T'	
bytes 15-26	Time	Time formatted as: "HH:MM:SS.sss"
byte 27	'Z'	
byte 28	ETX	
byte 29	Checksum	

The reply to this command will be the standard ACK if the date/time is accepted and applied. The NAK reply will be received if any parameter is invalid.

3.4.28 Write Location Data Command

This command is used to write preset location data into the controller memory. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	50h	command code
bytes 3-4	Index	1 to 10 Right-justified and padded with blanks
bytes 5-14	Name	10-characters maximum Left-justified and padded with blanks
bytes 15-23	Latitude	+dddmm (degrees-minute format) or +ddd.dddd (decimal-degrees format) +/-90.0 degrees (South latitude negative) Right-justified and padded with blanks
bytes 24-32	Longitude	+dddmm (degrees-minute format) or +ddd.dddd (decimal-degrees format) +/-180.0 degrees (West longitude negative) Right-justified and padded with blanks
bytes 33-39	Reserved	Fill with zeros or blanks
byte 40	ETX	
byte 41	Checksum	

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

NOTE: Data written with this form 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 3.4.23 of this document for more information.

3.4.29 Read Location Data Command

This command reads preset location data from the controller memory. The command has the following format:

byte 0	STX	
byte 1	A	address
byte 2	51h	command code
bytes 3-4	Index	1 to 10 Right-justified and padded with blanks
byte 5	ETX	
byte 6	Checksum	

The ACK reply will be in the following format:

byte 0	ACK	
byte 1	A	address
byte 2	50h	command code
bytes 3-4	Index	1 to 10 Right-justified and padded with blanks
bytes 5-14	Name	10-characters maximum Left-justified and padded with blanks
bytes 15-23	Latitude	+dddmm (degrees-minute format) or +ddd.dddd (decimal-degrees format) +/-90.0 degrees (South latitude negative) Right-justified and padded with blanks
bytes 24-32	Longitude	+dddmm (degrees-minute format) or +ddd.dddd (decimal-degrees format) +/-180.0 degrees (West longitude negative) Right-justified and padded with blanks
bytes 33-39	Reserved	
byte 40	ETX	
byte 41	Checksum	

4 Troubleshooting

4.1 No Communication Between ACU And Remote-Control Computer

There are numerous situations that could cause no communication:

1) The address set in the ACU 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 ACU.
2) The baud rate set in the ACU 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 ACU 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. Also check the cabling between the ACU and the remote computer.
4) The RS-422 adapter is not compatible with the ACU. Occasionally it has been found that a commercially available RS-422 adapter will just not work with the ACU. 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/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) Do not 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 Reference Information

5.1 ASCII Table

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	

5.2 Device Status Reply Mode and State Values

The following tables list the possible values for ACU modes and states returned by the Device Status reply. All modes can enter the states listed in Table 5.2.2. Additional mode-unique states are listed in Table 5.2.3. Only values shown should be considered valid.

Table 5.2.1 – Operating Modes

Value (hex)	Value (dec)	Mode (byte 60 & 62)
20	32	MANUAL
21	33	MENU
22	34	POSITION
23	35	LOCATION
24	36	HEADING
25	37	LOCATE
26	38	TRACK_ENTRY
27	39	
28	40	TRACK
29	41	
2A	42	SPECIAL_AXIS
2B	43	POWER_UP
2C	44	
2D	45	HEADING_FIX
2E	46	
2F	47	STOW
30	48	DEPLOY
31	49	
32	50	MOVE_TO
33	51	
34	52	
35	53	
36	54	DRIVE_RESET
37	55	
38	56	FLASH_SAVE
39	57	
3A	58	TILT
3B	59	REMOTE_POSITION
3C	60	POSITION_HOLD
3D	61	PEAKUP
3E	62	SHAKE
3F	63	LOCATE_ENTRY

Table 5.2.2 – Common States

Value (hex)	Value (dec)	State (byte 61 & 63)
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_LIMIT
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_ELEV_NOT_IN_POSITION
31	49	ERROR_SPECIAL_AXIS_NOT_IN_POSITION
32	50	ERROR_NOT_AT_STOW
33	51	ERROR_NOT_AT_DEPLOY
34	52	WAITING_FOR_LATLON
35	53	WAITING_FOR_HEADING
36	54	WAITING_FOR_TILT
37	55	ERROR_NO_LATLON
38	56	ERROR_NO_HEADING
39	57	ERROR_NO_TILT
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	ERROR_PULSE_SYNC_FAILED
3F	63	

Table 5.2.3 – Unique Mode States

Value (hex)	Value (dec)	POWER_UP States	MANUAL States	LOCATE States
40	64	CONFIRM_SAVED_POSITION	JOG_AZIM_CCW	ERROR_NO_LAT_LON
41	65	CONFIRM_TRACK_RESTART	JOG_AZIM_CW	ERROR_NO_HEADING
42	66		JOG_ELEV_DOWN	ERROR_NO_SAT_DATA
43	67		JOG_ELEV_UP	ERROR_FEED_BAND_MISMATCH
44	68		JOG_POL_CCW	ERROR_AZIM_RANGE
45	69		JOG_POL_CW	ERROR_ELEV_RANGE
46	70		AUTO_MOVE_POL	ERROR_SAT_PRESET_DATA
47	71		IDLE	WAITING_FOR_MODEM
48	72			
49	73			
4A	74			CALCULATING_POINTING
4B	75			CALCULATING_TLE
4C	76			
4D	77			READY_TO_LOCATE
4E	78			LOCATE_COMPLETE
4F	79			LOCATE_FAILED
50	80			
51	81			
52	82			MOVING_TO_INITIAL_SCAN_POSITION
53	83			ERROR_NO_RF_DETECTED
54	84			DETERMINE_NOISE_FLOOR
55	85			MOVING_TO_SCAN_ELEV
56	86			RESCANNING_WITH_WIDER_RANGE
57	87			
58	88			TUNE_DVB
59	89			TUNE_BEACON
5A	90			TUNE_FAILURE
5B	91			ATTEN_BEACON
5C	92			
5D	93			AZIM_SMOOTH_SCAN
5E	94			AZIM_STEP_SCAN
5F	95			
60	96			
61	97			SAMPLE_AGC
62	98			MOVING_TO_LOCK_CENTER
63	99			MOVING_TO_PEAK_SIGNAL
64	100			MOVING_TO_NOMINAL
65	101			NO_PEAK_FOUND
66	102			SPIRAL_SEARCH_BEGIN
67	103			SPRIAL_SEARCH_MOVING_TO_START
68	104			SPIRAL_SEARCH_MOVING_CW
69	105			SPIRAL_SEARCH_MOVING_UP
6A	106			SPIRAL_SEARCH_MOVING_CCW
6B	107			SPIRAL_SEARCH_MOVING_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

Table 5.2.3 – Unique Mode States (continued)

Value (hex)	Value (dec)	TRACK_ENTRY States	TRACK States	STOW States
40	64	ERROR_SAT_PRESET_DATA	INIT_PARAMETERS	STOW_COMPLETE
41	65	ERROR_NO_LAT_LON	CONFIRM_EXIT	
42	66	ERROR_NO_HEADING		
43	67			
44	68		TUNE_DVB	
45	69	RETURNING_TO_START	TUNE_BEACON	
46	70		TUNE_FAILURE	
47	71		ATTEN_BEACON	
48	72			
49	73		STEP_PEAKING	
4A	74		STEP_WAITING_FOR_SIGNAL	
4B	75		STEP_IDLE	
4C	76		SEARCH_ACTIVE	
4D	77		SEARCH_MOVING_TO_PEAK	
4E	78		SEARCH_WAITING_TO_SEARCH_AGAIN	
4F	79			
50	80			
51	81		MEMORY_IDLE	
52	82		MEMORY_REPOSITION	
53	83		MEMORY_UPDATING	
54	84		MEMORY_CHECKING	
55	85		TLE_IDLE	
56	86		TLE_REPOSITION	
57	87			
58	88			
59	89			
5A	90			
5B	91			
5C	92			
5D	93			
49	73			
4A	74			
4B	75		ERROR_PEAK_LIMIT	
4C	76		ERROR_ACU_ALARM	
4D	77		ERROR_CHECKSUM	
4E	78		ERROR_TLE_DATA	
4F	79		ERROR_UNDEFINED	

5.3 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 5.3.1 – Object IDs

OID	Status Item	Format	Description
x.0.0	CURRENT_MODE_ITEM	Unsigned	See Section 5.2
x.1.0	CURRENT_SUBMODE_ITEM	Unsigned	See Section 5.2
x.2.0	LAST_MODE_ITEM	Unsigned	See Section 5.2
x.3.0	LAST_SUBMODE_ITEM	Unsigned	See Section 5.2
x.5.0	TIMEDATE_ITEM	ASCII String	yyyy-mm-ddThh:mm:ss.fffZ
x.6.0	ACTIVE_ALARM_ITEM	Enumeration	Table 5.3.2
x.7.0	LOCATE_ACTIVE_ITEM	Unsigned	0=Not Done, 1=Done, 2=Good
x.8.0	LOCAL_JOG_CONNECTED_ITEM	Unsigned	0=Not Connected, 1=Connected
x.10.0	POS_SAVED_ITEM	Unsigned	0 = Not Saved, 1=Saved
x.11.0	POS_LOC_SOURCE_ITEM	Enumeration	Table 5.3.3
x.12.0	POS_LOC_LAT_ITEM	Signed	+DDDMM (degrees/minutes)
		Float	+DDD.DDDD (degrees)
x.13.0	POS_LOC_LON_ITEM	Signed	+DDDMM (degrees/minutes)
		Float	+DDD.DDDD (degrees)
x.14.0	POS_LOC_ALT_ITEM (future)	Unsigned	DDDDD (???)
x.15.0	POS_HDG_SOURCE_ITEM	Enumeration	Table 5.3.3
x.16.0	POS_HDG_ITEM	Float	DDD.DD (degrees)
x.17.0	POS_TILT_SOURCE_ITEM	Enumeration	Table 5.3.3
x.18.0	POS_TILT_PITCH_ITEM	Signed	+DD.D (degrees)
x.19.0	POS_TILT_ROLL_ITEM	Signed	+DD.D (degrees)
x.20.0	SAT_SOURCE_ITEM	Enumeration	Table 5.3.4
x.21.0	SAT_INDEX_ITEM	Unsigned	1 – 20
x.22.0	SAT_NAME_ITEM	ASCII String	10 Characters
x.23.0	SAT_LON_ITEM	Float	+DDD.D (degrees)
x.24.0	SAT_INCLIN_ITEM	Signed	+DD (degrees)
x.25.0	SAT_BAND_ITEM	Enumeration	Table 5.3.4
x.26.0	SAT_POL_SKEW_ITEM	Float	+DD.D (degrees)
x.27.0	SAT_EPHEM_ITEM	Unsigned	0=None, 1=TLE
x.28.0	SAT_POLARIZATION_ITEM	Enumeration	Table 5.3.4
x.30.0	TROPO_MODE_ACTIVE_ITEM	Unsigned	0=No, 1=Yes
x.31.0	SITE_SOURCE_ITEM	Enumeration	Table 5.3.4
x.32.0	SITE_INDEX_ITEM	Unsigned	1 – 10
x.33.0	SITE_NAME_ITEM	ASCII String	10 Characters
x.34.0	SITE_LAT_ITEM	Signed	+DDDMM (degrees/minutes)
		Float	+DDD.DDDD (degrees)
x.35.0	SITE_LON_ITEM	Signed	+DDDMM (degrees/minutes)
		Float	+DDD.DDDD (degrees)
x.36.0	SITE_ALT_ITEM (future)	Unsigned	DDDDD (???)
x.40.0	DVB_FREQ_ITEM	Unsigned	DDDDD (Mhz)
x.41.0	DVB_SYMRATE_ITEM	Unsigned	DDDDD (kS/sec)
x.42.0	DVB_FEC_ITEM	Unsigned	1 – 7, (3=3/4)
x.43.0	DVB_STD_ITEM	Unsigned	1=S1, 2=S2
x.50.0	BCN_FREQ_ITEM	Float	DDDDDD.DD (kHz)
x.51.0	BCN_ATTEN_ITEM	Unsigned	DD (dB)
x.52.0	BCN_DEMOD_ITEM	Unsigned	0=CW, 1=BPSK
x.60.0	TARGET_AZ_ITEM	Float	+DDD.D (degrees)
x.61.0	TARGET_EL_ITEM	Float	+DDD.D (degrees)
x.62.0	TARGET_PL_H_ITEM	Float	+DDD.D (degrees)
x.63.0	TARGET_PL_V_ITEM	Float	+DDD.D (degrees)
x.64.0	TARGET_RANGE_ITEM	Unsigned	DDDDDD (miles)

Table 5.3.1 – Object IDs (continued)

OID	Status Item	Format	Description
x.70.0	AXIS_ANGLE_ITEM: AZ	Float	+DDD.D (degrees)
x.70.1	AXIS_ANGLE_ITEM: EL	Float	+DDD.D (degrees)
x.70.2	AXIS_ANGLE_ITEM: PL	Float	+DDD.D (degrees)
x.71.0	AXIS_COUNT_ITEM: AZ	Unsigned	0 – 65535
x.71.1	AXIS_COUNT_ITEM: EL	Unsigned	0 – 65535
x.71.2	AXIS_COUNT_ITEM: PL	Unsigned	0 – 65535
x.72.0	AXIS_LIMITS_ITEM: AZ	Hexadecimal	Table 5.3.7
x.72.1	AXIS_LIMITS_ITEM: EL	Hexadecimal	Table 5.3.7
x.72.2	AXIS_LIMITS_ITEM: PL	Hexadecimal	Table 5.3.7
x.73.0	AXIS_ALARMS_ITEM: AZ	Hexadecimal	Table 5.3.8
x.73.1	AXIS_ALARMS_ITEM: EL	Hexadecimal	Table 5.3.8
x.73.2	AXIS_ALARMS_ITEM: PL	Hexadecimal	Table 5.3.8
x.74.0	AXIS_STATE_ITEM: AZ	Unsigned	Table 5.3.5
x.74.1	AXIS_STATE_ITEM: EL	Unsigned	Table 5.3.5
x.74.2	AXIS_STATE_ITEM: PL	Unsigned	Table 5.3.5
x.80.0	FEED_INDEX_ITEM	Unsigned	0 – 7
x.81.0	FEED_LNB_INDEX	Unsigned	0 – 2
x.89.0	HPA_ENABLE_ITEM	Unsigned	0=Disabled, 1=Tx Mute, 2=Enabled
x.90.0	SIGNAL_SOURCE_ITEM	Enumeration	Table 5.3.5
x.91.0	SIGNAL_LEVEL_ITEM	Signed	+/-4095
x.92.0	SIGNAL_LOCK_ITEM	Unsigned	0=Off, 1=On, 2=None Defined
x.101.0	TRACK_SIDEREAL_TIME_ITEM	Unsigned	0 – 84365
x.102.0	TRACK_STATUS_ITEM	Unsigned	Table 5.3.6
x.103.0	TRACK_ERROR_ITEM	Unsigned	Table 5.3.6

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

Table 5.3.2 – System Alarm Enumerated Values

Value (dec)	ACTIVE_ALARM_ITEM
0	None
1	Flash Version Mismatch
2	Flash Data Corrupted
3	NVRAM Version Mismatch
4	NVRAM Data Corrupted
5	Low Battery
6	Invalid Time/Date
7	Reserved
8	Reserved
9	Reserved
10	Azimuth Sensor
11	Azimuth Jammed
12	Azimuth Runaway
15	Azimuth Sync
20	Elevation Sensor
21	Elevation Jammed
22	Elevation Runaway
25	Elevation Sync
30	Polarization Sensor
31	Polarization Jammed
32	Polarization Runaway
35	Polarization Sync
40	Limits Inactive Warning
41	Drive System Error
42	Emergency Stop Active
43	Maintenance Interlock
44	Movement Interlock
45	Local Jog Connected
46	Summary Limit Warning

Table 5.3.3 – Location, Heading, and Tilt Source Enumerated Values

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	

Table 5.3.4 – Satellite Source, Band, Polarization and Signal Source Enumerated Values

Value (dec)	SAT_SOURCE _ITEM	SAT_BAND _ITEM	SAT_POLARIZATION _ITEM	SITE_SOURCE ITEM
0	None	C	None	None
1	Manual	Ku	Horizontal	Reserved
2	Preset	L	Vertical	Manual
3	Longitude	X	Right-Hand	Preset
4		Ka	Left-Hand	Remote
5		S	Neutral	

Table 5.3.5 – Signal Source and Axis State Enumerated Values

Value (dec)	SIGNAL_SOURCE _ITEM	AXIS_STATE _ITEM
0	None	Idle
1	External	Coast
2	Internal	Jog Negative
3	Reserved	Jog Positive
4	Reserved	Auto Move Config
5	L-Band Power	Auto Move Negative
6	DVB	Auto Move Positive
7	Remote	Alarm
8	Reserved	Off-Target
9	EIRP	
10		

Table 5.3.6 – Track Status and Track Error Enumerated Values

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

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 FFFFFF is possible.

Table 5.3.7 – 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 5.3.8 – AXIS_ALARMS_ITEM Mask

Value (hex)	SENSOR	JAMMED	RUNAWAY	DRIVE	OFF-AXIS	ESTOP	MAINT	INTERLOCK
xxx1	Yes							
xxx2		Yes						
xxx4			Yes					
xxx8				Yes				
xx8x					Yes			
x1xx						Yes		
x2xx							Yes	
x4xx								Yes